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VOL. IV.

JANUARY—DECEMBER, 1867.

THE

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NOS. XXXI. TO XLII.

EDITED BY

HENRY WOODWARD, F.G.S., F.Z.S.

HONORARY MEMBER OF THE GEOLOGICAL SOCIETIES OF GLASGOW AND NORWICH; CORRESPONDING MEMBER OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

ASSISTED BY

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AND

ROBERT ETHERIDGE, F.R.S.E., F.G.S., &c,

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# LIST OF PLATES.



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# LIST OF WOODCUTS.

## MAP.

THE

# GEOLOGICAL MAGAZINE.

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Our numerous correspondents are earnestly requested to make their letters as concise as possible, so as to admit of the insertion of as much and varied information as the space at our disposal will admit.

Our best thanks are due to our Geological friends, not only for their support, but also for their contributions of valuable original articles, of which we have had no lack.

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# GEOLOGICAL MAGAZINE.

No. XXXI.—JANUARY, 1867.

## ORIGINAL ARTICLES.

### I.—On an Old Lake-basin in Shropshire.

By Miss Eyton.

THE district known as the Wealdmoors of Salop is an ancient lake-basin about seven miles in length, by four in width. It lies east of the Wrekin, from which the ground slopes gradually down to it. On the S.E., the high ground of Lilleshall, and its vicinity, rises more abruptly, and on the N.E. extremity it is intersected by the river Tern, which probably formed the principal outlet. The centre of the basin is filled with peat, containing remains of oak and hazel trees, very much decayed, and matted together by thick layers of fibrous roots, and in the lower part, by a species of moss, of which the fibre is too fine for the *Sphagnum*, but which it is impossible to identify, on account of its decayed condition. This peat attains a thickness of about six feet. Some years ago, a bronze celt of fine workmanship, and which is considered to have been manufactured since the commencement of the iron age, was found imbedded in it.

I have already said that the lower part of the basin, from Crudgington to Bigwood quarry, a distance of about three-quarters of a mile, is intersected by the river Tern. At Crudgington, on the right-hand bank of the river, and at about one hundred yards distance from it, is an extensive deposit of low level gravel, which was opened by the Market Drayton Railway Company, but which, after being disturbed to the depth of about ten feet, is now closed. This bed contains three layers, thus,—fine gravel mixed with red sand, about 2ft.; larger pebbles, with yellowish sand, about 2ft. 6in., or 3ft.; pebbles and sand, with clay, depth unknown. This gravel is composed of very mixed materials. Pebbles of granite, quartz, flint, and greenstone, are numerous, as well as fragments of the neighbouring Red Sandstone, and, occasionally, rolled lignite. A granite boulder, several tons in weight, was quarried from it. It is not likely that a small sluggish river like the Tern, even in its older and more powerful days, could have brought together, all these different materials; but upon the hypothesis of a lake, receiving supplies from various sources, and with its waters tending towards one principal outlet, the difficulty is explained. Probably, too, much of this gravel is the remains of an older drift, re-sorted and arranged by the river, since the lake period.

Passing onwards to Bigwood quarry, we find the low shallow valley, through which the river flows, intersected by a bank of New Red Sandstone. And here, I doubt not, was once a fine example of a cliff, cut through by the river; but alas, the hand of the destroyer has been at work, and the face of the cliff is completely quarried away, for building stone, defacing every natural trace. Probably a dam once existed between this point and Crudgington, composed of drift, partially filling up the opening in the sandstone, which might then have been much narrower. The river water being thus pounded back upon the low land, helped to form the lake, and the bursting or gradual wearing away of the dam, to drain it.

Leaving the river, and passing on the inside (that is the lake side) of the bank, we are struck with its curved outline, forming a section of a basin, such as we may often see in the high ground surrounding a recent lake. Following the Market Drayton Railway, we find that it here cuts through a bed of grey mud, such as might have been deposited by a sheet of still water.

Long-lane brick-field is situated seven-eighths of a mile from the river on its left bank, and about eighteen feet above its present level. It consists of two layers, red clay, with numerous pebbles, 4ft.; stiff bluish clay, with rootlets, 5ft. The upper of these layers is composed of much the same materials as the lowest bed of Crudgington drift. Pebbles of flint and granite, both pink and grey, are equally common, with the denuded Red Sandstone, and fragments of Carboniferous limestone, from Lilleshall. I picked up one curious specimen of the latter, containing stems of encrinites, standing up in relief, the limestone having been weathered away between. The blue clay, which I suppose to have formed the original lake bottom, (the pebbly clay having been drifted over it,) contains numerous rootlets, showing that the water must here have been shallow enough, to allow of the growth of bog plants. Underlying the whole is a layer of loose, coarse sand.

I should be inclined to assign a date to this lake about contemporary with the low level drifts. Since that period it must have been gradually filling up, until the ground became firm enough to afford a hold for the roots of forest trees. Then came a later period, when, by the choking-up of the small streams which drained it, probably occasioned by falling trees, it was re-converted into a swamp, from which condition it appears to have been gradually subsiding at the time of the compilation of Doomsday-book. The local designations, often refer to this period, as Kinnersley, (Kinnaird's eye, or island,) Eyton, (Isle town,) &c. Lastly, the period of artificial drainage, which took place within the last hundred years, and has converted it into excellent pasturage, and, in places, arable land.

Note.—Two teeth, believed to be those of *Equus fossils*, have been found in the low-level drift on the margin of the Weald-moors.—C.E.


De Wilde lith. M.&N. Hanhart imp

TO ILLUSTRATE MR A.B. WYNNE'S PAPER ON DENUDATION &c

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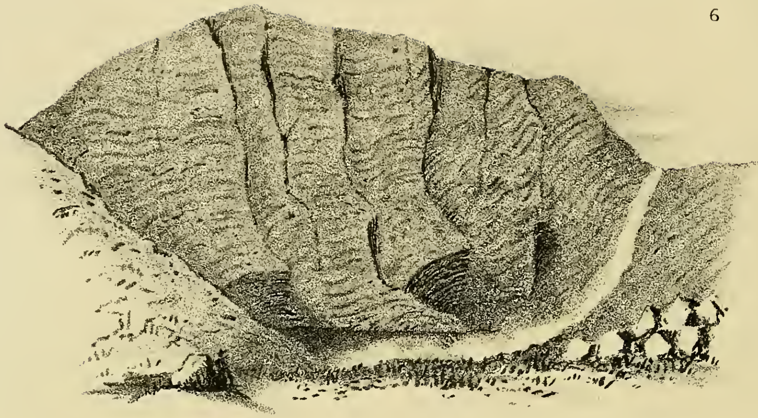

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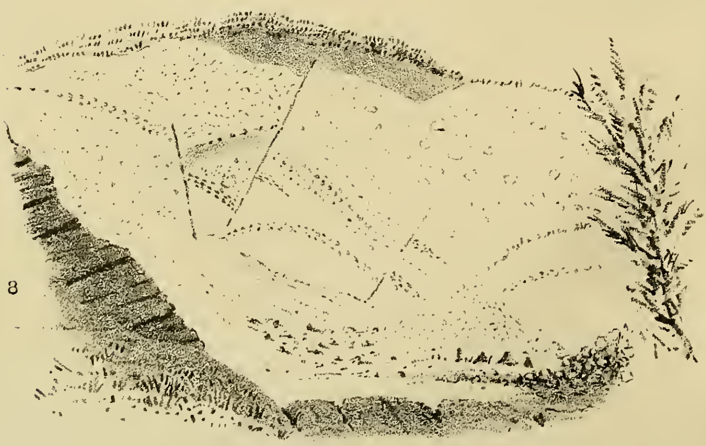

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TO ILLUSTRATE MR A. B. WYNNE'S PAPER ON DENUDATION &c.

## II.—On Denudation with reference to the Configuration of the Ground.

By A. B. Wynne, F.G.S., &c.

(PLATES I. and II.)

*INTRODUCTION.*—The consideration of the subject of Denudation requires so extensive an acquaintance with *Forms of the Ground* in a field large enough to embrace all countries, that general conclusions must be advanced with more or less reserve, in proportion to the extent of our research.

What we know concerning the external features of other worlds throws but little light upon the manner in which those of our earth were formed. From astronomers we learn, indeed, of mountains and valleys in the moon,[1] of more peculiar forms than those commonly occurring upon the earth; and differing from them in their manner of arrangement; but we have here totally different conditions in the supposed absence both of water and atmosphere, while the crater-like aspect of the elevations renders them comparable to but one kind of terrestrial mountains, and that the least connected with denudation. We hear also of great mountains upon some of the planets, those in Venus being supposed to have the enormous height of twenty-two miles.[2] In this case an atmosphere is believed to exist, but whether these mountains have a similarity to those of our satellite, or bear signs of denudation like those of the earth, remains uncertain.

On the earth, however, whether from difference of causes or different developments of some similar agencies, the features, though smaller, are yet of sufficient grandeur, and surrounded by mystery enough to invest with considerable interest enquiries into the methods of their production.

*Denuding Agencies.*—The various features which the land presents are generally understood to have been produced by a comparatively limited number of causes, sometimes simple in their action, but vast in their results; they are principally chemical changes, aqueous denudation, and the action of volcanoes in heaping up mountains of a particular kind. Of these, if denudation, either subærial or marine, be taken as the immediate and principal cause of the configuration of the ground, a more remote but not less necessary agency is to be attributed to forces of elevation and also of depression—having brought different portions of the land within reach of erosive action.

*Antiquity of these Agencies.*—It would be going too far back to speculate upon the probability or otherwise of our planet having ever presented a smooth unbroken surface in every part; enough that at incalculably remote periods land and water existed upon it; that in the water silts, sands and gravels were deposited, and that, therefore, denudation was taking place upon the land to an extent, some idea of which may be arrived at from the great thickness of aqueous formations known to Geology at present.

[1] Geology of the Moon.—Geol. Mag., Vol. iii., p. 141.
[2] Wm. Carter, M.B., Plurality of Worlds.—Quart. Jour. Science, p. 232.

*Differences in features of the ground the result of structure.*—In seeking to discover from the forms of the land, the history of their production, we soon become aware that marked differences in them are connected intimately with differences of geological structure, and that the shapes assumed have a stronger relation to such internal circumstances, than to the external agencies by which the forms have been developed.

The denuding actions in these countries while belonging to either of the kinds, subærial or marine, are complicated by including the operations of ice. It is here manifestly less easy to observe how much of the results are attributable to one kind of denudation or another, than in countries where ice is not believed to have been one of the agencies employed.

Notwithstanding this glaciation, it will be seen that the general effect produced by denudation upon rocks which have common structural peculiarities, such as horizontal stratification, etc., is nearly identical even in widely-distant localities. To take a few illustrations. The nearly flat-bedded and steep-sided hills of millstone grit, near Manchester, the tabular limestone mountains in the north-west of Ireland, the very similarly shaped mountains overlooking Cairo, Suez, and the west coast of the Red Sea, or those forming the scarps of the great Indian trappean table-lands, of which the Western and Malwa Ghâts are examples, show a general uniformity of aspect resulting doubtless from their nearly horizontal bedding. Very different from these are the hill-forms taken by contorted rocks which are as widely similar in their irregularity if in nothing else, while the familiar heavy outlines frequently given by denudation to granitic hills is equally well marked.

Some of these example are taken from a glaciated region, others are exposed to the influences of excessive periodic rains and heat, and others still are situated in what has been called a rainless district; but all are instances of forms produced by denudation, and their relative similarity is but little affected by circumstances of climate.

The valleys excavated out of rocks are even more similar in general characteristics than those hills which have a common geological structure; marked peculiarities being chiefly observed where they may be attributed to peculiar actions, such as that of ice; although there are some valleys whose denudation presents unusual singularity.[1]

Hence it may be assumed that there is a general tendency in rocks to yield upon the large scale certain similar results under the action of denuding forces.

*Cliffs: Subærial and Marine.*—Marine denudation being known to produce cliffs, these, when they occur inland, have been attributed to the former action of the sea; and as it is admitted that most of the land has been frequently beneath the ocean, many inland cliffs must have stood within reach of its denuding influence. But lofty inland cliffs very frequently occur in mountain recesses without such bold

[1] See Prof. Ramsay's paper, on Lake Basins.—Quart. Journ. Geol. Soc. vol. xviii. 1862.

features along more exposed external portions of their neighbourhood, thus reversing the order of things so often observable upon existing coasts.[1] See Plate II. Fig. 6 (Coomassig Cliff, 1100 feet high, forming one side of a glen or coom, near Sneem, Co. Kerry, Ireland).

With regard to the possibly subærial origin of these cliffs, we may remark, that, through the joints by which rocks are traversed, water finds its way more or less vertically downwards, tending to separate masses in this direction which—when deprived of support by springs, streams, ice, or it may be in some cases even by sea waves—naturally fall away, leaving vertical, or approximately vertical, faces of rock behind.[2]

In limestone rocks this action may be specially well observed. The illustration, Plate I. Fig. 4, represents one of many fissures becoming gradually enlarged along the brow of Benbulben mountain in Sligo. At A, a smaller one is beginning to open, another has separated a pinnacle of rock at B, and others have caused landslips and vertical cliffs in many places about this locality. Even clay, drift, or alluvial detritus contains joints or lines of division [see Plate II. Fig. 8, Lines of dislocation or division in drift (sand, clay, and gravel), at Goldengrove, Co. Tipperary, Ireland (see explanation of Sheet 126, Mem. Geol. Surv. Ireland)] ; and although it might be supposed in such homogeneous materials rain channels would always commence gradually, one has only to observe how frequently nullahs at their sources issue from abrupt vertical banks, which sometimes overhang, to see that rain not only acts upon the surface of the ground, but also in some cases at considerable depths, to which it finds its way in the manner above described.

Long lines of inland cliffs, forming terraces above one another, are assumed to have been caused by successive actions of coast denudation. Against this natural conclusion it would be difficult to argue, particularly in the case of countries otherwise known to have been submerged, while the reasoning in favour is strengthened by parallelism of the lines to each other, and sometimes to the plane of the horizon.

Nevertheless some long cliff terraces can be pointed out, like those in the County of Sligo, on Benbulben mountain, (part of which is seen sketched in Plate I. Fig. 5), presenting such an appearance as the cliff-forming strata, being bent into an anticlinal curve, which is *followed* instead of being *intersected* by the line of cliffs, the contrary to what might have been expected if their base had remained for a long period at sea level.

Other peculiarities in limestone cliffs occur, among the Burren hills in Clare, for instance, being equally well marked on all sides of narrow valleys and around nearly circular hills, instead of presenting stronger evidence of exposure to marine erosion on the exteriors of the hill groups, or like many existing islands, at one side than another.

[1] See Mr. Maw's paper.—Geo. Mag., No. 28.

[2] Since the above was written a very similar observation has appeared in a paper upon five types of Earth's surface, in the United States, by Mr. Lesley.

These—together with the absence of continuous terraces on mountains;[1] not formed of horizontal limestone, but lying between these limestone districts, while it may fairly be supposed that all were submerged at the same time,—are points tending to throw doubt upon the marine origin of certain of these cliffs and terraces (the crags and fissures of which abound in evidence to prove the powerful action of rain water): for it can hardly be supposed that the sea had power to form cliff-lines only out of limestone or horizontal strata: the coast of the intervening mountainous country formed of other rocks in various positions, presenting some of the finest examples of sea cliffs along this part of the Atlantic shore.

*Isolated Pillars and Openings.*—We may find instances of isolated rocky pillars upon hills the very aspect of which suggests that the stone is being gradually disintegrated by rain, (such as are represented in Figs. 1 and 2 Plate I),[2] and also along coast-lines where they are as evidently the results of marine denudation (an example being given in Fig. 3, Plate I).[3]

In like localities natural openings may be sometimes found tunnelled through rocks, thus a vacant space allows the light to be seen through the profile of one of the rugged rain-worn hills on the south side of the Great Indian Peninsular Railway, at some distance from the Lanowlee station in the Deccan; and another remarkable instance occurs in the sea cliffs of Innishnabro, one of the Blasket Islands, off the coast of Kerry, where the nearly vertically bedded rocks are pierced by large openings one above the other (Plate II., Fig. 7).

These examples will show, not so much that they are in both cases evidence of marine action, as that either marine or subærial agencies may under certain conditions produce similar forms.

*Subærial Denudation of Limestone, etc.*—Subærial denudation is perhaps most plainly visible upon limestone rocks. At all events its powerful influence upon them cannot be denied, whether observed on cliffs or upon mountain slopes, in the peculiar rain channels with which the rock is sometimes furrowed, in caves and subterranean river courses, or where boulders of different kinds rest upon pedestals of this rock, marking the depth to which surrounding portions of the

[1] My friend, Mr. Kinahan, in his paper, "Notes on some of the Drift in Ireland." —Royal Geol. Soc., Ireland, March 4, 1866—speaks of lines of cliff in the hills of Yar Connaught. The cliffs alluded to are supposed to be of the disconnected kind (of which that at Coomassig is given as an example): their marine origin not being strongly suggested by their appearance, which certainly differs widely from that of the continuous cliffs and terraces in either the Burren or Sligo districts. Their occurrence between certain sets of contour lines related to sea level may be as much a matter of course or of accident as the result of marine action, unless it can be *proved* that the whole country was elevated equally, or at the same rate, with reference to the present horizon.

[2] Fig. 1.—From a trappean hill at Wassid near the foot of the Inclines by which the Gt. Indian Peninsular Railway crosses the Western Ghâts. Fig. 2.—Part of a sketch from the elevated hill station of Matheran, between the Ghâts Proper and Bombay,—(Trap rock).

[3] Fig. 3.—"The Old Man Rock" formed (as well as can be recollected) of Purple Grit. Mouth of Bulls Creek, South-side of Dingle Promontory, Ireland.

latter have been, comparatively recently, removed by the action of rain. Still this atmospheric action is sometimes slighter upon limestone than upon other rocks, as may be witnessed in ruins and old buildings, the masonry of which includes both limestone and sandstone.[1]

Trappean rocks frequently yield to this action more readily than limestone; and even where silicious ones form large masses, local prevalence of joints or alternations of strata may favour the denuding power of the atmosphere.

Almost every rock fragment we pick up is found to be weathered, and if we observe a mountain slope covered with bare shingle, the result of subærial action, we cannot doubt its power to carry on the reduction of the fragments to their ultimate disintegration, or that the vast quantities of alluvium thus produced and left upon lower portions of the surface indicate but partially more extensive operations of this nature. The power of this agency to denude the land being admitted, it follows that the excavation of valleys and formation of hills is only a matter of time.[2]

*Coast Lines.*—Although the sea coast has a certain relation to the form of the land, it may be doubted whether it has any to show that the *surface* of the latter has depended for its shape upon marine denudation. To remove such doubt it must be proved that all parts of the *existing surface* have been successively acted upon by the sea, and consequently that atmospheric influences have not since materially altered its configuration; but this is just the point in dispute among the advocates of marine *versus* subærial denudation, and is certainly far from being proved.

Where deep valleys in a mountainous country open down to the coast the sea enters them, but shows its denuding power most upon the projecting lands between[3]—as might have been expected to occur if the Valleys were produced by atmospheric agencies.

It is hardly necessary to allude to the evidence that the British Isles at no distant geological period had a greater extent; while around the South of Ireland the frequent occurrence of peat below high water mark, even close to the bolder portions of the coast, serves to show that some of the present sea-cliffs can hardly be entirely due

[1] Numerous instances of the slow rate at which even limestone weathers, and therefore the enormous time required to produce results so evident, are familiar to most observers. An inscribed slab of this rock in the interior face of the battlement of a bridge, a couple of miles west of Athlone, although somewhat weathered, distinctly showed in the year 1862, a date 100 years previous. Another limestone slab in a very similar situation, facing the E.S.E., (The Liberty Stone), at Whitehall Bridge, near Limerick, has an inscription, in raised characters, about one-eighth of an inch relieved. The stone is but slightly weathered; the inscription, except in the last figure of the date, is perfect, and the date is 1635. The preservation of glacial striæ upon some smooth surfaces of limestone, indicates a certain variability in amount of subærial action.

[2] The absence of references prevents further allusion here to the subject of valleys which are lower than sea-level or those which being valleys of denudation discharge water over rock barriers at a greater height than that of their interior parts. The glacial origin of these will be found discussed in Professor Ramsay's paper to the Geol. Soc. Lond., Vol. xviii., p. 185.

[3] See "On Watersheds, by Geo. Maw, F.G.S. etc.— Geol. Mag. Vol. III. No. 8, p. 344." and the outline of the S. W. Coast of Ireland.

to the action of recent marine erosion, unless it be admitted that the seas at full tide can cut high cliffs out of hard rocks, and carry away their débris without removing the soft peat which rests near their base.

The part of the Irish Coast reaching from Waterford westward by Mine Head to beyond Youghal Bay presents from the sea a line of cliffs, with some intervals, where valleys open upon it. At the latter place a quantity of peat may be observed between tides along the strand; approaching at one spot within a few yards of the cliffs at the mouth of the River Black-water.[1]

If the coast line here merely coincides with *a portion* of an older one we should expect to find the old sea cliff following inland such contour lines of the ground as would include the present one, but although the ridges of that country frequently have steep sides, there is no inland cliff continuous with that which edges the coast, nor is there any reason to believe in the existence of one concealed by drift. Supposing the coast line now to *coincide entirely* with an earlier one, the land since the latter was produced must have presented a marked range of cliffs, at some unknown distance from the sea, such as is not now to be found at a greater altitude in that neighbourhood, and must subsequently have been depressed almost exactly to the same level which it occupied before the peat was formed, and this without the peat having been washed away during the depression or since it occurred.

Otherwise, if we suppose the denudation of the valleys which open upon this coast to have removed continuations of the older cliffs, either inland or across their mouths, while the formation of the now submarine peat was taking place it follows that this denudation was subærial and unconnected with the sea, thus pointing to the probability that the outlines of coasts are mainly the results of depression, and that their configuration frequently depends upon forms produced by subærial denudation.[2]

[1] The Valley of which is attributed to subærial denudation by Professor Jukes in his able paper and interesting letter, See Quart. Journ. Geol. Soc. Lond., Vol. xviii., and Geological Magazine, Vol. III., No. 5, p. 232.

With reference to the foot note to Mr. Kinahans paper. "On the Rock basin of Lough Corrib," Geological Magazine, Vol. III., (Nov. 1866,) p. 495.—Supposing the morass mentioned to be below high water mark, if a sand bar was thrown up by the sea, the swamps behind it would naturally become a receptacle for peat independently of the prior submergence of other localities. The argument requiring the former existence of sand bars around so much of the bolder coasts of Ireland, hardly explains their wholesale removal, while the supposition of depression would agree with the similar occurrence on the East Coast of England. (See Mr. J. Geikie's paper "On the Forests and Peat Mosses of Scotland. Trans. Rl. Soc., Edin., Vol. xxiv). In the example at Youghal a beach has been thrown up above and resting on the peat, which is said to extend out beneath the bay at low water, and was observed when the tide was very far out, or nearly at its lowest, beneath the sea as far as footing could be obtained.

[2] Among many examples showing somewhat of the rate of erosion effected by the sea, the case of the all but pre-historic Beehive Village of Fahan, in Kerry, may be mentioned—a portion of which remains upon the verge of the sea cliffs at Slea Head: or the tradition that Horse Island has been detached by the sea from Bolus Head in the same county; similar instances, save in the softer nature of the materials removed, are the old Abbey and graveyard encroached upon by the sea at Ballinskelligs Bay,

*Plains.*—The observations of Professor Jukes,[1] that the lesser elevations around a summit decline in altitude as they recede from it, so as to suggest the former existence of a wide, gently-sloping plain, is in uniformity with the fact that the superficial inclinations of ancient ground subsequently became sea bottom, covered by unconformable deposits, often sloping at very low angles ; although in many instances there is reason to assume that peaks and valleys like those of our own time were not absent. We can, however, form but a vague idea as to the shape of the original surface of the ground before the denudation of any particular locality began to take place, because that surface has been removed, and so few land surfaces of any period are known which have not suffered, more or less, from denudation.

The origin of plains is perhaps the greatest difficulty in the question of production of forms by denudation. We can conceive of sea-cliffs being forced into existence by waves, or inland precipices being the result of slow atmospheric agencies ; of gaps being cut in the land and portions isolated by marine action ; and of deep valleys being gradually eroded by ice or rain ; but the production of large plains, irrespective of the kind or stratification of their rocks, is not so easy to realise, perhaps because we do not absolutely see them in process of formation.

Knowing that the sea continually eats away the land, we can imagine that its action, being continued indefinitely upon land *at rest*, would produce some sort of plain ; but it is hard to conceive of this horizontal action upon rock, insoluble in salt water, having no limit ; while if the land were changing its position, slopes would be more likely to result than either cliffs or plains.

Most plains are formed of ground sloping at various low angles (in the case of alluvial flats, even these low angles are concealed by a surface more nearly horizontal), but although the sea seems to be the most likely cause for such an undulating surface, we do not generally find that plains are bordered by old sea-cliffs. It may be said that these could only be expected where an interval of rest took place in the elevation of the land ; yet while this seems reasonable, we must bear in mind that something approaching to such an interval appears to have been requisite for the production of a plain.

We may suppose, if the space between England and Ireland were elevated above sea level, a large but not quite horizontal plain would exist, with marked lines of cliff along each side : the ground would be covered with recent marine deposits—rivers would drain the water off, and yet it would be difficult to say that none of the configuration of the land was due to old subærial denudation, as we know that land beyond the limits of the coast line of Ireland has been submerged.

The old sea-cliffs would mark the passage from lower to steeper

near the latter of the above localities, and the ancient graveyard of Mahim, partly washed away at the northern extremity of Bombay Island.

[1] In his paper " On River Valleys of the South of Ireland." Quart. Journ. Geol. Soc., London, Nov., 1862 (p. 402).

ground, such as we have no examples of around the plains which now occupy so much of the centre of Ireland; but it is, perhaps, hardly fair to speculate as to the entirely marine origin of these plains from the appearances presented where the junction between their old surface and its covering of drift is seen, as we cannot tell how much of these appearances may be due to the action of field-ice or other glacial agencies. However, if we turn to the elevated plateaux of the Deccan in India, they afford even less positive evidence of having been sea-bottoms, in the absence of rolled detritus or wave-worn debris to indicate the approaches to ancient coasts, and yet their character as plains is most strongly marked.

In many cases we are unable to say what the stratified conditions of the rocks beneath such features may be; in many others we find a rough parallelism between the stratification and the surface, and in some instances we have underneath them bedded rocks, both flat and undulating, as well as highly inclined. If any rule exists, it may be indicated by the observation that where plains occur, the rocks, if stratified, are often nearly horizontal; or if inclined and contorted, or of igneous origin, they may have a certain general equality of texture, resulting from a wide extension of one kind of rock, or from a greatly jointed, cleaved or frangible condition, such as would facilitate their destruction by sea-breakers.

It is no new observation that rain seems to act vertically, its tendency always being to produce steep ground where it is not accumulating materials—thus we are obliged, in the absence of anything more likely to produce them, to attribute the formation of plains to the action of the sea.

*Conclusion.*—In concluding these observations it need only be said that the consideration of this subject strengthens the conviction that all the forms of the land cannot be fairly attributed to any one kind of denudation with which we are acquainted:—that the similarity of the *general results* notwithstanding differences in the causes from which they may have proceeded, and their close connexion with geological structure, involves their origin in some obscurity, which may lead to error, if a prejudice exist in favor of either marine or sub-aerial agency, and that while great changes are effected by the endless action of the sea, the equally continuous atmospheric agencies are sufficiently powerful to produce, in the lapse of time, results so enormous, that time also is required for their full appreciation.

## EXPLANATION OF PLATES.

### Plate I.

Fig. 1. Sketch of a Trappean hill at Wassid, near the foot of the Inclines by which the Great Indian Peninsular Railway crosses the Western Ghâts.

2. Part of a Sketch from the elevated hill-station of Matheran, between the Ghâts Proper and Bombay (Trap-rock).

3. "The Old Man Rock," formed (as well as can be recollected) of purple Grit: mouth of Bull's Creek, South side of Dingle Promontory, Ireland.

4. Sketch from the brow of Benluben Mountain, in Sligo. *A.* Fissure beginning to open. *B.* Detached pinnacle of rock.

5. Sketch of part of a long Cliff-terrace on Benluben Mountain, County of Sligo.

PLATE II.

Fig. 6. Coomassig Cliff, 1100 feet high, forming one side of a glen or coom, near Sneem, Co. Kerry, Ireland.

7. Innishnabro, one of the Blasket Islands, off the coast of Kerry. The nearly vertically-bedded rocks are pierced by large openings, one above another.

8. Lines of dislocation or division in Drift, (sand, clay, and gravel,) at Goldengrove, Co. Tipperary, Ireland.—(See Explanation of Sheet 126, Mems. Geol. Survey of Ireland).

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## III.—On the Lower Carboniferous Rocks of North Wales.

By A. H. Green, M.A., F.G.S.

It is well known that, though the Coal Fields of Lancashire and North Wales are now parted from one another at the surface by a broad tract of New Red Sandstone, there is reason to believe that the two are connected underground, and are both parts of one and the same great deposit; and that the beds which in Lancashire and Cheshire dip out of sight below the Red measures, reappear in Flintshire and Denbighshire. Attempts have been made, I believe, to identify the individual coal-beds of the two districts, but I do not know with what success. During a short stay at Llangollen, some years ago, I ventured on a like task for the Lower Carboniferous Rocks, and though the time at my disposal allowed of only scanty observations, these were recorded in my note-book, in hopes that an opportunity might occur of filling in the sketch thus roughly traced out. No such chance has befallen, or seems likely to befall me, and in the hope that the notes I then made may aid some one who, with more leisure, is willing to attempt a full solution of this problem, I now put them forward as a rough approximation.

The beds between the Coal Measures and the Mountain Limestone in North Wales have generally been classed as Millstone Grit, but I must beg leave to draw attention to the fact that this designation is an excessively vague one, the limits of that sub-formation being very differently defined by different authors. We must therefore, before we can have any definite meaning in calling a group of beds Millstone Grit, state whose classification we are following. In the present paper I will use that laid down by the Geological Survey for the Carboniferous Rocks of Lancashire, which is as follows:—

Lower Coal Measures.

| | | |
|---|---|---|
| Millstone Grit. | | First Grit, or "Rough Rock." |
| | | Shale. |
| | | Second Grit, or "Haslingden Flags." |
| | | Shale. ("Brooksbottom beds.") |
| | | Third Grit. (First millstone of some authors.) |
| | | Shale. |
| | | Fourth Grit. (The second millstone of some authors.) |
| Yoredale Rocks. | 1. | Shales. |
| | | Yoredale Grit. |
| | | Shales. |
| | 2. | Yoredale sandstones. |
| | 3. | Black shales with thin earthy limestones. |

Carboniferous or Mountain Limestone.

My wish was to determine whether the above sub-divisions, or any of them, could be recognised among the Lower Carboniferous Rocks of North Wales, and I came to the conclusion that the Millstone Grit is there feebly represented, and that the greater part of these beds is more likely to be the equivalent of a portion of the Yoredale Group.

I hope I shall not be thought guilty of presumption if I *seem* to differ from the eminent geologists who have called the whole of the rocks under consideration Millstone Grit. These authors seem to me to have used that name in a wide and somewhat vague sense, meaning by it, any sandstones which are found between the Coal Measures and the Mountain Limestone; and they would, I have no doubt, have classed as Millstone Grit, the beds which, under the scheme just given, form the two upper divisions of the Yoredale Rocks. The difference is thus, after all, one of words[1] only; and all I can claim is to have endeavoured to give a rather more detailed account of these rocks, and to fix more definitely their place in the geological scale; with what success further research must determine.

The rocks I was able to examine cover a belt of country, about two miles broad, between the Flintshire Coal Field and the Mountain Limestone of the Eglwysegle Rocks, and consist of sandstones parted by beds of shale.

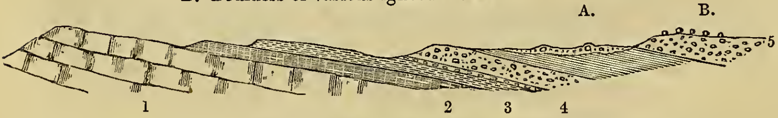
A good section of the lowest beds is seen near Tan-y-Castell, one mile and a quarter north-east of Llangollen. It is figured in the woodcut below, and shews the following beds, in ascending order.

SECTION NO. 1.

MOUNTAIN LIMESTONE.
1. Solid grey limestone.
2. Limestone, thinly bedded, somewhat earthy. Corals and shells in plenty.
3. Flaggy limestone, sandy, and holding here and there many small quartz pebbles. Band of encrinital limestone at the top.

4. Very closely-grained hard sandstone, highly quartzose, with small white quartz pebbles, most likely a calcareous cement, weathers into a honey-combed form.
5. Finely grained, softish sandstone, here and there full of small, white quartz pebbles.

A. Light sandy drift, pebbles of slate and igneous rocks.
B. Boulders of various igneous rocks.




SECTION ACROSS THE EGLWYSEGLE ROCKS, NEAR TAN-Y-CASTELL.

Though not immediately connected with our subject, the gradual passage upwards from the limestone into the sandstones is worth

[1] A recollection of this fact would have saved much needless controversy as to which of the many schemes for the subdivision of the Lower Carboniferous Rocks is most *natural*. All must be alike *artificial* and matter of convenience, for the simple reason that, with local exceptions, the Carboniferous Group is conformable from top to bottom, and so no lines of subdivision have been marked out in it by nature. One scheme may be more handy for certain districts, or more suited to individual taste, than another, but this does not make it more natural.

notice. The upper beds of the former were in places full of small pebbles of white quartz, and the bed (No. 4) seemed at times to pass into a limestone.

The sandstone (No. 4) forms a ridge to the east of the limestone cliffs, and if we follow this northwards for a couple of miles or so we come to a deep valley running down by Tyfynuchaf, along which the rest of the sandstone group is laid open in the brook course, showing us the following beds :—

Section No. 2. (Beds in ascending order.)

1. Sandstone (No. 4) of the former section.
2. Gap, no section.
3. Thinly bedded, shivery, cream-coloured rock, with a smooth marly fracture, *(Productus, Spirifer)*.
4. Gap, no section.
5. Hard, finely-grained, light-coloured grit.
6. Short gap, no section.
7. Hard, grey, sandy shale.
8. Hard finely-grained grit.
9. Black shale, about fifteen feet thick, with a band of earthy limestone containing *Productus*, *Spirifer*, and *Polypora*.
10. Closely-grained grit, some of it coarse.
11. Very coarse, massive, rough grit, and conglomerate, containing much felspar, the decomposition of which makes the rock crumbly.

Coal Measures.
12. Dark shale.
13. Coal, with Ganister floor.
14. Hard closely-grained sandstone.

The thickness of the beds, from No. 1 to 11 inclusive, is shown by the sections of the Geological Survey to be between 800 and 1000 feet.

About three miles east of Llangollen I got a good section of the bed No. 11, and there a coal about 1ft. 6in. thick lay very close on the top of the grit.

These were all the observations I was able to make, and I grant they are scanty enough, but the characters of some of the rocks are so marked that I felt sure I recognised in them some well-known acquaintances of Lancashire and North Staffordshire.

And first, No. 11 has all the distinguishing marks of the Rough Rock of those counties, and it has besides lying upon it a coal which may correspond to the Featheredge Coal of Lancashire. The highly felspathic character of the bed is the guide I trust to most, but besides that there was a likeness not easy to deseribe in words, but perceptible to a practised eye.

I failed, however, to find among the sandstones below this bed anything that bore a resemblance to the lower gritstones of Lancashire; all the grits of the Welsh section, from No. 10 downwards, had a common stamp, were very closely grained, highly quartzose, rung under the hammer, and broke with a clean, bright fracture. In this respect they agree very well with the shape which the Yoredale Sandstones wear in the neighbourhood of Leek and Congleton,[1]

[1] See "Geology of the country round Stockport, Macclesfield, Congleton, and Leek." (Memoirs of the Geological Survey of Great Britain.) p. 17.

and I think they are more likely to be the equivalents of this group, than of any other of the Millstone Grits.

The presence of Mountain Limestone Fossils, and the band of earthy limestone in No. 9, is in favour of the Yoredale affinities of these beds. Such remains and like limestones are common in the lowest, and perhaps occur sparingly in the upper, Yoredale Groups of Lancashire, Staffordshire, Derbyshire, and the West Riding of Yorkshire; but I do not know a single case of any such beds in the Millstone Grit of those districts.

I am inclined to think then, that the Millstone Grit is represented in North Wales by its uppermost member, the Rough Rock, alone: and that all the lower beds have thinned away before we reach Flintshire. This agrees with what we know happens elsewhere to this sub-formation as it is traced southwards.

It also seems that the sandstones underlying the Rough Rock are, in mineral character and fossils, more closely related to the Yoredale than to the Millstone group; and that in many respects they agree very well with the middle division of the Yoredale beds as seen in North Staffordshire.

Valle Crucis Abbey and the bridge at Llangollen are built, I think, of some of these, supposed Yoredale, sandstones: they have stood weather admirably, the carving and tool marks being as fresh as when first cut.

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## IV.—On the Genera of Trilobites *Asaphus* and *Ogygia* and the Sub-genus *Ptychopyge.*

By the late H. Wyatt-Edgell,[1] Esq., 13th Light Infantry.

By the able investigations of Mr. J. W. Salter, the various species of British Trilobites are now being systematically described, and referred to the genera to which they properly belong,[2] the *Asaphidæ* with the rest; but there seems to be still some doubt as to the true differences between *Asaphus* and *Ogygia*. The feature apparently considered distinctive in the masterly work alluded to, is the form of the labrum; which, if furcate, is to be set down to *Asaphus*; if obtusely pointed, to be the distinguishing mark of *Ogygia*. How *Ogygia peltata* (Woodcut, Fig. 5) can be reconciled to this division, I do not see; but the main difficulty in the way of this classification is the sub-genus *Ptychopyge* of Angelin—distinguished by "having the facial suture within the margin in front." This sub-genus Mr. Salter shows to be represented in Britain by *Ogygia Corndensis*, Murchison (Woodcut, Fig. 1): it is called *Asaphus* by Angelin, and has the wide axis, short and broad pleural furrows and simple caudal ribs of that genus. In addition to these features, the course of the facial suture finds a parallel in the sub-genera of *Asaphus*, *Isotelus*, (Dekay) and *Cryptonymus* (Eichwald); Mr. Salter

[1] From a MS. found amongst the author's papers.

[2] See Mr. Salter's monographs on British Trilobites, published by the Palæontographical Society. Part I., 1864; Part II., 1865; Part III., 1866. It is to these two latter parts that this paper specially refers.—Edit.

cites but one species of *Ogygia* that bears resemblance in this respect.[1] Yet with all the stamp of an *Asaphus, Ptychopyge Corndensis* has the obtusely-pointed labrum common to *Ogygia Buchii* and *O. Selwynii.* (See Woodcut, Fig. 2.)

Fig. 2.

Fig. 3.

Fig. 4.

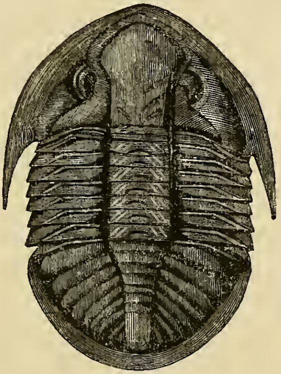

Fig. 1.

Fig. 5.

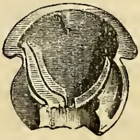

Fig. 1. *Asaphus* (*Ptychopyge*) *Corndensis*, Murch. Llandeilo Flags, Builth. Fig. 2. Labrum of same. Fig. 3. Labrum of *Ogygia scutatrix*, Salter. Fig. 4. Labrum of *Asaphus tyrannus*, Murch. Fig. 5. Labrum of *Ogygia peltata*, Salter. [Drawn from a sketch by the Author, after figures upon Plates XVI., XVII., and XXII., of Mr. Salter's Monograph.]

The question arises whether the form of the labrum is to be considered of such importance as alone to distinguish genera. The fact of the labrum of *Ogygia peltata* (Woodcut, Fig. 5) (which is an unmistakeable *Ogygia*, with narrow axis, remote fulcrum, and duplicate ribs to the tail) not being symmetrical, would make one think that too much stress has been laid on this point. The labrum has two small auricles, and slightly resembles that of *Asaphus tyrannus* (Woodcut, Fig. 4). *Ogygia scutatrix*, so nearly allied to *O. peltata* as to have been formerly confounded with it, has a symmetrical, almost rectangular labrum (Woodcut, Fig. 3). Thus the shape of this organ differs exceedingly in these two very similar forms. It may be added that in *Ogygia Selwynii*, which makes the nearest approach to *Asaphus* of any species of its genus (as here defined), the labrum is obtusely-pointed, though broad; so that, if its form were to be considered a generic distinction, the two last-named species would have to be separated from the first. But no, it is evident that they cannot be—surely we must look to other features to mark the genus; and this being the case, *Ptychopyge* must be separated from it to take its place as *Asaphus.*

Therefore setting aside the labrum altogether, the differences between *Ogygia* and *Asaphus* can be summed up as follows:—

1. *Ogygia* is not generally so convex, and has the fulcrum farther removed from the axis.
2. In it the pleural furrows extend farther, and have the appearance of incisions, not that of broad grooves.

[1] *O. dilatata* Dalman, a foreign species.

3. The tail-ribs are duplicate. This is an essential difference.
4. The axis is, generally speaking, narrower, and its width is nearly the same throughout: in *Asaphus*, the axis of the thorax always greatly exceeds in width that of the tail.

These distinctions will draw a broad line between the two genera, and will separate the British species belonging to them as in the list that follows. There will be no intermediate or doubtful forms, with the exception of *Ogygia? hybrida*,—of which the tail only has been hitherto discovered.

| | | | |
|---|---|---|---|
| ASAPHUS— | (*Basilicus*) | *tyrannus*, Murch. | Llandeilo Flags, Llandeilo. |
| | | *peltastes*, Salter. | Llandeilo Flags, Llandeilo. |
| | | *Powisii*, Murch. | Llandeilo Flags, Anglesea. |
| | | *Marstoni*, Salter. | Caradoc Shale, Horderley, Shropshire. |
| | | *laticostatus*, McCoy. | Llandeilo Flags, Builth. |
| | (?) | *radiatus*, Salter | Caradoc, Rhiwlas, near Bala. |
| | (*Ptychopyge*) | *Corndensis*, Murch. | Llandeilo Flags, Builth. |
| | (*Isotelus*) | *gigas*, Dekay. | Caradoc Rocks, Tyrone. |
| | | *affinis*, McCoy. | Up. Tremadoc Slate, S. of Portmadac. |
| | | *Homfrayi*, Salter. | Up. Tremadoc Slate, near Tremadoc. |
| | (*Brachyaspis*) | *rectifrons*, Portl. | Lower Silurian, Tyrone. |
| | (*Cryptonymus*) | *scutalis*, Salter. | Caradoc, Tyrone. |
| OGYGIA— | | *Buchii*, Brongn. | Llandeilo Flags, Builth. |
| | ,, | var. *convexa* | Llandeilo Flags, Builth. |
| | ,, | var. *angustissima*. | Llandeilo Flags, Builth. |
| | | *scutatatrix*, Salter. | Lr. and Up. Tremadoc and Arenig Group, Tremadoc, Portmadoc, and St. David's. |
| | | *peltata*, Salter. | Arenig Group, St. David's. |
| | | *Selwynii*, Salter. | Arenig Group, Dolgelly. |
| | (?) | *hybrida*, Salter. | Llandeilo Flags?—Carmarthenshire. |

## NOTICES OF MEMOIRS

### I.—ON THE PENTACRINITES OF THE WEST INDIES; WITH SOME REMARKS ON PENTACRINITES AND SEA-LILIES IN GENERAL.[1]

By Dr. CHRISTIAN LÜTKEN, Assistant Zoologist in the Museum of Copenhagen.

Translated from the original Danish, by Dr. GUSTAF LINDSTRÖM, of Wisby, Island of Gotland, Sweden.

IN this very elaborate memoir, the author first describes a new species, *Pentacrinus Mülleri*, and gives an excellent plate of the animal, natural size. He then gives an account of the other Crinoidea (*Pentacrini*, *Holopus*, etc.,) which have been found, or pretended to have been found living, but the knowledge of them seems to be very scanty and unsatisfactory. Next, Dr. Lütken compares the Pentacrini with the genus Alecto, and states, that these genera belong to the same natural family. The nearest allies of the Pentacrini are, nevertheless, the extinct tertiary forms, (the true Pentacrini from the London Clay, and the genera *Isocrinus*, H. v. Meyer, and *Cœnocrinus*, E. Forbes). Of these Dr. Lütken considers the last as

[1] Om Vestindiens Pentacriner med nogle Bemarkninger om Pentacriner og Sölilier i Almindelighed of Dr. Phil. Chr. Lütken. Af Naturhist. Foren. Vidensk. Meddeleser 1864.

undoubtedly a true *Pentacrinus*, and the former only as a slightly deviating sub-genus. The magnificent Pentacrinas of Jura, (*P. briarcus* and *P. subangularis*) differ in a higher degree as in the more branching arms, in the small radiaria, and in the solid plates of the perisoma.

As to the true confines of the family of the Pentacrines, the author thinks them very uncertain, and he also considers the question of the arrangement of all sea-lilies in natural groups, still to be in a highly unsettled state. Some have aranged them in *articulated* and *tesselated*, (Crinoidea articulata and tesselata). Those naturalists who acknowledge the Crinoidea articulata as an independent order, number all species, younger than the palæozoic formations, excepting *Holopus* and *Marsupites*, amongst them. They consider all the Crinoidea tesselata as Palæozoic. But Dr. Lütken thinks this opinion untenable, and it seems to him impossible to draw definite lines between them. "If you take to the definition," he says, "that those Sea-lilies are articulated, which have the radialia of the pelvic cup free, that is, articulated between themselves, not united by seams, . . . . . . it may be answered that the Jurassic *Apiocrinus* has the radialia united by small intercalated interradialia, and the radialia are thus immoveable, and not free." Moreover, the Palæozoic *Taxocrinus* has the radialia quite as free as the Pentacrines, and ought therefore to be ranged amongst the Crinoidea articulata. A satisfactory systematical arrangement of the Crinoidea is, nevertheless, highly desirable, as their forms almost daily increase in number. The author is very right in dwelling on the undue eagerness with which some palæontologists, who, with a very slight knowledge of the living crinoids, create so-called new species, often founded on few and insufficient fragments. Although Dr. Lütken does not yet consider it time to establish a true system of the Crinoidea, he gives what he calls "a guiding thread" through this maze of forms. He then in the first place designates as subordines, (*a*) the *Cystidea*, and (*b*) the *Blastoidea*, in opposition to (*c*) the true *Crinoidea*, and amongst the last, he separates as families, (1) the genus *Holopus* with *Cyathidium*, (2) *Cupressocrinus*, and (3) *Anthocrinus*, (*Crotalocrinus*), both distinguished by the peculiar structure of their arms, (although so widely unlike each other,) and by the absence of "pinnulæ"; perhaps also, (4) *Ctenocrinus*, (5) *Eucalyptocrinus*, so different from all true Crinoids in its whole structure. Then there rests the chief mass, (6) of *all typical Sea-lilies*, and as central or typical genera amongst these may be discerned, I.—*Pentacrinus*, (with *Alecto*, *Millericrinus*, *Taxocrinus*, and *Encrinus*); II.—*Apiocrinus*, (with *Guettardicrinus*); III.—*Platycrinus* and *Actinocrinus*.

The remarks of Dr. Lütken on the sexual organs of the extinct *Crinoidea* are very important. It is undecided whether the living Pentacrinites have a mode of reproduction resembling that of *Alecto*, with the ova and the spermatic fluid enclosed in the pinnulæ of the arms. The specimens of the European Museums have been searched in vain, the pinnulæ are in no way so inflated as in *Alecto*. On the other hand, there is no fact that contradicts the almost generally spread opinion, that the sexual products in all typical Sea-lilies have been lodged in the pinnulæ. In those genera again where these pinnulæ are absent, as in *Anthocrinus* and *Cupressocrinus*, the theory may be so applied that the ova, etc., had their place on the interior surface of the arms, covered by the membranaceous envelope of the arms. Or it may be, that in the last-mentioned genera, the sexual organs were placed in the interior of the pelvic cup, as can be assumed with certainty to have been the case with the *Cystidea* and the *Blastoidea*. In no typical Sea-lily, again, whether recent or fossil, has there ever been seen any opening on the calyx, that could be supposed to be sexual.

Lastly, our author most peremptorily protests against the opinions of some palæontologists, who consider the long tube seen on the apex, or near the apex of the upper side of the calyx, as a proboscidean mouth, or feeding tube. So, for instance, when M. de Koninck says that there is a circular opening on the apex of his *Cyathocrinus*, and that its borders are lengthened to a short tube, or proboscis, which he calls the mouth, and that the anal vent is lateral, Dr. Lütken is of an opinion quite contrary. In the existing Sea-lilies, no zoologist ever found a proboscidean mouth, only a circular vent, but the intestine *always* ends in a short or long proboscidean tube. Even if this tube is situated *near* the centre of the calyx, or *at* it, it does not thence necessarilly follow that it is the mouth. In some of the recent specimens, as *Actinometra*, the mouth is excentric, situated near the margins, and the arms cetnral. "It is the form, and not the place, that must decide if it is the anal-tube, or the mouth." Still, the author grants, that there may be a possible exception in the case of *Marsupiocrinus*, as stated in Siluria, and by Mr. Yandell.

The memoir deserves to be studied by all palæontologists working at these beautiful fossils, its true merits cannot be fully discussed in a short abstract.

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## II.—Verdhandlungen des Bergmännischen Vereins zu Freiburg.[1]

PROFESSOR Scheerer, councillor of mines, completed his remarks "on the Occurrence of Silver at Kongsberg.[2]

The district in which the Kongsberg mines have been worked for nearly 250 years consists of crystalline schists (placed by Kjerulf and Dahll in the oldest known azoic formation); they are mainly micaceous, hornblendic, chloritic, and quartzose schists, besides numerous subordinate varieties, and they appear in beds alternating with one another repeatedly and without any definite order.

The strike of the rock in this district is mainly North and South, and the dip is very steep, and even perpendicular in places. Some of the beds are remarkable for being impregnated with pyrites (iron pyrites, magnetic pyrites, copper pyrites) and still retain their old names of Fall (or Fahl) bands. They are crossed by numerous small veins, seldom more than a few inches wide, which run from East to West, and are filled up mainly with Calc spar, Heavy spar,

[1] Proceedings of the Mining Society of Freiburg, at a meeting held 3rd April, 1866. Extracted from the "Berg-und hüttenmännische Zeitung," 16th July, 1866.

[2] Based on the paper entitled "Betänkning af den ved Kongelig Resolution af 10 Juli, 1865, naadigst nedsatte Commission angaaende Kongsberg Sölvvärk."

Fluor spar, and Quartz; in places, however, these veins contain native Silver in more or less quantity. From the mode of occurrence it was thought possible to lay down the law, *that Silver occurs only where the veins cross Fall bands;* and sometimes this view was distorted into—more or less Silver occurs *everywhere* where veins cross Fall bands. The careful experience of the present day seems to show that the following are the real circumstances of the case:—

The impregnation with pyrites, on which the original idea of a Fall band was founded, is not confined exclusively to one particular bed, nor is it equal throughout one bed. All that can be said is that a certain set of beds, for a considerable length and depth, is irregularly impregnated with pyrites. This set of beds impregnated with pyrites, which we will call a *Fall band zone,* would be the proper extended notion of a Fall band, with the addition that within a Fall band zone, beds of various kinds of schist may alternate with one another. The occurrence of Silver where a vein crosses a Fall band zone, does not depend on the enclosing rock containing pyrites, nor upon its being a certain variety of schist. The above law has to be extended into the fact, that where a *vein crosses a Fall band zone* Silver occurs apparently in a quite irregular manner.

Even this law, based upon experience, must not be accepted without caution, in spite of its being so general. With regard to this, the following questions may be asked:—

*Firstly.*—Is it a well-ascertained fact that the Kongsberg veins contain no Silver outside a Fall band zone?

*Secondly.*—Is it always possible to say, when driving a level, whether one is within a Fall band zone or not? On account of the irregular and often very slight impregnation with pyrites, scarcely or not at all visible, it must be very difficult in many cases to answer this second question, and naturally this renders an answer to the first still more uncertain.

*Thirdly.*—Is it not possible that, besides the Fall band zones visible above ground at day, and worked upon, or supposed to be worked upon, there may exist other Fall band zones underground? Practically this question coincides with the first, and can only be answered by following the veins beyond the borders of a Fall band zone.

By these considerations the miner sees himself deprived of the sure basis of an old rule on which he had relied with confidence for more than two centuries. Let us hope that the loss thus sustained by the theory of veins will be richly compensated for by gain in Silver in ground hitherto considered as barren.

Besides this, in the above-mentioned report there is some further information about the Kongsberg veins, of which the following was specially mentioned:—

In Christian's adit driven as far as the mine, "God's help in time of need," to a length of nearly 2000 fathoms, 251 veins and strings were cut. Of these, 84 (veins) are at least $\frac{3}{4}$-inch thick, 167 (strings) possess a smaller thickness, some only as thick as a sheet of paper. Of the 84 veins, 43 were till then unknown, 31 unexplored at this depth, 10 partly being worked and partly worked out. The adit did not cross any veins which, separately, would entitle one to particular expectations. On account of the very irregular and unequal distribution of the Silver, it must not be inferred that all these veins contain no Silver. Although with regard to their thickness many of the veins may seem of little consequence, still they are important, on account of their continuing most regularly from the surface to the level of the adit, and, indeed, as far down as they have been worked. Where several veins are close together and form a group of veins, the Silver appears to have collected in greatest quantity.—C. L. N. F.

## REVIEWS.

### I.—On the Buried Forests and Peat Mosses of Scotland, and the Changes of Climate which they Indicate. By James Geikie, Esq., of the Geological Survey of Great Britain.

[Communicated by Archibald Geikie, Esq., F.R.S., to the Royal Soc. Edin. Vol. XXIV., Part ii., pp, 363-384.]

THE personal observations of the Author, and those of Prof. Young (Glasgow University), are combined with a mass of recorded and traditionary evidence, to arrive at the geological history of these Mosses, the phenomena connected with which are stated to be three-fold :—

1st. The buried trees and condition of the country at the period of their growth;

2nd. The causes which led to the destruction of those trees;

3rd. The present aspect of the Peat Mosses.

The former abundance of forest trees in these countries (and also in maritime Norway), even in our most northerly islands, where cultivated saplings can but struggle for existence, is thus brought forward.

"Throughout the bleak Orcades and sterile Zetland large trees have at one time found a congenial habitat. Of the main-land it is difficult to say what region has not supported its great forests. The bare flats of Caithness, the storm-swept valleys of the Western Highlands, the desolate moory tracts of Perthshire and the North-eastern counties, the peaty uplands of Peeblesshire and the Borders, and the wilds of Carrick and Galloway, have each treasured up some relic of a bygone age of forests."

From the submergence of peat containing trees, and old forests, around the British Isles, along the coasts of Brittany and Normandy, and the Channel Islands, the author argues a continental condition of these regions attached to the rest of Europe and each other before the deposition of the marine beds of the Drift Formation, when "the climate was still cold enough to nourish glaciers in the higher valleys of our mountains." . . . . "a climate more nearly approaching that of the wooded regions of Canada than to that which characterises Germany at the present time."

With regard to the distribution of the trees, atmospheric conditions and a light gravelly soil are supposed to have favored the growth of the Pine in more elevated positions, while the Oak grew in the Drift Clays and Earths at lower levels; the great conifers of a former period having flourished in the South of England and Ireland, but their native growth being now confined to a limited area in the North of Scotland.

The destruction of the ancient forests by wind, lightning, ice, and the hand of man, is treated of at considerable length,—the fact that the buried trunks frequently lie all one way, in a direction corresponding with that of the prevailing wind, where they occur, being stated, and numerous references to "Rennie's Essays," and other sources of information, being given. "In winter time the trees of the American forests sometimes become so heavily laden with snow and ice that they are borne to the ground by the pressure." "The marks of fire are conspicuous upon the trees of some of our Peat Mosses," and, "besides the evidence of his [man's] hand afforded by the charred wood under peat, we sometimes come upon marks of adze and hatchet."

The condition of the country with regard to its forests anterior to and in the times of the early writers is described from many sources, including Solinus, Ossian, Torfaens, Boethius, Chalmers, Tytler, and Æneas Silvius, and the cutting down of the woods by the Romans and older inhabitants of Britain, with the stringent measures enacted by Scottish Parliaments, from the time of James the First, to preserve them, are noticed. One of the latter, in the reign of James IV., says, "Anent the artikle of greene wood, because that the wood of Scotland is *utterly destroyed*, the unlaw theirof beand sa little: Therefore," etc.; and subsequently, in 1587, an act inflicted the penalty of death upon "whatsoever persone or persones wilfully destroyis and cuttis growand trees and cornes."

Having considered these causes for the disappearance of ancient forests, Mr. Geikie proceeds to give his own view as to the chief agents in the work of destruction, bearing the structural peculiarities of peat in mind, and mentioning them in detail,—from the close compact peat below to that which is less so above it, in which mossy fibres of "*Sphagnum* and its allies" may be detected, long grasses being seen throughout the section, becoming more abundant near the top, where twigs of heather may be observed, the uppermost foot or so being chiefly made up of heather and grasses, and such plants as *Polytrichum.*

The deposition of another variety, under water, the tissue of which has been nearly lost, is stated to occur in flow-bogs, the peat of which is a mere crust overspreading a sheet of water. The origin of the latter kind is considered evident, deposition taking place from what is growing above; but the author admits some difficulty in accounting for that of the former, in which the trees are found. He argues well that the overturning of the timber was not necessary to have produced sufficient drainage obstruction, and consequent moisture, for the growth of the moss, and refers both the decay of the trees and the rapid increase of the moss to climatal changes resulting out of the gradual separation of the islands from the continent.

He then enters upon an interesting description of the succession of different kinds of trees in the peat, showing that over England and Scotland the Oak and Pine occur on the same horizon contemporaneously ; above them a stratum of Birch and Hazel, and if there be a third layer its prevailing wood is Alder, while in Danish Peat Mosses the Pine lies at the bottom, and is succeeded in ascending order by the Oak and Beech.

The very existence of the Peat-mosses is taken to indicate, during the continental period, an atmosphere "moist from excess of vegetation," the moisture being greatly increased during the following insular condition of the country ; and the more extensive occurrence of peat on the west side of Britain, where the rain-fall is greatest, agreeing with this view.

The occurrence of the bones of the great Irish deer and other large animals in old lake hollows, long since filled up with peat, is accounted for by supposing the water to have been covered by a crust of this substance, through which they sank, as might have been the case if these lakes were but partially overgrown, and the animals obliged to resort to them for water when remaining sources were unavailable : in consequence, perhaps, of heavy snows. Others have supposed these local accumulations to have resulted from habits of the animals, which deer of the present day still possess ; and it seems too much to suppose that the crowding together of their remains was entirely caused by their accidentally sinking into natural pit-falls.

Regarding the natural decay of the trees, Mr. Geikie says, "The stems, invested by the wet mosses in their upward growth, gradually rotted away, and were thus ready to yield to the first strong wind : so the destruction proceeded, the mosses ever widening their area, creeping outwards and downwards from the misty hills, and inwards from the storm-swept coasts."

From different portions of the paper, it may be gathered that the author chiefly attributes the death of these forests to natural decay, accounting for the parallel directions in which the trunks lie by supposing them to have *grown inclined* from the wind, and the uniformity in the height of their stumps, which is observed, to result from the Moss having crept around them in the manner described in the last quotation.

An acquaintance with the Irish Peat-bogs favors the idea that these old trees came naturally to their life's end, layer over layer of upright tree-stumps with spreading roots and much intervening peat occurs, and the wind cannot always have been the agent which prostrated the stems, for trees so acted upon, often break high up, or their roots are torn from much better holding ground than yielding peat. Whether the mosses cut the trees across at an even height as suggested, or what did this ;—whether they perished from water having risen around them, or the growth of the peat upwards preserved the bases until the stems decaying downwards reached its level, remains an interesting question, which may or may not be considered solved: but it should be observed that upon Peat-covered uplands in Ireland the "sticks" are often withdrawn from highly-inclined positions, showing, as well as a case cited from the Isle of Man, that they did not always break off and fall flat, perhaps because of want of room.

In the concluding portion of his paper the author contends that from a decrease of moisture the Peat-mosses have not only ceased to spread, but are rapidly disappearing, the influences of rain and frost conspiring to remove them, and that the decay has first taken place upon the continent to the South, gradually extending itself Northwards to these Islands. However this may be with regard to Scotland, it is a conclusion which will hardly apply to the bogs of the Sister Isle, where peat is still admitted to be growing, or cause any fear for the exhaustion of this fuel-supply from natural causes. Nearly all the appearances—such as ragged peat upon hill tops, black bare spots upon the bogs, winding gullies, and "Moss-hags"—pointed to as evidence of the decay and removal of the Peat are to be found there also; but notwithstanding this, we have heard of Mosses growing so high as to shut out the view of distant objects, and have seen land reclaimed from them, by reason of neglect, fast relapsing into their original condition.

The subject of these Peat-mosses is both an important and interesting one, to which we are glad to see attention drawn, by those capable of examining it properly. Curious circumstances connected with certain indentations of bones and horns found in some bogs have been brought forward by Professor Jukes and Dr. Carte in the "Irish Quarterly Journal of Science" within the last few years, where also will be found a paper by H. O'Hara, Esq., C.E., referring to the economic part of the subject, the industrial bearings of which no doubt deserve more consideration than they receive.

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## II.—Royal Geological Society of Cornwall.

THE annual Meeting of this Society was held on the 5th October, at Penzance.

The President, Mr. Charles Fox, gave a long and able address, in which he passed in review the principal topics which are now interesting the Geological world. After mentioning the conflicting opinions concerning the *Eozöon*, he suggested, that this fossil might possibly occur in some of the Cornish serpentines. He then gave an outline of Professor Jukes' ideas, with regard to the Geology of North Devon, and next touched upon the subject of denudation. Upon this question the President seems hardly to have made up his mind, for in one place, he says, that many of our valleys are mainly due to "great lines of faults," and shortly afterwards, apparently recollecting himself, he adds, "Geikie's very able work on the effects of rivers cutting their way across ridges of Silurian and other rocks, should make us cautious in limiting the erosive powers of water." Croll's "ice-cap" theory was next mentioned. Of course the subject of the duration of our coal-fields could not be passed by. Sir

Roderick Murchison's opinions expressed at Nottingham were given at length, and Mr. C. Fox went on to say, and it should be recollected that he has been acquainted with mining all his life, that "no practical ventilation would enable men to work at a depth of 2000 yards." The address concluded with some arguments in opposition to Darwinism, and Grove's *Continuity.*

The first paper was by Mr. W. J. Henwood, F.R.S., F.G.S., "on the Berehaven Mines, near Cork." A short communication followed from Mr. John S. Ellis, F.G.S., in which he expressed his opinion that the hardness and strength of some old Cornish mortar, which he exhibited, were due to the admixture of elvan, a volcanic rock, just as some of the Italian mortar owes its solidity to pozzolana.

The last paper was by Mr. Nicholas Whitley, entitled, "Notes on the contorted strata of Hartland."

This Society, which was instituted in 1814, is so distant, and has apparently done so little of late years, that it is hardly known to some people. Yet on looking through the Transactions, one is struck by the vast accumulation of facts, and capital papers by Mr. Joseph Carne, Mr. John Hawkins, Dr. John Forbes, Dr. Henry Boase, and above all, Mr. W. J. Henwood, who is still engaged in preparing for the press the eighth volume of the Society's Transactions. If this at all resembles the fifth volume, also, entirely written by Mr. Henwood, it will be a master-piece of accurate and careful observation. One feels that it is a great pity that a good Society, which has done so much in its day, should be showing so little sign of active life. To judge from the papers read at the meeting, there can be but few working members of the Society, for there was not a single paper on the Geology of the Duchy, so pre-eminent above most other parts of the kingdom for the advantages it possesses for the study of Geology, presenting as it does, such fine cliff-sections, and affording to the observer the opportunity of studying rocks at a great depth below the surface. The phenomena of mineral veins form an interesting branch of geological study; every day fresh sections are being laid open, new veins or "lodes" are often cut and worked upon.

No doubt the dearth of papers may partly arise from the tardiness of the Society in printing its Transactions, and authors prefer sending their papers to other Societies, where they will sooner appear in print. Now the remedy for this lies partly with the authors themselves, and partly with the Society; for were the number of papers read during the year sufficient to form a respectable pamphlet, say, half as big as an ordinary number of the Quarterly Journal of the Geological Society of London, then the Society need not be afraid of printing and circulating its Transactions at once. But now the answer to reproaches of tardiness is, "If we print a small pamphlet of a dozen or so pages, it will get lost, and when the time comes for binding there will be nothing to bind." The Society cannot expect to have a sufficient supply of papers to form a respectable pamphlet, if it holds but one meeting every year. Quarterly meetings at the very least should be held, and we think that the Society would do well to imitate some of its brethren in the Midland Counties—and indeed, the Antiquarian and Natural History Society of its own town—and institute field-excursions. In the neighbourhood of Penzance, with such interesting geological and mineralogical localities as Botallack, St. Ives, Gurnard's Head, St. Michael's Mount, the Lizard, and others, there is ample material at hand to last for a long time; and then the rail—especially now that the broad-guage is open all the way to Penzance—affords easy means of access to many other parts of Cornwall. Such field-excursions stimulate members to fresh exertions, and bring new members by creating an interest in the Science of Geology, for they show that it does not consist merely in learning the hard names of uncouth reptiles and other fossils, but that much interest is to be derived from observing how nature is acting at the present day, and endeavouring to explain by these means how she has acted in ages long gone by.

It would be unfair, however, to insist too much on the want of interest felt in the Society, when we recollect the really fine museum which is now in course of construction, and will be opened next year. The building does great credit to the Society, and, when completed, will form an additional attraction to the town of Penzance, and the Duchy of Cornwall.

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## III.—NOTES ON BOOKS, ETC.

Herrn K. von Seebach has published a geological sketch of the Island of Bornholm.[1] This island consists largely of crystalline schists, overlain by Silurian rocks, with Trilobites and Brachiopods (*Acrotreta*), the *regio Conocorypharum et Olenorum*, of Angelin; these palæozoic rocks are followed unconformably by the Bornholm Coal-formation, which, from the associated plants (Cycads) and shells, is of Jurassic age, and this is overlain by Cretaceous rocks—Greensand, conglomerate, grey limestone, etc.—with many characteristic Chalk fossils, as *Belemnites mucronatus, Terebratula carnea, Lima Hoperi, Pecten serratus.* Brown coal and Amber are found on the South coast.

An enumeration of fossils, collected in the Limestone at Chicago, Illinois, has been prepared by Professor A. Winchell and Professor O. Maury,[2] and which is considered to be of the age of the Niagara limestone of New York. The total number of species noticed from this locality is eighty-two, of these about forty are new and are fully described, and mostly figured, the work being illustrated by the authors in two lithographic plates. The remaining species have been identified with already published figures, but none of the *Gasteropoda* or *Cephalopoda* have been identified with New York species.

The Second Part of the Palæontology of the Jura and Chalk formation of North-western Germany, by Dr. Schloenbach,[3] has

[1] Zeitschrift der deutschen geolog. Gessellschaft, 1865, p. 338.
[2] Boston Society of Natural History, Vol. i. p. 81.
[3] Beiträge zur Paläontolgie der Jura-und Kreid-formation, 1866.

appeared, the first part having been already noticed in the GEOLOGICAL MAGAZINE.[1] It contains a critical study of the Cretaceous *Brachiopoda,* and is illustrated by three plates; the genera noticed are—*Terebratulina, Lyra, Magas, Morrissia, Argiope* and *Crania;* comprising 23 species with their geological distribution.

Dr. Dupont's researches[2] in the Caverns and Quaternary Deposits along the borders of the Lesse have been attended with much interest. Fourteen caves were discovered. In one of which, the Chaleux cave, about 30,000 flint implements have been exhumed, together with many bones of the Reindeer, Goat, Ox, Horse, Boar, Brown Bear, Fox, Badger, Polecat, Hare, and Water-rat; most of these animals are supposed to have served as food for man.

In another cave, (Trou de la Naulette), the most important discovery was made, human bones (a jaw and cubitus) were found, associated with bones of the Wolf, Arctic Bear, Fox, Badger, Bat, Marmot, Water-Rat, Elephant, (*E. primigenius*), Rhinoceros, Horse, Reindeer, Wild Boar, Chamois, Stag, Sheep, and a Fish. Several of these bones were cut and pierced by man.

The Quaternary deposits are divided into three stages by Dr. Dupont—The upper stage, with *Cervus tarandus;* the middle stage, with *Ursus spleæus*; and the lower stage, with *Elephas primigenius.*[3]

## REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—November 21, 1866.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The following communications were read:—

1. "On marine fossiliferous deposits of Secondary Age in New South Wales." By the Rev. W. B. Clarke, M.A., F.G.S.

In Australia, until the year 1860, the existence of deposits of Secondary age had not been demonstrated, although Sir T. L. Mitchell, in 1846, collected Belemnites and a few other fossils, which are now said to belong to a Lower Secondary formation. Since the year 1860, Secondary fossils have been collected by several explorers, and the author therefore gave a history of their discovery, with lists of the genera and of some of the species found in each locality. His own investigations of the country near the Maranoa River, in Queensland, and the examination of collections sent to him from localities between there and the Flinders River, have led him to the belief that there exist in that area formations ranging from the Trias up to the Cretaceous. Mr. Clarke also stated that the deposits occurring on the eastern and western sides of Australia do not seem to be identical, fossils of the age of the Lias and Inferior Oolite having alone been obtained from the latter.

[1] See Vol. iii., p. 175.

[2] Bullet de l'Acad. Roy de Belgique, 2 me. série tomes xxi and xxii, 1866.

[3] See Description of a visit to the Caverns, etc., of the Valley of the Lesse, by Sir W. Vernon Guise, Bart., and the Rev. W. S. Symonds. GEOL. MAG., Vol. III., No. 30, p. 564.

2. "On the *Madreporaria* of the Infra-lias of South Wales." By P. Martin Duncan, M.B. Lond., Sec. G.S.

Referring first to Mr. Tawney's paper on the Sutton Stone, and his own note on the Corals, appended thereto, as having been the first-fruits of the recent researches on the Infra-lias in South Wales, Dr. Duncan stated that in preparing this communication he had been largely indebted to Mr. Charles Moore for the specimens which he had examined, as well as for a considerable amount of information embodied in the descriptions of the deposits. He then described the strata of Brocastle and Ewenny, giving lists of their fossils, and especially of the new species of *Madreporaria* described in this paper, and illustrated by lithographs prepared for the Palæontographical Society; he then stated his views of their geological position, their relations to, and differences from the zone of *Ammonites Bucklandi* and the strata in France and Luxemburg, which have the same homotaxis, and gave a general view of the distribution of the *Madreporaria* from the Keuper to the zone of *Ammonites Bucklandi.* The chief conclusions were:—(1) that the fossiliferous beds of Sutton, Southerndown, Brocastle, and Ewenny are important members of the series which intervenes between the Trias and the beds containing *Ammonites Bucklandi, Gryphæa incurva, Lima gigantea,* etc., and which have been named the Infra-lias; (2) that the *Mollusca* and certain well-known species of *Madreporaria,* which are grouped together at Brocastle, have similar relations to each other in the Calcaire de Valogne, in the zone of *Ammonites Moreanus* of the Cote d'Or, and in the Gres de Luxemburg; and (3) that the above-mentioned beds in Wales, constituting a coralliferous horizon, are the equivalents of the Upper beds of the French and Luxemburgian Infra-lias.

3. "On some points in the structure of the *Xiphosura,* having reference to their relationship with the *Eurypterida.*" By Henry Woodward, Esq., F.G.S., F.Z.S., of the British Museum.

The author pointed out that Professor M'Coy's tribe, *Pæcilopoda,* was intended to include the *Limuli,* with *Eurypterus, Pterygotus,* and *Belinurus.* Professor Huxley had already shown (in 1859) that this classification was founded upon an erroneous interpretation of the fossils, then (1849) only known in England by extremely fragmentary remains.

The object of this communication was to demonstrate, that, although Professor M'Coy's classification was based on conjecture, rather than upon a minute acquaintance with the anatomy of these extinct forms, yet the subsequent researches of Professors Agassiz, and Hall, in America, Professor Nieszkowski, in Russia, and the independent investigations of Mr. J. W. Salter and the author, in this country, have shown, that a close relationship actually does exist between the *Xiphosura* and the *Eurypterida.*

The author then gave a detailed comparison of the structure of these two divisions, which he proposed to call Sub-orders of Dr. Dana's order *Merostomata.* He also pointed out that the *Xiphosura* were divisible into three genera:—1st, *Belinurus,* Baily, having five freely articulated thoracic segments, and three anchylosed abdominal ones and a telson; 2nd, *Prestwichia*, a new genus, having the thoracic and abdominal segments anchylosed together; and 3rd, *Limulus*, Müller, having a head composed of seven cephalic and one thoracic segments, followed by five coalesced thoracic somites bearing branchiæ, and one or more coalesced apodal abdominal somites, to which is articulated the telson. Although so great a dissimilarity exists between *Pterygotus* and *Limulus*, yet in the genera *Hemiaspis*, *Exapinurus*, and *Pseudoniscus*, we have forms which, in the number of body-rings, are intermediate.

The order *Merostomata* offers a parallel group to the *Decapoda;* the *Eurypterida* representing the *Macrura*, and the *Xiphosura* the *Brachyura*. The author did not, however, intend by this comparison to indicate that *Limulus* was higher in the Crustacean scale than *Pterygotus*, but rather that the former was one of those low, but persistent types, like the *Brachiopoda*, which have remained unchanged through long geological ages, whilst forms capable of further development, like *Pterygotus*, have been modified and disappeared.

December 5, 1866.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The following communications were read:—

1. "A Description of some Echinodermata from the Cretaceous rocks of Sinai." By P. Martin Duncan, M.B., Sec. G.S.

The existence of Cretaceous rocks in the district of Sinai has been surmised for several years; but owing to the scarcity of fossils, they have not been correlated with any of the Asiatic formations. An examination of the Echinodermata collected by the Rev. F. W. Holland from the limestones of Wady Mokatteb and Wady Badera has enabled Dr. Duncan to show their parallelism with the red limestones in South-eastern Arabia, the fossils from which he described in a former paper. All the species not determined are well-known forms, characteristics of the typical Upper Greensand of Europe; but those formerly described from Sinai by MM. Desor and D'Orbigny seem to be peculiar to that region. The author observed that by adding the Echinodermata from Sinai to those from South-east Arabia, we obtain a fauna eminently characteristic of the Middle Cretaceous period; and in conclusion he drew attention to the interesting fact that the majority of the wide-wandering Echinoderms had a tendency to vary from their types both in Europe and in Arabia, while the rest remained persistent in form.

2. "Geological Description of the First Cataract, Upper Egypt." By J. C. Hawkshaw, Esq., F.G.S.

At the first cataract the Nile flows over crystalline rocks consisting principally of quartz, felspar, and hornblende, combined in various proportions, and then appearing under the forms of syenite, greenstone, hornblende, and mica-schists, or else occurring in separate masses. In the bed of the river the surface of the harder portions of these rocks is beautifully polished. The whole district is traversed by dykes of greenstone, of which the prevailing direction is E. and W.

The crystalline rocks forming the bed of the river are overlain by a sandstone, sometimes coarse and gritty, and at other times fine-grained and compact. The prevailing colour is light-yellow, but in places it is dark-purple and even black, owing to the presence of iron. As yet no organic remains have been discovered in it. This sandstone rests on the uneven surface of the syenite in slightly inclined strata, dipping N.N.E. It is nowhere altered at its junction with the syenite, nor is it anywhere penetrated by dykes.

To the eastward of the first cataract is a wide valley, commencing opposite the Island of Philæ, and joining the Nile valley again about three miles below Assouan. Through this valley the Nile may have formerly flowed, as freshwater shells and deposits of Nile-mud are found at a considerable height above the present level of the river.

To the westward of the first cataract the crystalline rocks disappear below the sandstone, and the country is almost entirely covered with sand of a rich yellow colour, composed of fine rounded grains of quartz.

3. "On the Drift of the North of England." By J. Curry, Esq. Communicated by the Assistant-Secretary.

Having first given a general sketch of the district under consideration, and noticed the various rock-formations occurring therein, the author described in detail the distribution of the drift, showing that the prevailing direction in which it had been carried was from north-west to south-east, with certain variations, dependent upon the configuration of the land. He then described the wide distribution of Shap-fell granite, especially referring to its occurrence in radial lines from the granitic mass, and called attention to the fact that detritus of various rocks in the vicinity of the lakes has been carried over the Stainmore ridge into the valley of the Tees. Mr. Curry then described the occurrence of drift along the western slope of the Pennine chain, and from Castle Carrock across the northern end of that chain, as well as in the valleys of the Tyne and the Tees, pointing out also the absence of drift from Alston Moor and Upper Teesdale, and down the valley of Wear to the city of Durham. In conclusion the author discussed the manner in which the drift-materials had been transported, referring it chiefly to marine operations on ancient shore-lines at various altitudes; and in explanation of the fact that the upper limit of the drift is not at a uniform elevation, he suggested that it may in great measure be due to a variation in the volume of the ocean instead of to elevations and depressions of the earth's crust.

II.—Norwich Geological Society.—On October 2nd, 1866, the Monthly meeting of the above Society was held in the Museum. In the absence of the President, the chair was occupied by T. G. Bayfield, Esq. The principal subject of the evening was a communication made by C. B. Rose, Esq., F.G.S., "On the Cretaceous Groups of Norfolk and Kent," illustrated by a section through West Norfolk, and by specimens of the Sandstones and Fossils.

Mr. Rose commenced by stating that he had recently visited Folkstone and Hythe, and had there examined the Chalk-marl and Upper and Lower Greensands, and he thought that a comparative view of the Norfolk and Kentish beds might be interesting as well as instructive to the members assembled.

The Cretaceous group includes the Upper and Lower Chalk, Chalk-marl, Upper Greensand, Gault, and Lower Greensand.

The late Mr. Woodward, in his "Outline of the Geology of Norfolk," 1833, divided the Chalk with flints in Norfolk into Upper and Medial, which Mr. Rose considered a legitimate division, justified by characteristic fossils.

The Upper Chalk has a soft texture, and its characteristic fossils are *Belemnitella mucronata* and *lanceolata*, very abundant; *Cardiaster granulosus*, *Ananchytes ovatus*, some peculiar *Ammonites*, and large, "Paramoudra," or "Pot-stones," as they are called, so familiar to people in the neighbourhood of Norwich. The *Ananchytes* is, indeed, common to both the Upper and Medial Chalk, but it nowhere reaches such a size, or is so abundant as in the Upper Chalk, proving that the most favourable circumstances to its development then existed. One or two species only of *Inocerami* are peculiar to the Upper Chalk.

The Medial Chalk is harder than the Upper; *Ammonites* and *Belemnites* are very rare in it; *Inocerami* exceedingly abundant, there being no fewer than nine species; the rare *Cardiaster excentricus* is here met with. Mr. Rose remarked that geologists sometimes stumbled upon *colonies* of certain fossils, and this *Cardiaster* is an instance of the kind, which occurred to him in the parish of Swaffham, not having met with a specimen since; equally scarce is *Cardiaster rostratus*, Mr. Rose possessing but two specimens,—locality, Litcham.

The Lower Chalk is so hard that it is used for building purposes; *Ammonites* are tolerably plentiful in it, such as *A. peramplus*, *A. Austeni*, *A. Mantelli*, etc.; these, with *Belemnitella plena*, may be considered characteristic; as also the following, *Echinidæ*, *Discoidea cyclindrica* and *subucula*, *Holaster trecensis*, found in one locality only. *Inoceramus mytiloides* is confined to this stratum. The Chalk-marl is slightly gray in colour, and arenaceous. It may be seen at West Dereham, near the Church, and at Hunstanton cliff; at the latter place it is well marked by a great abundance of fragments of an *Inoceramus*. *Turrilites tuberculatus* and *Pecten Beaveri* are characteristic of this bed.

Of the Upper Greensand, Mr. Rose said, if there be a special bed at the *outcrop* of the Cretaceous strata at Hunstanton, judging zoologically, and from position, it is found in the white and red *zoophitic* beds—those containing the *Madrepora paradoxica* (*Syphonia* of Woodward). The Gault in Norfolk occurs as the usual blue clay, and as a red limestone at Hunstanton, viz., the *lower* division of the red beds in the cliff. At West Dereham, Pentney, and Gayton, where the blue clay obtains, the small *Belemnites* with *Dentalium ellipticum*, and *Ammonites dentatus*, are characteristic. At Hunstanton, *Ammonites dentatus*, *A. lautus*, *A. tuberculatus*, and others, also *Inoceramus sulcatus*, with the small *Belemnites*, determine this Lower Red bed to be the representative of the Gault of Cambridge and Folkestone.

The Lower Greensand at Hunstanton cliff is clearly divisible into two kinds—a friable ferruginous sandstone, and a hard conglomerate. At Bilney, between Swaffham and Lynn, *three* varieties are distinguishable—1st, a brown tabular sandstone; 2, a *green* clay; 3, a brown Carstone in large rhomboidal blocks. In Norfolk the Lower Greensand rock is provincially called "Carstone;" organic remains are very sparsely distributed through it. At Downham, *Trigonia alæformis* and *T. clavellata* are met with in a bed of ferruginous sand; at Dersingham-heath, *Nautilus radiatus*, a *Thetis*, and a *Natica*, similar to those found in the Lower Greensand of the Isle of Wight; at Hunstanton, *Ammonites Deshayesii*, and a *Syphonia* in fragments, are found.

Mr. Rose next called attention to the Cretaceous group in Kent, contrasting the physical characters of the Chalk-marl and Upper Greensand of Folkestone with that of Norfolk; the Chalk-marl of Kent being of an *ash-gray* colour, and the Upper Greensand of a still darker gray, the Upper Greensand in Norfolk appearing as a white and red limestone.

The Author adverted to the transition of the red bed of Hunstanton into the blue Gault clay in its *strike* southwards at Leziate, from whence it continues entirely blue to West Dereham.[1]

The Lower Greensand of Folkestone is very calcareous. Dr. Fitton divided it into a series of three beds, the middle bed of which "abounds in green matter, and is retentive of moisture." On comparing these with the *three* beds at Bilney, previously mentioned, Mr. Rose was of opinion that only the three upper beds of the Lower Greensand of Folkestone are represented in Norfolk.

The inferior beds of the Lower Greensand at Hythe possess the character of a greenish coloured limestone, which is sufficiently calcareous to burn into lime, and abound in organic remains.

In conclusion, the author observed that a person acquainted with the Norfolk strata only, would be at a loss to recognise those in Kent as rocks of the same era. He therefore laid it down as advisable not only to employ Dr. Wm. Smith's mode of identification of strata by their organic remains, but also to call in the aid of *position* in the series of formations; for example, when a stratum contains fossils common to two or three other strata—the *lower* red bed in Hunstanton cliff being a case in point—then its proper place in the series must be decided by its relative position.

A cordial vote of thanks was passed to Mr. Rose for his very instructive paper.

[1] The Artesian well-boring at Messrs. Colman's Works, Carrow, Norwich, after passing through the chalk, struck a *blue* clay, containing *Inoceramus sulcatus*, *Belemnites minimus*, and other Gault fossils.—*Edit.*

## BRITISH ASSOCIATION REPORTS.

### SECTION C., GEOLOGY.

### I.—Report on Dredging among the Hebrides.

By J. Gwyn Jeffreys, F.R.S., F.G.S., etc.

THIS exploration lasted nearly two months—namely, from the 24th of May to 14th July, 1866. Although its main interest is of a zoological nature, yet, in some respects, it has so important a geological bearing that we should be wanting in our duty to our readers if we allowed it to pass by unnoticed. The following extracts illustrate the advantages to be derived by geologists from a careful examination of recent marine areas in investigating the conditions under which the successive fossil fauna of our island existed in remote periods of time.

"Some of our most conspicuous and prized shells, that are also of a northern type, are wanting in the Hebrides. *Saxicava Norvegica, Natica Grœnlandica, Buccinum Humphreysianum, Buccinopsis Dalei, Fusus Norvegicus, F. Tutroni,* and *F. Berniciensis* are in this category. All the above (with the exception of *Buccinum Humphreysianum,* which inhabits Shetland and the coasts of County Cork) are met with on the Dogger Bank; and the first two are fossil in the Clyde beds. Six out of the seven being univalves, I would venture to surmise that their non-existence in the western seas of Scotland may have arisen from the circumstance that the diffusion of univalves is slower than that of bivalves. The spawn of the former is attached to the spot where it is shed, or in a few cases (eg. *Capulus* and *Calyptrœa*) it is hatched within the shell of its sedentary parent; so that the fry forms a colony, and need not roam to any distance, provided it has a sufficient supply of food and other requisites of habitability. Not so with bivalves. These shed their ova into the water, or else (as in some of the *Kellia* family) hatch them within the folds of the mantle, whence they are excluded on arriving at maturity. Their fry swim freely and rapidly by numerous encircling cilia. The metamorphic state lasts many hours. During that period they can voluntarily traverse considerable distances, or they may be involuntarily transported by tidal and oceanic currents. Time is the only element necessary for their widest dispersion over the adjacent seas, where no barrier intervenes. Should, however, such an obstacle present itself, whether in the shape of previously-existing dry land—like that which separates the North Sea from the Atlantic—or from an upheaval and drying up of the neighbouring sea-bed by geological or cosmical causes, the further diffusion of any marine animals in that direction must necessarily be stopped. An opposite result would, doubtless, be produced by a sinking and submersion of dry land below the level of the sea, whereby the diffusion of such animals would be greatly facilitated. This appears to have been the fluctuating course of events since the formation of the Coralline Crag, which was probably the cradle or starting point of our molluscan fauna—a period long antecedent to the last Glacial epoch, and incalculably far beyond the advent of man, unless his origin is much more remote than it is at present supposed to be. I am not inclined to attribute the northern character of some of the Hebridean mollusca to the persistence of what have been called "Boreal outliers." The idea savours more of poetry than of philosophy or fact. The boreal or truly arctic species which once flourished in this district have become quite extinct, probably in consequence of one of those revolutions above suggested, by which the sea-bed was converted into dry land. These boreal species consist chiefly of *Rhynchonella psittacea, Pecten Islandicus, Astarte crebricostata* or *depressa, Tellina calcaria, Mya truncata,* var. *Uddevallensis, Trochus cinereus,* and *Athyris Holbollii;* and I have lately, as well as on a former occasion, dredged them on the coasts of Syke and West Ross, at depths of from 30 to 60 fathoms, or 180–360 feet. They had a semi-fossilized appearance. Not one of the above-named species has ever, to the best of my knowledge and belief, been found in a living or recent state in any part of the British seas. All of them occur in Post-tertiary or Quaternary deposits on the west coast of Scotland, from a few feet above high water mark[1] to 320 feet above the present level of the sea.[2] The greatest subaerial height (320 feet) being added to the greatest submarine depths, as above (360 feet), gives an extent of elevation and subsidence equal to 680 feet. But as *Pecten Islandicus*, for example, now inhabits the arctic ocean at depths varying from 5 to 150 fathoms, let us take the average of these depths—viz., 77½ fathoms, or 465 feet, and add it to the 680 feet. This would make 1145 feet, and probably represent the height at which the sea-level might be supposed to have stood when *P. Islandicus* lived on the highest fossiliferous spot, noticed by Mr. Watson. The non-fossiliferous Boulder-clay, indicating the simultaneous presence of arctic land, which was also subject to glacial conditions, is stated by Mr. Watson[3] to be about 800 feet higher than the marine deposit. The height of the layer of sea-shells on Moel Tryfaen, in Carnarvonshire (evidently the remains of an ancient beach) exceeds that of the similar deposits at Cardigan by more than 1300 feet; and the difference of height observed in the case of other fossiliferous deposits in the north of England (*e.g.* Manchester and Kelsey Hill) shows that the disturbing movement has been unequal and probably not synchronous over the same area. It would seem that the extent of such oscillation has not altogether amounted to 2000 feet in the British Isles, taking Moel Tryfæn as the greatest height, and the Shetland sea-bed as the greatest depth, at which quaternary shells of recent species occur. The Scotch and Irish deposits, however, are on the whole far more ancient than those of Wales and England, judging from their geographical nature; the former are chiefly arctic, and the latter merely northern. Whether other parts of the North Atlantic sea-bed have

[1] British Association Report, 1862, Trans. Sect. p. 73; Jeffreys on an Ancient Sea-bed and Beach near Fort William, Inverness-shire.

[2] Transactions of the Royal Society of Edinburgh, 1864, p. 526; Rev. R. B. Watson on the Great Drift-beds with Shells in the South of Arran.

[3] *l.c.* pp. 524.

undergone a much greater change of level since the Tertiary epoch, is not so well established. Dr. G. C. Wallich, in his admirable and philosophical treatise[1]—with which all marine zoologists and geologists are, or ought to be, familiar—believed that certain star-fishes, which he had procured at a depth of 1260 fathoms (7560 feet), in lat. 59° 27′ N., long. 26° 41′ W., about half-way between Cape Farewell and the north-west coast of Ireland—were originally a shallow-water species, but had gradually, and through a long course of generations, accommodated themselves to the abnormal conditions incident on the subsidence of the sea-bed." [2]

"The Hebridean sea-bed, at very moderate depths (which Dr. Wallich would call "shallow-water") mainly consists of a soft and, more or less, tenacious mud, mixed with stones of different sizes, and resembling in its composition the Boulder-clay or Glacial drift of Scotch geologists. It tells us of rocks ground down by glaciers year after year in an arctic region; of the mud produced by such attrition being carried into the sea in the melting season by overwhelming floods, "non sine montium clamore" (see Dr. Kane's description of the great Humboldt glacier); of its dispersion over the sea-bed by the action of tides and currents; of the deposit thus formed being inhabited by a variety of animals of a high northern type during a long and quiet course of time; of the sea-bed being elevated by slow degrees above the surface of the water by an agency which we cannot satisfactorily explain, but which may be volcanic, or, perhaps, steam;[3] of the consequent extermination of these marine animals; of an interval during which the raised sea-bed was dry land; of a gradual amelioration of the climate; of another oscillation of the earth's crust in a downward direction, when the surface of the land, covered by its former deposit, again becomes the bottom of the sea; and of a fresh succession of life which is still in existence. Thus a cycle of similar events continually recurs. Nothing is lost or altogether perishes; all the old materials are used up and assume new forms."

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## II.—Petroleum in North America[4].

By Professor C. H. Hitchcock, M.A.

During the past six years the United States of America have produced about 450 millions of gallons of Petroleum. The average daily yield for the past year (1866) has been at least 12,000 barrels. The business of collecting, transporting, and refining it employs as many hands as either the coal or iron trade. The economic importance of this commodity, therefore, demands a passing notice of its geological relations.

[1] The North Atlantic Sea-bed, 1862.

[2] *l.c.* p. 41.

[3] *Vide* Mr. R. A. Peacock's pamphlet "On Steam, as the Motive Power in Earthquakes and Volcanoes, and on Cavities on the Earth's Crust." Jersey, 1866.

[4] This notice of the geological relations of Petroleum in North America, has been obligingly furnished by the author.—Ed.

1. Petroleum sometimes occurs in *synclinal basins* like the subterranean streams of water penetrated by Artesian bore-holes. This is the case in Western Pennsylvania, the most prolific of all the "oil-regions." It is found beneath three sandstones or sets of impervious strata, called the "first," "second," and "third." In the small-yield wells the oil may constitute the drainage of an inconsiderable thickness of saturated layers. The fluid may often require the aid of pumps to bring it to the surface.

2. Petroleum may occur in *cavities and fissures in the strata*, either upon synclinal basins or anticlinal slopes. The existence of a cavity is inferred from the prodigious flow of fluid, as of the Grant Well, which at the time of my visit was spouting in a hissing stream 1800 barrels of petroleum every day. Many of these wells discharge their products intermittently. Besides petroleum, brine and gas are commonly, if not universally, discharged from the orifice; and we may suppose that before the tapping of the cavity they were arranged according to their specific gravities, the gas uppermost and the brine beneath the others. The varying phenomena of discharge may be explained by supposing different parts of the cavity to have been reached by the boring rod in the several instances. When a cavity is large two or more boreholes may penetrate it, as was the case with the celebrated Phillips and Woodford Wells. Generally the wells of one neighbourhood seem to have some connection with one another; for if old and unproductive holes are not closed, the discharge from new and promising wells is impeded. Abandoned holes should always be plugged up; partly for the benefit of new enterprises, and partly because it has been discovered that by rest they will again become productive.

The oleiferous reservoirs may be irregular cavities—vertical, horizontal, or inclined fissures; an enlargement of natural joints, etc. Explorers look for regions where the strata have been much folded and broken, premising that the dislocations may produce cavities in which fluids will collect.

3. Petroleum may occur along *lines of faults*. Examples of this nature are in Western Virginia, Cumberland and Barren Counties, Kentucky, and elsewhere.

4. Petroleum may exist *in great quantities beneath anticlinal arches*. These run into No. 3. Examples of this nature are in Albert Co. N. B., Gaspe C. E., and in the productive region of Canada West. The roof acts as an impervious cover to confine the fluids until the drill of the workman appears for their liberation.

These facts show us where to expect petroleum in considerable amount. If we search in that area where the oil-layer comes to the surface, or its distribution as represented by the colors of a geological map, we shall find only shallow and small producing wells. Nevertheless these may be more permanent than the deeper ones, and may be profitably worked from generation to generation where labour is inexpensive. The great wells involve three essentials—first, plenty of bituminous matter in the petroleum formation, from whence an abundant supply may be drawn; second, cavities and crevices in the strata; third, an impervious cover, like the roof of an anticlinal, to have prevented the escape of the fluids in past ages. The best "surface indications" generally guide to shallow wells. The best reservoirs have been found at considerable depths.

5. There are no less than fourteen different formations in North America (not including the West Indies) from which petroleum has been obtained, generally in productive amounts.

(*a*) Pliocene Tertiary of California. This has been known for a century.

(*b*) In Colorado and Utah, near lignite beds of Cretaceous age—not yet explored.

(*c*) In small amount in the Trias of North Carolina and Connecticut.

(*d*) Near the top of the Carboniferous rocks in W. Va. Most of the producing wells of this state are from this horizon.

(*e*) Shallow wells, near Wheeling, W. Va., and Athens, O., not far from the Pittsburg coal.

(*f*) 425 feet lower, near the Pomeroy coal beds.

(*g*) At the base of the Coal-measures, in Conglomerates or Millstone grit.

(*h*) Small wells in the Archimedes limestone (Lower Carboniferous) of Kentucky.

(*i*) Chemung and Portage groups—certainly three different levels—in W. Penn. and N. Ohio.

A careful study of the distribution of the producing wells upon Oil Creek has satisfied me that they are arranged in four groups, with scarcely any intermediate stragglers. These centres are at Titusville, Petroleum, Cherry Run and vicinity, and about Oil City. Those at Pit Hole constitute another group. The quantity and quality of petroleum obtained is proportioned to the depth attained by the bore-holes. Shallow wells yield a small quantity of superior quality, because heavier. The lightest oils generally come from the greatest depths. In the Cherry Run districts the wells in the valley average 550 feet in depth; those at Pit Hole average 620 feet. At both these localities attempts have been made successfully to obtain petroleum by boring into the hill-sides; and that from levels above the average depths of the valleys.

(*j*) Black slate of Ohio, Ky., Tenn., or the representatives of the New York formations, from the Genessee to the Marcellus slates. This is near the middle of the Devonian.

(*k*) Corniferous limestone, and the overlying Hamilton group in Canada West, extending to Michigan. This is largely productive.

(*l*) Lower Helderberg limestone, at Gaspé, C.E. This is Upper Silurian, and awaits development.

(*m*) Niagara limestone, near Chicago. Not yet remunerative.

(*n*) In the equivalents of the Lorraine and Utica slates and Trenton limestone of the Lower Silurian, in Kentucky and Tennessee. One well in Kentucky in these rocks was estimated to have yielded 50,000 barrels.

The immense territory in North America—several hundred thousand square miles in extent, underlain by the formations mentioned above, in an unaltered state—assures the world that the petroleum of the New World, like the coal, is probably practically inexhaustible.

6. Petroleum is unquestionably of organic origin. In my opinion the great mass of it has been derived from plants; but some think it comes from animals, being either a fish-oil or a substance related to adiposcere. It does not appear to be the result of a natural distillation of coal, since its chemical composition is different from the oil manufactured artificially from the cannels, containing neither nitro-benzole nor aniline. Moreover, petroleum occupied fissures in the Silurian and Devonian strata long before the trees of the Coal period were growing in their native forests. The nearly universal association of brine with petroleum, and the fact of the slight solubility of hydro-carbons in fresh, but insolubility in salt water, excite the inquiry whether the salt-water of primæval lagoons may not have prevented the escape of the vegetable gases beneath, and condensed them into liquids? The hint appears to be worthy of consideration.

## CORRESPONDENCE.

*To the Editor of the* Geological Magazine.

Sir,—The faults in the Drift at Hitchin, made the subject of correspondence in your Magazine, were shewn by me in the lithographic sections accompanying the map of the Drift of the East of England, which I printed for private distribution in May, 1865; and a copy of which is in the libraries of the Geological Society, of the Woodwardian Professorship, and of those of most other scientific bodies. This was more than a year before Mr. Salter, unacquainted, as I understand, with that work, had his attention attracted by them. I now write to call your readers' attention to the fact that the most striking features of the Hitchin section do not appear in Mr. Salter's paper. The sand and gravel which has been slightly faulted at the Station, is that which, in thickness varying from twenty-five to sixty feet, underlies the wide-spread Boulder-clay (termed by me the Upper Drift) over most of the East of England; but which has a more limited extent in the north-east portion of the Central Counties, where the upper Drift rests most frequently on the older rocks. Now this sand and gravel (or middle Drift) is always strictly conformable to the upper Drift; and over western Hertfordshire lies generally at the surface, owing to the denudation of the upper, which there occurs only in outliers. In the centre of Herts, between Baldock and Buntingford, and for some way south of the latter place, it is generally absent, the upper Drift resting on the Chalk. If any of your readers will walk up the Great Northern Railway, from Hitchin to Hatfield, they will see, at Wymondley cutting, this middle Drift rising up sharply from beneath the upper, and (except where it is capped, near Stevenage, by the upper) occupying the cuttings as far as Hatfield station; some way north of which, and close by the Luton-line junction, there was some time ago well shewn, by the removal of some of the material for ballast, the upper Drift for a space of several yards faulted perpendicularly into the middle. The section, however, between Hitchin and Wymondley shews, not only that the Drift has been faulted in the way seen at Hitchin station, but that the whole mass of Chalk, through which Hitchin cutting passes, has been forced up since the Drift was deposited. The following is the section:—(See Woodcut, Fig. 1.)

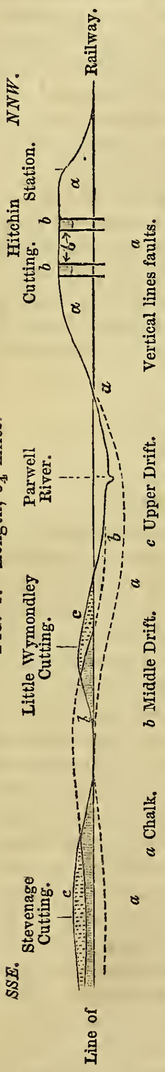


Fig. 1.—Length, 3¼ miles.

The faulting of the Drift is a common thing in the East of England, and one or other of the following instances may, perhaps, fall within the convenience of some of your readers to observe for themselves.

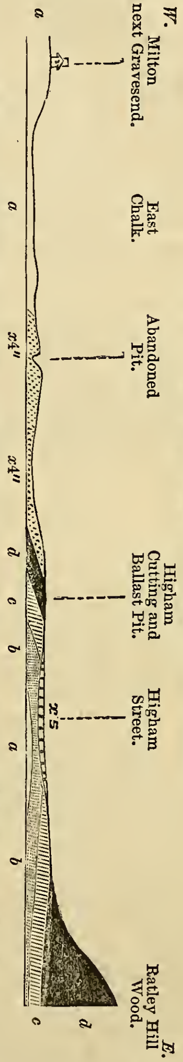
In a pit in the N.E. portion of Ordnance Sheet 50, and adjoining the farmhouse, three furlongs S. E. by E. of Bulchamp workhouse, and eleven furlongs from Blythford church, the upper Drift occurs side by side with sand; the two standing against each other like a wall. This sand I believe to be that which intervenes between the Crag and Chillesford beds, in which case the vertical drop of the upper Drift cannot be less than forty to fifty feet. If, however, it be the sand of the middle Drift, then the drop is proportionately less. A pit marked "Sandpit" in the S.E. corner of the same sheet, nine furlongs S.S.E. of Chillesford church, and adjoining the Butley River, shews exactly the same thing in all respects. A pit in Sheet 49, marked "clay and sandpit," four furlongs from the shore at Sizewell Gap, shews the junction beds of the upper and middle Drift, conformably to each other, but tilted at an angle of about twenty degrees with the horizon.[1] A pit two miles S.W. by S. of the last pit, and one furlong South of Aldringham church, shews the same junction beds arching (by lateral pressure as I regard it) in a double curve, like the letter ∞ laid horizontal, but less sharply bent than the curves of that letter. The coast section between Pakefield and Kessingland, and a little north of the lighthouse, shews a small fault of some six or eight feet; and another between Corton and Hopton of about equal extent that has caused a depression which has been filled with post glacial gravel; both of these extend through the upper and middle Drift. A third, between Hopton and Great Yarmouth, shews

[1] This was shewn in the sections accompanying a paper on the crag and drift in Ann. and Mag. of Nat. Hist. for March, 1864.

the upper Drift dropped into the middle Drift, of which the cliff is composed, and the whole capped unconformably by Post-glacial gravel. The Brickfield at the north end of the low cliff on which Southwold stands (Sheet 49) shews a series of Post-glacial sands, interstratified with white marl containing freshwater shells, resting on the upper Drifts, and with that Drift thrown into an angle of more than 45° with the horizon. At Rockland Staithe, 6¼ miles E.S.E. of Norwich Castle, the beds intervening between the Crag and middle Drift are faulted; but it requires a familiarity with the beds, or a description which the compass of a letter will not allow, before the extent of the fault could be shewn. A pit in the S.E. corner of Sheet 66, one mile and six furlongs N.N.E. of Beccles church, and two hundred yards above the fine exposure of the Chillesford beds, shews (unless now worked out) Post-glacial gravel faulted into the sand of the middle Drift, and standing like a wall against it for several feet.

These throws affect the Drift; but more important than these, because affecting beds much newer than the Drifts, are those which occur in the Post-glacial series. One of these is shewn by Messrs. Topley and Foster, in their paper on the Medway gravels; two others were given by me in the papers, in your Magazine, on the Thames and East Essex gravels; one of them being at Bradwell-on-Sea, and the other in Wickham Lane, near Woolwich; the latter is very accessible to your London readers, and is just now well exposed by a three-sided projection which shews the stratification very finely and that it is not due to the oblique bedding, as well as the amount of the dip, 18° to 20°, directly towards the fault which brings up the Chalk face on the opposite side of the lane.[1] Lastly, there is that at Higham shewn by me in the sections in your numbers for February and March last.[2] This is the most important of all, because it affects a

FIG. 2.—Section along a slightly irregular line, 5 miles.




*a* Chalk. *b* Thanet sand. *c* Woolwich beds. *d* London clay. *x4''* Thames gravel. *x5* Brickearth.

Absence of sections and low ground between the abandoned pit and East Chalk, renders it doubtful whether any of the Tertiaries come out from under *x4''*, or whether that bed be faulted against the chalk. The chalk is exposed at Higham station, close by Higham Street, and there *x5* overlaps the Thanet sand and chalk. Hard by, in the lane, a quarter of a mile north of the station, *x5* rests on the Woolwich beds.

[1] There are two brickfields in the lane, this is in the nearest to Wickham church.

[2] GEOL. MAG. Vol. III. pp. 57 and 99.

formation as much newer than the Drift as is implied by its occupation of a trough cut down, in its deepest part to more than 500 feet from the upper Drift; and because it is also in intimate connexion with the disturbances under which the Thames gravel emerged. In the sections I gave in your Magazine, space necessitated this being shewn as a vertical drop, but in reality it arises from a pitch in a north-west direction, as the following detailed section shows :—(See Woodcut, Fig. 2.)

These are instances in which actual ocular evidence of violent dislocations is obtainable. There are many more which are deducible from the structure of the crag and Drift, and I believe that many of the sections in these upper beds which present perplexing features are due to this cause. Thus the capping of Boulder-clay which rests on the Chillesford beds, at Chillesford, and which Mr. Fisher, in his paper, read before the Geological Society, brought into his evidence of "trail," I believe is nothing but an oblique throw of the upper Drift, on to the Chillesford beds; for in a pit, only a furlong and a half north of this section, there occurs one of the junction of the upper and middle Drift, which shews both these formations in strict conformability to each other, and arching under the influence of lateral pressure, somwhat in the same manner in which the beds are exhibited in the section of Aldringham church.

I am, Sir, etc., SEARLES V. WOOD, JUN.

## FAULTS IN THE DRIFT AT HITCHIN.

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR,—My friend, Mr. A. H. Green, who is nothing, if not critical, has been very gentle in his criticism in my case; and, indeed, he is so genial a man that I am sure it must go against his grain, and be an act of stern duty in any case to find fault at all. Perhaps this may be the reason why he overlooked the faults at the Hitchin station. I can hardly think they have grown larger since his visit. But there they are; and confused as the mass of gravel and loam, which form the Boulder-drifts in that locality, may be, there is a tell-tale bed of conglomerate at the bottom which has betrayed all its movements—while surely, not even a tyro could mistake the dark brown gravel which caps the drift and fills the pipes, and which is so common in the Hitchin section, for the light-coloured sand and loam below.

The uneven surface of the Chalk here is indeed due to the same cause which has produced so many inequalities in the surface of our island—viz., the much-abused "unequal elevation" of faulted ground, however these faults may have been produced. In the case of the Chalk, that may, no doubt, in some cases be due to sinkings over subterraneous cavities produced by rivers and streams in Post-glacial times. For this idea I am indebted to my friend and former colleague, Mr. Thomas T. Mc K. Hughes, with whom I had previously examined the Boulder-drifts near Hertford, and therefore came to the section more prepared for examination than I should otherwise have been.

Whether this or a larger movement be the source of the appearances at Hitchin, I do not mean now to argue.[1] But that the clean-cut faults, passing through Chalk, pebble bed, and loamy gravels, exist in this locality, only needs a second visit to ascertain. Indeed, as I hope I fully mentioned in a note to the paper (for I have not the Journal at hand), one of these faults have been previously marked in the sections given by Mr. S. V. Wood, jun.—a fact I was not aware of when the paper was read at Somerset House.

After all, in most cases, we only see what we look for; and if I had been examining the Chalk specially, I should probably not have seen these dislocations. I am sure your correspondent could not have been long at Hitchin without making many good friends there, so I shall recommend him to go and dine with some of them this holiday time, and pay a visit to the old chalk-pit again.

I am, yours truly, J. W. Salter.

Malvern, *Dec. 3rd*, 1866.

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GLACIATION IN DEVON AND ITS BORDERS.

*To the Editor of the* Geological Magazine.

Sir,—I have always distrusted my own power of observation in Glacial and other superficial phenomena, for whenever I have made an observation to a regular glacialist, or "drift describer," I have generally had to *stand corrected.* It would not, therefore, be at all surprising to me to find I was quite wrong in my conclusions as to what appeared to me to be a glaciated surface on the cliff on the banks of the Exe above Barlynch Abbey.

The first time I ever was able to see these phenomena of rounding, moulding, and striation, so as to recognise them, was in the S.W. of Ireland, about the year 1851, under the guidance of the late Sir Henry De la Beche. Since then I have had many opportunities of observing them not only in Ireland, but in other parts of the British islands and in the Alps.

Coming down the valley of the Exe on the occasion described in the letter published in your Magazine in 1865 (Vol. II. pp. 473), I saw before me a cliffy ridge marked, as it appeared to me, precisely in the same way in which so many so-called glaciated surfaces are marked.

These markings being large and obvious, and my time being all too short for geological observations of much greater importance, I did not spend more than ten minutes in examining them. If, therefore, they are not glacial as my friend, Mr. Pengelly and Mr. Vicary, have concluded, it only assures me of the wisdom of the old proverb, *ne sutor ultra crepidam,* and warns me to stick to the rocks themselves, and leave their external markings and superficial covering to those whose tastes and powers of observation are more suited to them than mine are. I hope, however, that some practised

[1] I may as well observe, that the faults at Hitchin station, large and small, are very nearly parallel to one another—as in most of our faulted districts. I think this indicates a more general movement than is implied in the idea of subsidence over cavernous ground, such as may account for the minor flexures in the drift gravel.—J.W.S.

glacial observer may visit the locality some day, and give us the benefit of his opinion upon it. In the meantime, as Mr. Pengelly, in his letter in your last number, agrees in the correctness of my description of the facts, perhaps he will favour us with his ideas as to their origin, for I certainly have never seen anything like them except on a so-called glaciated surface.—Yours truly,

Dublin, *Dec.* 4, 1866. J. Beete Jukes.

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## DR. FRAAS ON PRE-HISTORIC SETTLEMENTS.

*To the Editor of the* Geological Magazine.

Sir,—In your impression of this month (page 550), Dr. Fraas concludes an interesting article on Pre-historic Settlements with two remarks, thus: "And, secondly, that the discovery at Schussenried indicates a totally different climate, such as *now* begins at 70 degrees of north latitude." But he gives a *fact* which fully contradicts this *theory*. The remains of *horses* were found at Schussenried. "In one case the skull is still nearly perfect, and it belonged to a species with a large head; while certain bones of the extremities indicate a *strong, bony, and powerful animal.* The brain cavity has been opened, the vertebræ had been split, and the bones containing marrow had been broken in pieces, so that there can be no doubt of horse-flesh having been one of the table delicacies of the ancient Swabians." Are there wild horses at the North Cape *now?* or in Nova Zembla? or at the Samoyede Promontory?

I have the honour to be, Sir, your obedient servant,

George Greenwood, Colonel.

Brookwood Park, Alresford,
*December 7th*, 1866.

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## THE DEVONIAN ROCKS OF NORTH DEVON.

*To the Editor of the* Geological Magazine.

Dear Sir,—I wish I had power at present to enter the lists on the new issue raised by Professor Jukes as to the integrity of the Devonian system. It seems so odd to try to explain away a series of rocks which must have some place, and are distinguished, as all know, by a peculiar set of fossils. Though the Devonian has not *many* striking peculiar types of shells, it has some quite distinct, while the mass of its species are undoubtedly peculiar, and neither Silurian nor Carboniferous. And it is 10,000 feet thick!

Meanwhile, till I have more opportunity, let me just keep your younger readers in possession of the facts that in North Devon, proceeding southwards from Linton and the N. Foreland to the Culm-measures, there are the following distinct series, which Professor Jukes rather summarily groups into Coal, Carboniferous-slate, and Old Red. I know "a rose by any other name will smell as sweet," but I prefer the well-known names:—

1. Slates and sandstones of Linton and the North Foreland (Lower Devonian).

2. Grey slates and limestones of Combe Martin and Ilfracombe (Middle Devonian).

3. Purple grey grits and slates—Morte Bay, etc. (Upper Devonian ? no fossils).

4. Marwood sandstones and *Pilton* and Barnstaple group (Uppermost Devonian).

5. Dark soft Carboniferous shales—Barnstaple and Fremington (Carboniferous slate).

6. Limestones and Culm Measures (Mountain Limestone, Millstone-grit (and Lower Coal ?).

Now this succession has been made out by De la Beche, Sedgwick, Murchison, Phillips, and others; and I have verified a good deal of it myself. Let us understand each other. I am glad to see that Professor Jukes has lately covered more of the ground; and I am sure, if he spends more time in both North and South Devon, he will end by agreeing with his geological brethren. Already he perceives the resemblance in what we call the Lower beds (No. 1), and in No. 3, to the Old Red, as he knows it so well in the South of Ireland. And if he will remember that, in S.W. Ireland, the Upper beds of the Old Red Sandstone lie unconformably on its mass, just as they do in Scotland (Geikie), and through Wales, right away into Pembrokeshire, he will see the importance and extent of the duplex formation which he is endeavouring to supplant. If, indeed, he can find us true Carboniferous fossils in the three lower divisions, we may yield the point to him. Hitherto they have only yielded Lower and Middle Devonian species. No. 4, as he well knows, is the representative of his own "Coomhola grits," which in Ireland lie, at all events, at the base of the Carboniferous slate, and which I have proved to be of the same age as the conglomerate beds (or part of them) of the Upper Old Red in Pembrokeshire. And I have also shown that No. 5 contains Carboniferous fossils only. If, therefore, the uppermost members of the Old Red are equal to the uppermost member of the Devonian, why not make room for the lower, which cover the Silurians ?—I am, yours truly, J. W. Salter.

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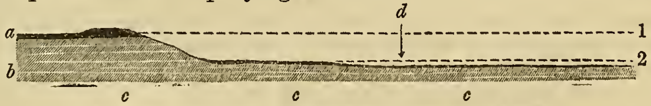
FLINT CORES FROM THE INDUS.

*To the Editor of the* Geological Magazine.

Sir,—With reference to my letter in the October number of the Geological Magazine (Vol. III. p. 433), on some Flint Cores found by my Son, Lieut. Edward D'Oyly Twemlow, of the Royal Bombay Engineers. When he wrote last, about 20 feet of water covered the place, but he has from memory defined the exact spot and depth in the accompanying sketch.




Section on the River Indus, near Sukkur Pass, Upper Scinde.

The lower limestone rock is not seen in the above section, but crops up about 400 yards away from the river, with an upward inclination. The upper 30 feet ($c$) is found in layers of one and a-half to two feet in thickness. Above this occurs a band, six inches to one foot in thickness, of nummulitic limestone in loose slabs. Again, above this occurs (*b*) a mass of flints, packed together, in layers of from one and a-half to two feet in thickness. This is covered by (*a*) a recent silt deposit (alluvium) of the river, exactly similar to what lies over the whole of Scinde. In the deposit (*b*) at the point (*d*), the flint-cores were found, four feet beneath the surface, and 20 feet below the dotted line (1), the level of the highest flood: (2) is the line of lowest flood level.

I enclose a seecimen of the limestone,[1] and also some granular bodies, found with the flint-cores.[2]

My Son is sending home several more examples of flints from this deposit.—I remain, Sir, yours faithfully,

George Twemlow, Major General.

Poyle Lodge, Guildford, 1866.

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## THE BRITISH ASSOCIATION AND THE NATURAL HISTORY FIELD-CLUBS AND GEOLOGICAL SOCIETIES.

*To the Editor of the* Geological Magazine.

Sir,—I wish to call the attention of your readers to a rather important subject. How is it that the authorities of some of our Field-Clubs fix their meetings for the week of the British Association meeting? It can hardly be intentionally done; but common sense would dictate, that when such a mistake has been made, it should be rectified as soon as discovered by altering the day. Now both the Malvern and the Woolhope Clubs held their meetings this year during the British Association week, to the annoyance of those members who wished to enjoy both. What most surprises me, however, is, that my friend the able President of the Malvern Club, who is such an enthusiastic man of science, should have made such a "faux pas."

I trust you will insert this in order to guard against similar carelessness next year.—I remain, Sir, your constant reader,

Ludlow, 19*th Nov.*, 1866. Robert Lightbody.

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# MISCELLANEOUS.

Professor Sedgwick, the occupant for nearly fifty years of the chair of Geology at Cambridge, in commencing his annual course of lectures,[3] stated that he should not be able to deliver his lecture on the following Friday, having to meet his oculist, his sight being very much impaired; nor was it, he said, surprising, that one so far advanced in life should be infirm, for this, if it pleased God to spare him to complete it, would be the forty-ninth course of lectures which he had delivered as Woodwardian Professor. Reviewing the history of his professorship, founded in 1734, he said that practically

[1] The Limestone is true Nummulitic Limestone full of *N. laevigata*.—Ed.

[2] The granular bodies are pisolitic grains of Iron-ore. They have since been presented to the British Museum.—Ed.

[3] October 21st, 1866.

no lectures had been delivered by any of its holders until he received the appointment, after a severe contest, in 1818. The science of geology was always looked upon then as dangerous and suspicious, and he mentioned one attempt to lecture which had been nipped in the bud, it was said, by a hint from high quarters. Another difficulty was that the founder of the professorship had decreed in his will that the lectures should be in conformity with his own theory of geology—a theory, said Professor Sedgwick, the most wild and irrational. It amounted to this, that at the deluge the whole earth was melted down into a sort of Irish "stirabout," but that, at the same time, by some inexplicable, unaccountable contrivance, all fossils, even the minutest, were preserved from the general destruction and handed down to us. Such a theory it was impossible for a man to lecture upon who had anything like a conscience. When he received the professorship, however, a grace of the Senate made lectures a necessary preliminary to receiving the professorial salary; and in the course he had adopted he had given a liberal interpretation to the spirit of his founder's will, and had endeavoured to adapt his teaching to the progressive state of the science. To his founder, however, he gave all credit for having most religiously preserved the name of the locality from which every specimen in his collection had been gathered; and this in geology was of vast importance. Still Woodward's collection, as he (the Professor) found it, was not sufficient to lecture upon, and, together with his friend, the late Professor Henslow, he had set to work to increase it; and it had gone on increasing till at last the difficulty was, not to find sufficient to lecture upon, but to choose from so great abundance what was best.—One very good remark the Professor made in reference to geology and other physical science clashing with religion: he said that those who had any faith worth the name in the revelation on which their religion was founded would never fear that which was impossible, that one truth would contradict another. All truth was in harmony, and nature had this grand characteristic, that she possessed no isolated phenomena—everything in nature was regulated by beautiful fixed laws, and this preserved us from the errors into which solitary phenomena would lead us. Taking up a fossil that lay before him, the Professor said we knew that the earth exercised an attraction upon it, tending to draw it to itself, but we also knew this beautiful and wonderful fact that, by that same law of gravitation, it was connected not only with the earth, but with every particle in the universe. In conclusion the Professor cautioned his hearers not to fall into the error of the so-called *positive* philosophers, who, with all their boasted worship of Nature, fail to render homage where homage is due. For a man to be profound in his worship of Nature, without being also profound in his worship of the Creator of Nature, seems as irrational as it would be for a man, sitting at one of our grand Norwich festivals and having his soul stirred within him by the almost heavenly harmonies, should feel impelled to give expression to his emotion, and instead of rendering his tribute of praise to the master-mind who had conceived the glorious music—should fall down and worship the kettle-drum and fiddle-stick.—[Taken in part from *Pall Mall Gazette,* Oct. 26, 1866].

In the February Number of this MAGAZINE, Professor Huxley will describe a new Saurian *Acanthophilis horridus* from the Chalk-marl. It is allied to *Scelidosaurus, Hylæosaurus,* and *Polacanthus.*—R.E.

## OBITUARY.

We have to deplore the untimely loss of a young and most promising palæontologist, HENRY ADRIAN WYATT-EDGELL, who died of diptheria, at Belfast, Nov. 6, 1866, aged 19. He had become during the last few years well known to collectors and students of the older fossils, and his talents and zeal bade fair to place him in a very prominent position in geological circles, when the results of his close study should be given to the world. He had not yet published more than a paper or two, one of which will be found in the present Number, at p. 14, and another in Vol. III. p. 160.[1] But his acumen and industry in this, his favourite pursuit, would assuredly have given him a high title to consideration had his young life been spared but a little longer.

Ensign Wyatt-Edgell was born May 17, 1847. He was the second son of the Rev. Edgell and the Hon. Henrietta Wyatt-Edgell of Stanford Hall, Leicestershire. At a very early age he was placed at the College of St. Louis, Paris, where before he was eleven years old he was honorably distinguished for classics; he acquired his first taste for geology from the teaching of Mr. Charles D'Orbigny. In 1858 he left the College of St. Louis, and afterwards passed three years at Eton, where he distinguished himself in mathematics, and completed his education at Sandhurst, entering second on the examination list. He obtained a commission without purchase in the 59th Regiment, from which he exchanged into the 13th. In the last six or seven years of his short life his whole leisure was given to the collection and study of the Silurian and Cambrian Fossils. In this wide and almost unoccupied field he had the friendly assistance of several fellow-students, and willingly devoted himself to this special group of rocks as most needing illustration. He visited every available locality; and his polished manners and winning address gave him ready access to every cabinet. The testimony of his friend, Mr. Salter, with whom he studied a good deal, is, that for sound judgment of species and acute and critical observation of their characters he was quite exceptionally eminent. Nothing escaped his eye; and he was no less happy in the power of generalization in respect of generic groups and the relation of cognate forms. To this power he added the charm of a classic taste, which rendered his correspondence and descriptions remarkably correct and clear—no mean gift, in these days of slovenly diagnoses. Several fossils will be found to bear his name: e.g. *Homalonotus Edgelli,* etc.; and

[1] See also a paper by him on the characteristic fossils of the Arenig group, and its distinction from the Llandeilo, in Geol. and Nat. Hist. Rep. for July, 1866.

many new species, determined by himself, exist in his cabinet. A paper on "The Division of the Upper Llandeilo Rocks by their Fossils into an Upper and Lower Group," was read by him in 1865 before the Geologists' Association, and will be found in their proceedings. Another on the Fossils of the Llandovery Rocks, and a fasciculus of new species from his cabinet, were both in progress when he left London for military duty in Ireland. The packages sent home from thence, to be worked up in the leisure which, alas! never came, testify his devotion to his favorite pursuit to the end. He will not easily be forgotten by those who knew him, and the loss to our science is, indeed, a heavy one.

Alexander Bryson.—Alexander, eldest son of Robert Bryson, was born at Edinburgh on the 14th October, 1816. He received his early education at the High School, and being destined to pursue the same occupation as his father, was apprenticed to a watchmaker at Musselburgh. On the expiration of his apprenticeship, he went to London for a time to obtain a further knowledge of the details of clock and watch making, and on his return to Edinbugh entered with his brother Robert into a partnership, which continued up to the time of his death. But, conjoined with his mere business aptitude and qualifications, was a strong taste for scientific inquiry and pursuits, which led him, on returning from London, to enter as a student at the University—the Chemistry and Natural Philosophy classes of Professors Hope and Forbes. At the School of Arts, in the foundation of which his father, along with Leonard Horner, had taken a very active part, he was for some years a constant attender, and frequently expressed himself as greatly indebted to that institution for the opportunities of scientific improvement it had given him. Mr. Bryson took an interest in the physical sciences generally, but he devoted himself chiefly to the departments of mineralogy and geology. Owing to a community of pursuits, a friendship early in his life sprung up between him and the late Mr. Nicol, the inventor of the well-known prism which bears his name, and who left him not only a fine library and collection of minerals, but made him heir to his property. With the distinguished naturalist, the late Dr. Fleming, he was on terms of great intimacy. For many years they made geological excursions together. In our scientific societies, or elsewhere, no more strenuous defender of the opinions of that eminent man was found than Alexander Bryson, and in the 22nd volume of the Transactions of the Royal Society at Edinburgh, a discriminating memoir of Dr. Fleming appears as the product of his pen. Mr. Bryson was also long on terms of friendship with the late Sir Thomas Makdougall Brisbane, for many years the president of our Royal Society; and to the Transactions of that body he communicated a memoir of that distinguished astronomer and soldier. Few men, indeed, had so wide a range of friends and acquaintances as Mr. Bryson; his general attainments, his frankness of manner, and his unselfish and kindly disposition endeared him to all who knew him. Mr. Bryson was an active member of the principal scientific societies of Edinburgh. He was proposed as a Fellow of the Royal Society of Edinburgh by Sir T. Makdougall Brisbane, and was elected in 1858. He filled the presidential chair both of the Royal Physical Society and the Royal Scottish Society of Arts, and was also a Fellow of the Geological Society of London. To the proceedings of these various scientific bodies he was a not unfrequent contributor. His published papers are about thirty in number, and comprise articles on geology, mineralogy, and zoology. In 1864 he read to the Scottish Society of Arts an account of a new method of detecting the presence and position of icebergs at sea, which was considered of so much importance that the Hepburn Prize was awarded to it. In 1862 he made a trip to Iceland, and published a short description of his journey, one of the most interesting results of which was the determination of the fact that the temperature half way down the tube of the Great Geyser was 270° Fahr., whilst at the very bottom it was not more than 240° Fahr. He was elected a member of the Town Council, for Newington Ward, in 1861, which office he resigned on account of failing health, in November last. During that period he took an active part in the introduction of telegraphic communication between the various police stations in the city. His brother Councillors testified their opinion of his scientific abilities by appointing him last year one of the Curators for the election of professors in our University. In the spring of the present year, whilst engaged in making experiments to test the applicability of the employment of the electric light in the capture of fish, for which he obtained a patent, he contracted a severe cold, which was shortly followed by an attack of jaundice. He lingered on during the summer and autumn, gradually becoming weaker, when an attack of bronchitis supervened, which in his then debilitated condition rapidly proved fatal. He died on the morning of the 7th of December at his house, Hawkhill, near Edinburgh. On the evening of that day the Royal Physical Society held the first meeting of its ninety-sixth session. After the minutes were read and approved, the president expressed his regret at having to announce the death of Mr. Alexander Bryson, which had occurred that morning, and moved that the Society should immediately adjourn, as a mark of respect to his memory. Mr. Bryson had long been connected with and was one of the most active supporters of the Society. He had filled the office of president, and at the time of his death was a member of Council. The secretary was also instructed to communicate with the members of deceased's family, and to express the deep sorrow of the Society for his loss. The motion was agreed to, and the Society adjourned accordingly.

Senor Casiana di Prado, of Madrid, For. Mem. G. S., died at the close of 1866. He was Inspector-General of the Mines of Spain, and was zealously devoted to the elucidation of its gelogy. A full account of his principal work, "Descripcion física y geológica de la Provincia de Madrid" (1864), was given by Mr. Hamilton in his Presidential Address to the Geological Society of London in 1866.

THE

# GEOLOGICAL MAGAZINE.

No. XXXII.—FEBRUARY, 1867.

## ORIGINAL ARTICLES.

### I.—On the Alleged Hydrothermal Origin of Certain Granites and Metamorphic Rocks.

By David Forbes, F.R.S., etc.

THE study of the crystalline and metamorphic rocks seems hitherto to have been rather avoided by British geologists, who have more exclusively devoted their attention to the stratified and fossiliferous deposits, and left this field of research all but entirely to be cultivated by their continental brethren.

Latterly, however, the subject appears to have received some attention from the members of the Geological Survey of Great Britain, and the present communication is devoted to remarks upon the substance of two papers lately published by Mr. James Geikie, of that survey, respectively entitled :—

I.—On the Metamorphic Silurian rocks of Carrick, Ayrshire. Quarterly Journal of the Geological Society, vol. xxii. p. 513, *et seq.*

II.—On the Metamorphic origin of certain Granitoid Rocks and Granites, in the Southern Uplands of Scotland. Geological Magazine, Vol. III. p. 529, *et seq.*

These communications, coming from the pen of one of the staff of the Geological Survey of Great Britain, are sure to arrest attention, and they are written in a bold, and, if without offence it might be added, somewhat dogmatic style, such as would be perfectly justifiable if the views therein expounded are to be regarded as representing general conclusions drawn from the deliberate and careful study of the numerous examples of metamorphic action which must have presented themselves in the course of the Survey; but which, if considered in conjunction with several novel and rather startling statements embodied in these papers, and which assuredly the author's colleagues in the Survey will not endorse, may probably be considered as rather "*de trop.*"

The publications of the Geological Survey are generally, and justly regarded, as master-pieces of geological and paleontological research; and what may be termed the extra-official scientific productions of the members of the Survey fully sustain the high character accorded to the official publications.

In the present instance, it may fairly be questioned as to whether the papers here under consideration come up to the mark, and whilst Mr. James Geikie deserves the geologist's best thanks, for bringing this intricate subject into the field of geological inquiry, and for expressing himself with such decision and boldness as assuredly to wake up the attention of such as have devoted themselves to similar investigations, it must at the same time be regretted that the substance of the papers themselves does not prove the author to be much at home either in chemistry, mineralogy, petrology, or physics, and accounts for his placing such apparently implicit reliance upon crude observations made in the field, and undervaluing the all-important assistance to be derived from a knowledge of the collateral sciences.

In a report on the igneous rocks of South Staffordshire,[1] the writer of these remarks stated, "In these investigations it is absolutely essential that the chemist, geologist, and mineralogist shall go hand in hand in the inquiry," and nobody believes more thoroughly than he does in the words of Mr. James Geikie, "that the question of the origin of granite and other allied rocks will ultimately be solved by the field observer." But he would add, however, "certainly not by the mere field observer; but by the man who, in addition to being a correct field observer, brings into the field a sound knowledge of chemistry and mineralogy, with the more mathematics and physics the better, and who employs the microscope to assist his eye in the examinations of the more compact or apparently homogeneous rocks.[2]"

It must also be remembered that the progress of science demands that the geologist, also, shall no longer put his whole reliance in a pair of good legs, and plenty of field practice, but must avail himself of every possible assistance and advantage afforded him by the rapid strides of the collateral sciences: and depend upon it, before this is done, such intricate problems as the origin of the metamorphic and crystalline rocks, the formation of lodes, etc., stand but a poor chance of solution.[3]

The writer does not speak upon the strength of an acquaintance with this subject of a few months or years, but for more than twenty years has continuously occupied himself in a special and minute study of the crystalline and metamorphic rocks, having examined them in the field over a great part of Europe, North and

[1] British Association Reports, 1865. Transactions of Sections, p. 53.

[2] Geologists have not as yet learned to appreciate the true value of microscopic investigation, In very many cases the simple examination of a rock section can at once determine whether a rock is a true igneous rock, or the product of a secondary metamorphism. The admirable researches of Mr. Sorby show how much may be effected in geological research by the use of the microscope. The writer, fully appreciating this, has devoted much time and labor since 1851 to this branch of petrology, and has now above 900 sections of crystalline and metamorphic rocks from about 480 localities, in different parts of the world.

[3] Mohr in his Geschichte der Erde, 1866, p. 516, gives as No. 92 of his Theses, "Geologus non aestimatur ex calceis in peregrinationibus detritis;" it is admitted that some geologists of repute are neither Palæontologists nor Petrologists, nor much at home in either mineralogy, chemistry or mathematics: it becomes, therefore, somewhat perplexing to define what constitutes a geologist.

South America, Polynesia, part of Africa, etc., with all requisite appliances at his command, and without having neglected the study of chemistry or mineralogy; but, even now, must confess that, like most of the continental men of science who have made this subject a special study, he has not yet been able to arrive at any such immediate or sweeping conclusions as Mr. James Geikie, after his short examination of the Scottish rocks, has been so fortunate as to convince himself of.

Without, however, being either a Neptunist, Plutonist, or Hydrothermalist, he believes that nature has employed all these and other agencies in her metamorphic operations, and is fully prepared to become a convert to Mr. James Geikie's or any other's views as soon as a searching but impartial examination of the evidence brought forward convinces him of their soundness.

In this communication it is not intended to comment upon or question the accuracy of the local geology referred to in these memoirs; but it is proposed, as the real object of these remarks, to examine into certain statements and arguments (quite independent of purely local data) made use of by the author in the working out of these memoirs, in order to convince himself of whether they are sound or not, and thereby to arrive at a proper estimate of how far conclusions dependant upon such data are entitled to confidence.

The perusal of these two papers would, he supposes, produce very different impressions upon different readers: On the mere field observer, after skipping sundry little passages, the science of which he could not quite understand, the memoirs in question would read well, smoothly, and plausibly, and in conclusion, probably convinced by the boldness of the style and the apparently indisputable chemical knowledge of one who writes with such ease of chemical re-agents, magnesian, alkaline, and basic properties of rocks, and explains the actions of the alkalies, magnesia, etc., would, without further inquiry into a subject which always had been a puzzle and a bore to him, be quite content to accept all these new conclusions, and for the future to believe that any stratified sedimentary bed, like grauwacké, etc., can, by the wondrous agency of hydrothermal action, be converted *in situ* into granite, minette, diorite, serpentine, porphyrite, etc., etc., or any other rock.

On the geologist, however, who possessed even a very small knowledge of chemistry or mineralogy, a very different impression would be produced; he would at once perceive that the chemistry was incorrect in points where even the merest tyro ought not to blunder, and that, to say the least, the petrology was exceeding "loose;" and, unless he determined to visit the localities and to study the matter for himself, would lay aside the memoirs with the intention of not putting any confidence in conclusions arrived at by the help of such unsound data.

These remarks may appear severe, and although, as will be seen, they admit of easy and indisputable proof, they have only been here brought forward after serious consideration, and in the firm belief that it is the duty of every geologist not to accept any new views whatever, before he has submitted the data, upon which they are founded to as strict and impartial a scrutiny as his own knowledge of the subject permits.

Of such a scrutiny a short abstract is now given, and for convenience it is divided into several heads :—

(1) *Chemistry.*—Although Mr. Geikie admits "that the labours of the chemist have been invaluable," and that he has "no disrespect for the work of the laboratory," he generally finds a *but* or *perhaps* to qualify his praise, and to show how much more dependence ought to be placed in the field observer.

It is interesting, however, to observe how much chemistry he has introduced into his first memoir, and how he endeavours to base his entire conclusions thereon. From the style of this memoir (but for its errors) it might have been written by a chemist, but certainly not by a mineralogist or petrologist.

Every chemist knows that magnesia is the oxide of the metal magnesium, and that it possesses no colour in itself, nor even the property of communicating colour to its compounds, unless white be regarded as a colour; and that, moreover, the minerals containing magnesia are invariably colourless, unless some other element is also present capable of communicating a colour to them.

Mr. James Geikie differs from chemists on this point, and appears to have made the interesting discovery that magnesia is a colouring body and has the property of colouring minerals green. Thus (p. 515, Quart. Journ.), he states that the magnesian matter colours the rocks green, and when speaking of the greywacké of Peebleshire states, (p. 518,) "The beds have a greenish tinge from the abundance of magnesian matter which they contain," and all throughout the memoir it is evident that he looks upon this new colouration test for magnesia (greenness) as a means of assuring oneself of its presence in rocks.

A well known mineralogist, when looking over Mr. James Geikie's memoir along with the writer, expressed his opinion that this misconception was one likely to occur to a field observer from confounding magnesia with serpentine—that latter mineral, when pure, being commonly green, and its chemical analysis showing it to contain some 40 per cent. of magnesia. The field observer might therefore infer that the colour was due to the magnesia it contained, but the chemist could have informed him it was due to iron.

Again, we find (p. 518, Quart. Journ.), when alluding to the unaltered strata, it is stated, "In places they are parti-coloured, showing yellow and green blotches owing to the decomposition of alkaline matter with which the beds appear to be more or less charged." This paragraph may be understood by the author, but neither the writer, nor several eminent chemists, before whom he has laid it, can pretend to explain the peculiar chemical action alluded to in this sentence, and as regards the assertion contained in the latter part of the same, that all the beds appear to be more or less charged with alkaline matter, it may be stated at once, that the external appearance of such rocks could not prove to any chemist, mineralogist, or geologist, whosoever, either that the beds in question contained more or less alkaline matter, or that they even contained any alkaline matter whatsoever.

In the present state of science it is an utter impossibility, by any means except careful chemical analysis (not to be performed by unskilled hands), to determine the presence and amount of alkali contained in rocks; and under these circumstances, geologists are fairly entitled to require some explanation from the author, as to whether such analysis had been made before expatiating so boldly as he does, all throughout the papers, upon the alkaline nature of the rocks described.

If such analysis had been made, the simple statement of the results, what alkalies had been found present, and their percentages, would, in itself, have been a valuable contribution to science.[1]

In these memoirs no analyses of rocks are cited, and when such expressions are found, as "they ought perhaps to be followed up by analysis of the rocks," and "future chemical analysis will enable us to clear up this point," it is concluded that they were not made, and, in such case, statements appearing all throughout the memoir in the Quart. Journ., as p. 516, "less alkaline;" p. 518, "no recognisable amount of alkaline matter;" p. 519, "greenish alkaline felspathic part;" p, 521, "portions more highly alkaline than others;" "alkaline character of strata;" "admixture of alkaline matter;" p. 522, "highly alkaline wacké;" "harder and more compact, (in other words, *less alkaline*);"[2] p. 526, "insufficient supply of alkaline matter;" "whenever the strata begin to get alkaline, the altered crystalline areas become amygdaloidal," etc., are thoroughly unwarrantable.

As we know that many of the hardest minerals and rocks in nature contain no alkali whatever, it is difficult to imagine where the author could get the notion that alkalinity was the cause of hardness in rocks, and it may be also asked, what he means, p. 526, "alternations of very highly basic, with less alkaline beds," as if basicity was dependant only on alkaline character.

In the same manner, the repeated statements of the presence of magnesia, if not confirmed by chemical analysis, but only given upon the strength of the "greenness" observed in the rocks, cannot be accepted by either chemist or mineralogist.

Much more might be written on the chemistry of these memoirs, but, to avoid extending these remarks to too great a length, only one more reference will be made.

In the communication to the Geological Magazine, p. 529, Mr. James Geikie, alluding to his proofs and evidence, says, "although to render them complete, they ought *perhaps* to be followed up by analysis of the rocks."

[1] When it is remembered that a single accurate chemical analysis of such a rock, which shows but a few lines in print, represents a value of from five to ten guineas in actual labour and expense to the chemist, it is easy to understand how, in general, so much appears in print about the ideal composition of rocks, and so little verification of the same by actual chemical analysis.

[2] The italics are *sic* in memoir.

The conviction on the writer's mind is not only that the *perhaps* should have been omitted, but also, that the analyses should have preceded, and not followed, the enunciation of views which these analyses, when made, may not improbably entirely annihilate.

How, may it be fairly asked, can any educated man, whether geologist or not, be expected to believe that greywacké may be converted into granite; unless, first of all, he is shown by chemical analysis that you have present in the first, the chemical elements requisite for the formation of the latter, or if not, that you have a rational mode of explaining how any deficiency in component parts has been supplied, or any surplus removed.

If such tangible data and explanations cannot be given, then all like hypotheses must share the fate of the old alchemical visions of transmutation, and it is but waste of time, thought, and energy to place them before a rational public.

Supposing, for the sake of argument, however, that data are given which showed that there was no obstacle, from a chemical point of view, to believing that a certain bed of greywacké had been converted into granite, then these very facts would be most conclusive arguments against Mr. James Geikie's assertion that this greywacké had not only been converted into granite, but, also into diorite, serpentine, porphyrite, etc., etc.; all rocks, differing essentially in chemical and mineralogical composition, not only from granite, but from one another.

(2) *Mineralogy.*—Although the mineralogy of these memoirs will be considered, chiefly in conjunction with the petrology, still some points, purely mineralogical, require more definite explanation than the author gives; for example, with respect to felspar, on the study of which so much of his results are based, is not the mineralogist entitled to demand (seeing that this name is only a generic one, including mineral species widely differing from one another in chemical composition, as orthoclase, oligoclase, albite, anorthite, labradorite, etc.) that the author should state what mineral he actually alludes to, or if not crystallographer enough to do so, at least state whether he writes of potash, soda, or lime felspars; for how else can any opinion be formed as to whether the species of felspar is at hand which is characteristic of the rock which he supposes is formed by his metamorphic agency. For example: supposing the felspar alluded to was a lime felspar, then the crystalline rock formed by the metamorphic action could not be a granite, for we know that lime felspar is never a normal constituent of any granite.

At page 516, Quart. Journ., under the head of "Amygdaloid," it is stated that "the matrix consists of a paste of felspathic matter, with here and there a variable admixture of magnesia and lime." Mineralogists would find this somewhat difficult to explain, as native lime is never found in the mineral kingdom, and native magnesia only occurs in some active volcanoes, as the extremely rare mineral periklase,[1] so that neither of these substances are likely to have been

[1] A hydrate of magnesia is also known as brucite.

met with. If intended in a chemical sense, nothing short of actual analysis could prove their presence.

Again (page 521, Quart. Journ.), the crystallographer will be rather puzzled by the reference to "Porphyritic Felspar Crystals."

(3) *Petrology.*—In such an investigation as the present, it ought to be superfluous to insist upon the most scrupulous care and attention being devoted to the petrological character and description of the rocks forming the subject of the inquiry; for how otherwise can geologists know that they are referring to one and the same rock in their inquiries ?

Here it is to be feared that the Geological Survey have not shown an example worthy of imitation, when such names are used as syenitic granite for hornblendic granite, augitic greenstone for dolerite, greenstone porphyry for porphyritic greenstone, along with granitic porphyry, syenitic porphyry, dioritic porphyry, trachytic porphyry, felspar porphyry, syenitic greenstone, felspathic greenstone, felspathic trap, etc., etc.; and when upon examination in the field, rocks coloured as greenstones on the map of the Survey frequently turn out to be dolerites, felstones, altered clay slates, etc., whilst at the same time no explanations have been furnished by the Survey, whether mineralogical or chemical, for the use, or rather misuse, of such names.

Surely the petrologist may throw up his hands in despair when he finds Mr. James Geikie defining minette as a *quartzless* granite; just as soon would he expect to see limestone defined as a clayless marlstone, or as a calcareous sandstone without the sand. If the mineral component which specially characterises granite, when composed with all other analogous rocks, is to be left out, surely there can be no sense in retaining the name of granite at all.

Such similes are unworthy of the geologist as tending to mislead others less versed in petrology; for even if minette was proved to have been formed from greywacke,[1] by hydrothermal or any other action, such a fact does not value one iota in proving that it also could be transmuted into granite, but the reverse.

At page 527, Quart. Journ., petrologists are told, "that under the term dioritic are included all those rocks which consist essentially of silicates of lime and magnesia set in a Felspathic base or matrix," a definition which no petrologist would for a moment admit, for then he would have to regard as diorites, not only many porphyrites, dolerites, &c., but also such true volcanic lavas of the present period as are composed of a felspar with olivine, wollastonite, monticellite, augite, etc.

The petrologist defines diorite to be a rock composed of one or more felspars with hornblende, and regards greenstone as that variety of diorite in which green or dark-coloured hornblende either predominates, or, when the rock is fine grained, renders more obscure the presence of the felspar.

What therefore a "granitoid diorite," (referred to page 530, Geol.

[1] A rock which, it must be remembered, consists essentially of seventy-five per cent. of quartz.

Mag.) may be, is difficult for a petrologist to understand, especially since he is immediately informed that it "is simply an admixture of hornblende with white and pink felspar," and further told that it is "of a more granitoid and less basic character than the usually finer grained and often dull earthy rocks of dykes, which here and there intersect the coal-measures;" and, to complicate this confusion, in a foot-note adds, "most of the trap dykes of the Scottish carboniferous strata, however, are not hornblendic, but augitic *greenstones* or dolerites."

In investigations where exactitude is essential, trap is an extremely vague name to designate rocks by, as was long ago admitted, for as early as 1827, Brongniart[1] says, "C'est encore un très mauvais nom, etc," and the term "felspathic traps" for one of their many varieties of same is certainly not an improvement in the name of a rock which, under all circumstances, is essentially felspathic, having a felspathic base. The name trap, originally adopted from the Swedish geologists, was understood to denote any compact dark-coloured rock composed of felspar with augite.

The name wacké is another, which has but little true signification, further than being usually applied to any dirty, indistinct mass, in which the structure is obliterated; it is evidently, however, a favourite with the author, who writes of "decomposing wackés," "calcareous wackés," "altered wackés," and "highly alkaline wackés," etc.

Again the term porphyry, when applied to rocks, is frequently improperly employed; when used as an adjective, to imply a definite structure, it is understandable, as porphyritic greenstone; but the terms felstone porphyry, felspar porphyry or felspathic porphyry, sound rather tautological. If the application of this term in petrology, when used to designate a definite rock, is inquired into, it will be found that it was originally used to denote such rocks as consisted, like the true antique porphyry, of crystals of felspar set in a paste of semicrystalline or amorphous felspar. It is therefore difficult to imagine a rock more felspathic than one composed mainly of felspar, and one might just as well write of quartzitic quartzites as "of felspathic porphyries;" again, what is to be understood by the term "porphyritic felstones" as different from porphyries?

4. *Geology.*—It would be impossible to enter into an examination of the geology of these memoirs without some local knowledge, which the writer does not possess; but before concluding he would still enter his protest against some of the geological views put forth by the author.

Thus, at page 517 and following of the memoirs read before the Geological Society, great stress is laid upon the circumstance that, as, instead of being flattened and drawn out, the vesicles found occurring in these rocks are spherical, and are so over considerable areas, the rocks therefore cannot be trappean or igneous; now surely, any geologist acquainted with volcanic rocks knows that spherical is

[1] Classification des Roches, p. 63.

the invariable normal form of all such vesicles in lavas, etc., and that the drawn out or elongated flattened form is a subsequent modification assumed by the spherical vessels, either under the influence of superincumbent pressure, or from the lava cooling more slowly, and thus allowing the movement of the mass, when still in a viscid condition, to draw out the spherical vesicles into somewhat of an almond-like shape. Abundant instances, however, could be cited where both lavas and traps also have retained their original spherical shape over extensive areas, probably from their having cooled somewhat more quickly, or from having not had much motion communicated to them under solidification.

Again, page 532 of the Geol. Mag., it is stated in a foot-note that "It is certain, however, that rocks such as diallagite, hypersthenite, diorite, syenite, and even granite itself can be developed directly from aqueous rocks, etc." This assertion appears to be put forth solely upon the authority of Mr. James Geikie, for a careful examination of the literature of the subject in the English, French, German, Spanish, Italian, Swedish, and. Danish languages, certainly does not confirm it, and it is to be hoped that geologists will require positive facts, and not vague hypotheses, before they accept such a statement for granted.

The writer believes that in several cases, at least, where views of this nature have been entertained, they have been formed by persons not much acquainted with petrology or mineralogy, from their confounding certain rocks with names which did not in reality pertain to them. An example, illustrative of this, may be cited: The writer of these remarks, finding from an examination of the sheets of the Geological Survey that large masses of greenstone were represented as occurring in Cornwall, near Penzance, and at the Botallack mines, immediately imagined that he would there find the same relations of this greenstone to the metallic lodes, occurring as he had found to be the case in South and North America, Spain, Norway, Sweden, etc., and made a journey expressly for this examination; on arrival he at once found that the rocks had evidently been metamorphosed *in sitû*, and they no doubt originally had only been the ordinary sedimentary clay-slates. Had he now been content with the decision of the Geological Survey that the rocks in question really were greenstones, then he must at once have come to the conclusion that greenstones could be formed by the alteration of clay-slates *in sitû*. It did not, however, require a long examination to prove that the rocks were neither petrologically, mineralogically, or chemically, greenstones, or even any allied rock, being nothing more than clay slates altered *in sitû* and possessing none of the properties of greenstones beyond the greenish tinge which coloured them.

Geologists have been accustomed to define, as eruptive or intrusive rocks, such rocks as are met with apparently breaking through, protruding into, or sending out ramifications, dykes, or veins, into the adjacent stratified deposits.

Mr. James Geikie (p. 530, Geol. Mag.) refuses any longer to accept this definition, and cautions geologists against accepting such, as a test of the eruptive origin of such rocks.

The writer would state that his experience, both in the field and out of it, confirms himin adhering to the old definition, and he finds (in which he believes most geologists will concur with him) no evidence in Mr. James Geikie's memoirs to shake his confidence in it.[1]

The writer of these remarks does not, in this communication, even wish to express any opinion as to whether the views adopted by Mr. James Geikie are right or wrong; but leaves it to the geological reader, after perusing them, to decide for himself how far the conclusions arrived at by that gentleman are entitled to confidence. He would, however, wish it to be understood that in bringing forward these remarks, he is not in any way influenced by any feeling of personality against a gentleman whom he has never even seen; and he may state that the substance of this communication was put upon paper long before the papers here referred to appeared, having been intended as an answer to similar views[2] elsewhere put forward, and based upon similar (in the writer's opinion) unsound data. The appearance of Mr. James Geikie's memoirs, apparently representing in some measure the views entertained by the Geological Survey of Great Britain, decided the writer in at once protesting against the nature of the evidence by which the opinions were supported. No theoretical views can now expect to be accepted in science without having had the evidence in their favour thoroughly scrutinized and subjected to the cross-examination of the collateral sciences, for times are much changed from what they were some fifty years ago, when it was a common practice to explain effects, apparently unaccountable, by referring them to the agency of electricity, or some other then little understood cause, thereby finding a convenient solution for avoiding the labour of working out abstruse problems; it is, however, to be hoped that geologists

[1] The writer takes the opportunity of here stating, that the results of a protracted study of this subject (several of the details of which will be found in a series of communications, which have appeared at intervals, since 1853, in the Magazin för Naturvidenskab, Skandinaviske Naturforskeres Forhandlinger, Philosophical Magazine, Quarterly Journal of the Geological Society, Edinburgh Philosophical Journal, and other periodicals), have induced him to conclude :—

(1.) That when the geological epoch of the appearance of an eruptive or intrusive rock is known, such rock will be found to differ essentially, in mineral constitution, from similar rocks injected at a different geological period.

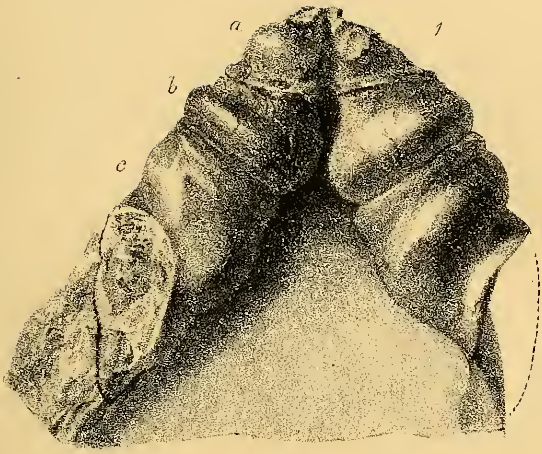
(2.) That eruptive or intrusive rocks of identical mineral constitution, have made their appearance or intrusion into the earth's crust at the same geological epochs.

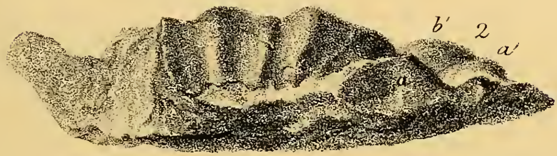
(3.) That the minerals, or classes of minerals, accompanying or associated with such intrusive or eruptive rocks, may serve as a means of distinguishing the several eruptions in geological chronology, in a manner analogous to the determination of sedimentary strata, by the fossils, or classes of fossils, which they may be found to contain.

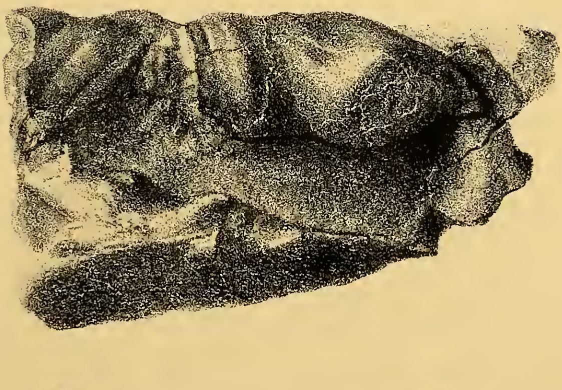
[2] The views in question are far from being new, for under various dresses they appeared, were discarded, and re-appeared from time to time, even from the infancy of geology; some of their advocates having even gone so far as to suppose that the state of granite was one which all rocks would ultimately arrive at, after undergoing a process of slow but constant internal alteration or fermentation.

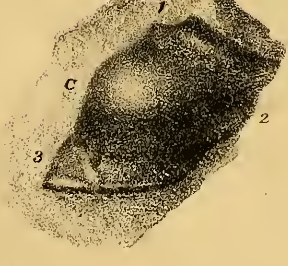

J. Dinkel del. et lith. W West imp

COCHLIODONTS.





J. Dinkel del. et lith. W West imp.

COCHLIODONTS

will not now make a similar convenience of hydrothermalism, but put their shoulders to the wheel, study hard at the collateral sciences, and work out upon a sound basis the true parts which each different agency has played in nature's operations.

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## II.—On the Mandible and Mandibular Teeth of Cochliodonts.

By Professor Owen, F.R.S., F.G.S., Etc.

[PLATES III. AND IV.]

THE extinct cartilaginous fishes represented in 'mountain limestone' and similarly aged carboniferous formations by detached teeth, or dental masses adapted for crushing, have been referred to the Cestraciont family; and, so far as I know, have now no nearer living representative, in the class of fishes, than the Port Jackson shark (*Cestracion Philippi.*)

The detached condition of the so-called 'palates,' indicates a similar ligamentous attachment of the teeth to a cartilaginous jaw, as in that genus, and the oblique course of their main elevations and furrows (Plate III., Fig. 1, e. g.) is repeated in the arrangement of the series of smaller and more numerous crushing teeth of *Cestracion* ('Palæontology,' p. 127, Fig 41), so as to have suggested the remark that "it would seem as if the several teeth of each oblique row in *Cestracion* had been welded into a single dental mass in *Cochliodus*, the proportions and direction of the rows being closely analogous" (*ib.* p. 128).

Whether, however, the resemblance between the carboniferous and existing Australian conchivorous sharks was carried out in the form of the jaws, and especially their forward prolongation with a rasp-like arrangement thereon of pointed teeth for working down to, and extracting from, their sandy beds and burrows, the shell-clad mollusks and crustaceans, constituting the food of such fishes, I had not been able satisfactorily to determine at the date of the above-quoted paragraph (8vo. 2nd Ed. 1861).

I have since, however, been favoured by the Earl of Enniskillen and the Rev. Professor Sedgwick with the opportunity of examining some specimens that settle this point, and indicate that the extinct crushing-sharks of the mountain limestone period, though instructively represented by a lingering member of a once numerous section of *Chondropteri*, must be relegated to a distinct though conterminous family, for which I propose the name *Cochliodontidæ*, from what may be regarded as the representative genus, *Cochliodus* Ag. (Pl. III).

The specimen, Figs. 1 and 2, of the dentary part of the mandible with the teeth of each ramus, though somewhat mutilated as regards both jaw and teeth, shows the confluence of the rami at a symphysis which, in relative position to the teeth, would correspond with the parts of the mandibular rami of *Cestracion* containing the anterior crushing teeth. The fore-part of the symphysis itself is, indeed, broken away; but its small vertical depth at the point of fracture, together with the small tranverse extent, and the angle at which the rami converge thereto, afford no ground for assuming that the symphysis was prolonged, as in *Cestracion*, for the support of conical or any other teeth. The absence of such conical teeth, detached, in the matrix, had, indeed, led to the inference of their non-development in the jaws of these mountain limestone fish. But the better-preserved mandible of *Tomodus convexus*, Ag. 1859,[1] (Pl. IV. Figs. 2-5), leaves no doubt of the short-pointed edentulous termination of the symphysis a little way anterior to the series of large molars or crushing teeth. The resemblance of this mandible to that of the similarly endowed jaw of the elephant, is interesting, as exemplifying the adaptive relations of bone, sustaining and working dental masses like millstones in species of classes the most remote from each other in the vertebrate series.

In the mandible of *Cochliodus* the teeth are, originally, three in each ramus, and the primitive distinction sometimes remains longer in the 'vasodentine,' or osseous basis of the tooth, than in the 'vitrodentine,' or enamel covering of the tooth.[2] The anterior tooth, *ib.* Fig. 1 *a* is the smallest, of a triangular form; its chief part formed by the mid-lobe or ridge, *a*, which is very convex and obliquely and gently contorted from behind and below, upward, inward, and forward, with a slight increase of breadth or, fore-and-aft diameter, in this course, and with the moderately convex inner or mesial border in contact with that of the tooth of the opposite ramus. The anterior lobe seems to have had the form of a small tubercle, but its summit is broken off; the posterior lobe is a narrow, seam-like, raised border, extending farther back on the outer side, Fig. 2 *a*, than on the inner side of the ramus.

The middle tooth, (Pl. III, Figs. 1 and 2 *b*), is of greater transverse than antero-posterior extent, and, like the foremost, consists mainly of the second or mid-lobe: its crown is a longish triangle, with the short base 'mesiad,' and the obtuse apex laterad, or outward. This, in the tooth of the right side, is shown in Fig. 2 *b*: as it rises from this side or end the lobe is very prominent, but it slightly subsides, as it expands and bends over the mandible to the inner surface, where it is in contact for four-fifths of its extent with the same surface of the opposite tooth, (Pl. III. Fig. 1 *b*). The anterior lobe, very narrow at the outer side or apex of the tooth, increases in antro-retral breadth to the inner side or base of the triangle, but with scarcely any elevation. It makes, thus, part of the border of the tooth slightly concave, as shown on the right side, in Fig. 1. The posterior lobe, or ridge of this tooth, *b*, is obsolete.

The third and largest tooth is that on which the genus and

[1] *Cochliodus magnus*, Ag. 1835.

[2] This structure of the teeth, recent and fossil, of *Cestracionts* and *Cochliodonts*, was microscopically determined and described in my Paper "On the Structure of Teeth," Reports of British Association, 1838, p. 135. "These teeth are composed of two substances, viz., an external almost colourless layer, with a finely punctate surface, which represents the enamel, and a coarser dentine composing the body of the tooth, and continuous with and passing into its basis of support."—*Ib.* and Odontography, p. 54. In the article 'TEETH,' Cyclopædia of Anatomy, vol. iv. 1852, these dental tissues are defined under the names 'vasodentine,' and 'vitrodentine,' p. 865.

species was originally founded, and is the most common among the many detached 'palates' of the English mountain limestone localities. It is mutilated in both halves of the jaw; but I have figured more entire specimens of this tooth, from the right ramus of the lower jaw, (Pl. III. Fig. 5), and from the left ramus, (Pl. III. Fig. 4); which positions in the jaw, the specimen (Fig. 1) enables one to determine, in detached teeth.

In this third or posterior grinder (Pl. III, Fig. 1 *c*) the longitudinal exceeds the transverse diameter, but the triangular form of the crown prevails, the base now forming the longest side (Fig. 5,[1, 2, 3]), and the apex being more truncate than in the middle tooth. The apex, or outer side of the third tooth, is shown at Fig. 2 *c*, or rather the vasodentine supporting the apical part of the vitrodentine, which is here very thin, and a small part of it is broken off in the specimen. The mid-lobe, *c*, as it rises, bends inward and slightly backward, maintaining its convexity as it expands, better than in the tooth *b*, and terminating, medially or internally, in a gently convex thin border. In the detached homologues of this tooth, from both sides of the jaw, the mid-lobes hows at its inner half a surface worn more or less flat by trituration and sloping from before, outward and backward. The reticulate surface of the osteodentine often takes the place of the punctate surface of the vitrodentine at the middle and toward the back part of this worn surface, showing where the pressure and attrition was greatest from the opposite upper crusher. The anterior lobe of the third tooth, at its apex or outer end, Fig. 2, is almost as broad from behind forward as the middle lobe, but it gains in that diameter very slightly as it curves over the tooth to the inner side, and it is very little elevated, especially in the upper and inner surfaces; there is, however, some variety in this respect, as in the detached tooth, Fig. 4, but not to a degree which I am disposed to regard as specific. The posterior lobe (Figs. 4, 5[3]), of equal breadth with the middle one on the outer border (Fig. 2 *c*), increases in antero-posterior extent, as it curves inward, in a greater degree than does the anterior lobe, but in a less degree than does the middle one; it soon loses the slight degree of fore-and-aft convexity, with which it began externally, and, from being flat, becomes slightly concave on its inner and broader end. In passing from without inward, the third lobe inclines more backward than either of the preceding lobes, and the anterior lobe the least so, the almost (antero-posteriorly) flattened surface on the third lobe slightly rises toward its posterior border, which is smoothly rounded, Fig. 4[3].

The substance of the mandible supporting the teeth equals in vertical extent that of the tooth it supports; it goes on increasing in depth posteriorly for the extent to which it is preserved, but diminishes in breadth, indicating a shape of jaw like that in *Cestracion*. The structure of the bone resembles that of the better ossified parts of the chondrine of plagiostomous fishes.

The third tooth, right side, lower jaw, of *Cochliodus* (Pl. IV, Fig. 1) presents specific modifications of form, as compared with that of

*Cochliodus contortus*, Ag. (Pl. III, Figs. 1, 4, 5), as well as with those of *Cochliodus magnus*, Ag. (now *Tomodus*) and *Cochliodus striatus*, Ag. (now *Xystrodus*) ; it retains, however, the present restricted generic characters of *Cochliodus*, and I indicate the species under the name of *Cochliodus compactus*; the predominance of the middle (2) over the anterior (4) and posterior (3) lobes giving the grinding surface of the tooth a more compact and simple character.

The specimen of the teeth *in sitû* of *Cochliodus contortus*, Ag. (Pl. III, Figs. 1 and 2,) is from the Carboniferous Limestone at Bristol, and forms part of the collection of the Rev. Professor Sedgewick, at Cambridge.

In Plate III., Fig. 3, is figured a small portion of the mandible or lower jaw, with the third tooth, *c.*, of the right side, and part of that tooth of the left side, of *Streblodus oblongus*, Ag. The third lobe forms a larger proportion of the tooth in this genus then in *Cochliodus* and gives a greater proportionate length to the breadth of the grinding surface of the entire tooth. The anterior lobe is represented by a mere seam. The middle lobe, commencing narrow, prominent, and ridge-like, externally expands, and subsides to a moderate convexity as it bends backward and inward over the jaw. The third lobe much more rapidly expands as it rises from the outer apex to arch over the inner side, where it has a wavy margin, an inch in extent, in a total length of grinding surface of one inch, seven lines. The upper convex surface of this third lobe shows the chief area of attrition. The portion of the jaw preserved shows a large and deep cavity within and behind the third tooth, which probably lodged the matrix or germ of its successor. The symphysis of the jaw was shorter and the rami met there at a more open angle in *Streblodus* than in *Cochliodus* ; the anterior ends of the last crushing teeth came into contact at the back part of the symphysis. What were the proportions of the homologues of *a* and *b* in *Cochliodus* (fig. 1), or whether both or either were developed in *Streblodus*, the mutilated outer or fore part of the symphysis, in this specimen, does not permit to be determined.

The present specimen (Pl. III. Fig. 3.), is from the mountain-limestone of Armagh ; and forms part of the collection of the Earl of Enniskillen, at Florence Court, Ireland.

The most completely preserved specimen of the mandible of a *Cochliodont* is that of the *Tomodus convexus* (Pl. IV. Figs. 2-5,) from the carboniferous limestone of Bristol. Apparently the whole of the dentary part of the right ramus and the anterior half of that of the left ramus are here shown (Fig. 2). The posterior end of the right dentary is of little breadth and depth, but it gains in both, and chiefly in the latter dimension, as it approaches the symphysis, and there rapidly acquires great breadth and thickness. The lower border (Fig. 3), is thick and rounded ; the outer side, (Fig. 4) moderately convex ; the inner side, (Fig. 5) somewhat wavy, being concave lengthwise at its middle part. The hind part of the symphysis extends back like a shelf (Fig. 2), from below the dentigerous surface of that part of the mandible.

The first and second of the teeth meet above the symphysis, as in *Cochliodus*; the third pair are rather wider apart than in that genus. The angle at which the two rami meet at the symphysis, is intermediate between those that respectively characterise the mandibles of *Cochliodus* and *Streblodus*.

The first tooth (Fig. 2, *a*) of *Tomodus* is relatively smaller to the the others than in *Cochliodus*; it is also more simple and conical in form—so far it resembles more the anterior teeth in *Cestracion*, but the apex is obtusely rounded. The second tooth has similar proportions to those in *Cochliodus*, but the middle lobe is somewhat less convex, and a posterior seam is better indicated. The third tooth (Fig. 2 *c*) is longer from before backward, in proportion to its breadth, than in *Cochliodus*, and it differs both from it and from *Streblodus*, in the lower and more general convexity of the grinding surface of the last tooth. This surface has been crushed in the specimen here figured, but will be illustrated, as also the teeth of *Streblodus*, from better preserved detached specimens, in a consecutive paper.

### EXPLANATION OF PLATES III. & IV.

#### PLATE III.

Fig. 1. Upper view of dentary part of the mandible, and of the teeth of *Cochliodus contortus*, Ag. From the Mountain Limestone of Bristol. Woodwardian Museum.

2. Outside view of right ramus of ditto; *a*. surface from which the right anterior tooth has been detached; *a'*. corresponding tooth of left ramus; *b*. right middle tooth; *b'*. part of left ditto; *c*. right posterior tooth, outer margin of.
3. Posterior view of part of mandible and teeth of *Streblodus oblongus*, Ag. From the Mountain-Limestone of Armagh. Museum of the Earl of Enniskillen.
4. Right third tooth of *Cochliodus contortus*, Ag.
5. Left third tooth of *Cochliodus contortus*. Both this and Fig. 4 are from the Carboniferous Limestone, Bristol. Museum of the Earl of Enniskillen.

#### PLATE IV.

Fig. 1. Right third tooth of *Cochliodus compactus*. From Carboniferous Limestone of Yorkshire. Woodwardian Museum, Cambridge.

2. Upper view of mandible and teeth, *Tomodus convexus*, Ag.
3. Under view of ditto.
4. Outer side of right ramus of ditto.
5. Inner side of ditto. From the Carboniferous Limestone, Bristol. Museum of the Earl of Enniskillen.

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## III.—On the Occurrence of Grey-Wethers at Grays, Essex.

By Professor John Morris, F.G.S.

THE occurrence of "Sarsen-stones," or blocks of so-called Druid sandstone, has not, I believe, been generally noticed in this locality, and their position may be of interest to some of your readers, more especially as the extensive workings both for Brick-earth and Chalk have obliterated many of the interesting sections for which the pits were celebrated.[1] Grays is well known both for its fine chalk-pits and extensive brick-earth deposits, the latter containing numerous

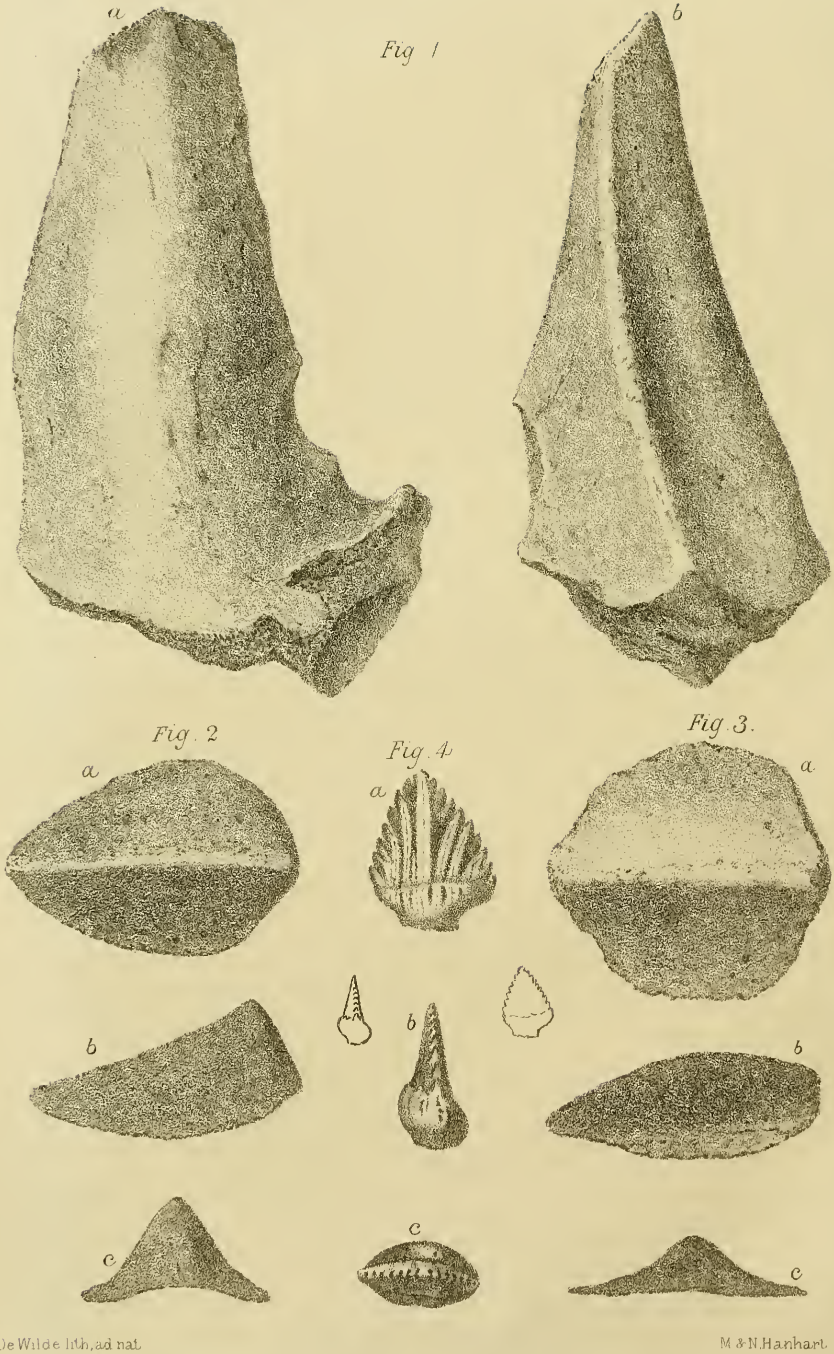
[1] Mag. Nat. Hist. 1836, p. 261; 1838, p. 539.

remains of fossil mammalia, associated with land and freshwater mollusca. The sarsen-stones (of which some may be still seen lying about the large chalk-pit), I have noticed during the progress of the workings as occurring on the upper surface of a bed of disturbed chalk, above the solid chalk, and covered by a blackish or carbonaceous clay containing freshwater shells. They are of various sizes, some very large, and more or less waterworn, and may have been originally derived from the boulder-clay. Their position was about mid-way between the back of the present workings and the entrance to the pit; but little if any brick-earth has been worked here, and it is probable that their position is equivalent to the base of the brick-earth deposits in the adjacent eastern brick-fields. The northern side of the great chalk quarry only exposes the eroded chalk and green-coated flint bed, overlain by Thanet sands covered by false-bedded sand and gravel and some brown clay. The brick-earth of two of the adjacent pits is almost worked out, these pits presenting only the obliquely-laminated sands and brown clays, which formerly were seen to rest on the brick-earth below (sometimes, however, separated by a thin bed of gravel), from which and its subordinate beds all the interesting fossil remains were obtained; the brick-earth being separated from the subjacent chalk by a bed of gravel varying in thickness in different parts of the area. The position of the brick-earth, with its shell-beds (*Cyrena, Paludina, Unio,* etc.), is only well seen now in the eastern field covered by the false bedded sands above noticed, where, in the upper part of the same field, the Thanet sands overlying the chalk may be observed.

The general section of these pits may be divided into two series, the lower, or fossiliferous zone, comprising the gravel and overlying brick-earth, in which both the mammalian and molluscan fauna occurred, and the upper or unfossiliferous zone, comprising the false-bedded sands and brown clays from which to my knowledge no fossil remains have been obtained.

Whether both these appearances are mainly due to the same agency, that of river action, may be considered doubtful. That the formation of the lower zone is evidently so, is proved by the nature of the remains embedded in it, while the false-bedded character of the upper sands affords evidence of a constant change, not only in the direction of the currents, but in the nature of the material deposited and the absence of any organic remains. The uppermost bed is again different, and may have been the result of other agencies than those which formed the preceding subjacent strata. Generally speaking, the deposit at Grays may be mainly due to the action of a river flowing through a valley, which it has partly excavated, in the lower tertiary and upper chalk beds, and most probably posterior to the boulder-clay period.

NOTE.—A paper by Lieut.-Col. W. T. Nicolls, entitled "Remarks on some 'Sarsens' or Erratic Blocks of Stone, found in the Gravel in the neighbourhood of Southampton, Hampshire" (with a plate), appeared in the GEOLOGICAL MAGAZINE, for July, 1866. Vol III., p. 296.—*Edit.*




De Wilde lith. ad nat. M & N. Hanhart imp.

ACANTHOPHOLIS HORRIDUS.

*Chalk Marl, Folkestone.*

## IV.—On *Acanthopholis Horridus*, a New Reptile from the Chalk-marl.

By Thomas H. Huxley, F.R.S., V.P.G.S.,
Professor of Natural History in the Royal School of Mines.

PLATE V.

SOME time since, my colleague, Dr. Percy, purchased from Mr. Griffiths, of Folkestone, and sent to me, certain fossils from the Chalk-marl near that town, which appeared to possess unusual characters. On examining them I found that they were large scutes and spines entering into the dermal armour of what, I did not doubt, was a large reptile allied to *Scelidosaurus*, *Hylæosaurus*, and *Polacanthus*. I therefore requested Mr. Griffiths to procure for me every fragment of the skeleton which he could procure from the somewhat inconvenient locality (between tide-marks) in which the remains had been found, and I eventually succeeded in obtaining three teeth, with a number of fragments of vertebræ, part of the skull and limb-bones, besides a large additional quantity of scutes. I am still not without hope of recovering other parts of the skeleton; but as the remains in my hands are sufficient to enable me to form a tolerably clear notion of the animal's structure, a brief notice of its main features will probably interest the readers of the Geological Magazine.

The dermal bony plates or scutes (Plate V. Figs. 1–3) are of very various forms and sizes, from oval disks slightly raised in the middle, and hardly more than an inch in diameter, up to such great spines as that represented in Plate V. Fig. 1, which could have fallen little short of nine inches in length and five inches in the antero-posterior measurement of its base. The outer surface of all these scutes is irregularly pitted and, in the case of the long spines, is occasionally marked by branching grooves which doubtless lodged vessels.

Each scute is excavated on its attached face in proportion to the elevation of its outer surface, so that a transverse section of one of the depressed scutes is more or less roof-like, while that of one of the long spines shows it to possess a great internal cavity like the medullary cavity of an ordinary bone.

Some of the scutes, though comparatively few, are almost flat, with an obtuse median ridge, which is highest about the middle of the scute (Plate V. Fig. 3). But when the ridge is more prominent, as in Plate V. Fig. 2, its summit is usually placed very much nearer one edge than the other, so that one side of the triangular lateral aspect is much shorter and more perpendicular than the other. The short side, however, is not absolutely perpendicular in any scute among those which have reached me, and the summit consequently always lies within the circumference and never overhangs it.

The spine-like dermal plates are altogether unsymmetrical. If, as I suppose, the convex edge of that represented in Plate V. fig. 1 was anterior, then the posterior edge is concave, and the left side convex, with a slight longitudinal excavation in its anterior half; while the right side is much more deeply hollowed in the same direction. Furthermore, the anterior, convex, edgeis not straight, but is slightly concave towards the left, and convex towards the right side ; while the posterior, concave, edge is concave towards the right, and convex towards the left side. The ridge which forms the posterior edge is suddenly interrupted near the base of the spine by a deep notch, (Fig. 1, *a*,) which probably received the anterior edge of the next succeeding spine. The transverse diameter of the base of this spine could not have been less than four inches when it was entire.

I estimate that the more or less complete remains of nearly a hundred scutes of the different forms now mentioned, must have passed through my hands, and, as they all came from one small area, they probably belonged to one animal.

Such vertebræ as have been obtained, are in a very fragmentary state. The body of a dorsal vertebra is about 1·5 in. high, but has a less width; its length cannot have exceeded two inches. Its articular ends are very slightly concave, and it is somewhat narrower in the middle than at the ends. The neural canal is spacious, being not less than one inch high. The neural spine appears to have been low and inclined somewhat backwards. Another detached body of a dorsal vertebræ is 2·1 in. long, 0·2 in. high, 1·85 in. wide at its articular ends, and 1·5 wide in its centre. The sacrum of this reptile would be very interesting, but no fragment of that part of its skeleton has as yet made its appearance. Of the skull I possess only a very much mutilated fragment, showing the basioccipital and basisphenoid. The occipital condyle measures 1·4 transversely, or has about the same diameter as that of the skull of a *Crocodilus biporcatus,* which measures 16 inches in length, from snout to occiput. But it is more elongated transversely and excavated above than in the Crocodile, and the exoccipitals enter more largely into its composition. The Crocodilian disposition of the Eustachian tubes is absent, and the carotids run up the side of the basisphenoid in Lacertilian fashion. The *sslla turcica* has a well developed posterior plate.

Only three teeth have been found in connexion with these remains, but one of them is in a very perfect state, and was readily detached from the matrix, so as to be easily viewed from all sides, (Plate V. Fig. 4, *a*, *b*, *c*). The crown is broken off from the fang, which another specimen shows to be about as long as the crown and sub-cylindrical. The crown is nearly 0·4 long, the greater diameter of its base is 0·27, and the less about 0·2 ; it is shaped like a lance-head, with an acute point and sharp edges ; these edges are notched in such a manner that the crown exhibits eight serrations on each side of its apex. The enlargement of the crown into its swollen base is somewhat sudden, and takes place higher up on the one face of the tooth than in the other, so that when the tooth is viewed from one edge the one face appears concave and the other convex (Plate V. Fig. 4, *b*).

The most curious feature about this tooth, however, is its colour. The ground hue of the crown is pale brown, but vertical lines of dark chocolate colour run vertically and parallel to one another from the serrated edge to the swollen base, on which they die out. The middle of each intermediate pale brown band exhibits a very delicate dark line.

One of these pale brown bands occupies the middle of each face of the tooth and its apex. On each side of this are six or seven dark bands and as many interspaces. The dark bands correspond pretty nearly, but not exactly, with the summits of the serrations.

The shape of these teeth is quite different from that of the teeth of *Scelidosaurus,* which they approach most nearly.

The most perfect fragment of any of the bones of the extremities appears to be the distal end of a humerus. It presents a division into two condyles by wide and shallow anterior and posterior depressions, and the width of the bone in this part, when perfect, could hardly have been less than five inches. It narrows very rapidly, however, and where it is broken, at 3·5 in. from the dorsal end, its shaft is not more than 1·7 in. wide and as much in antero-posterior diameter. It has a large medullary cavity, the bony walls of which are on the average not more than 0·3 in. thick.

From the general resemblance of the dermal armour and teeth of this reptile to those of *Scelidosaurus, Hylæosaurus,* and *Polacanthus,* it plainly belongs to the same group; but its teeth separate it from the first genus, and the characters of its dermal armour from the two latter. I propose to call it *Acanthopholis horridus.*

My colleague Mr. Etheridge is good enough to supply me with the following precise determination of the stratigraphical position of the remains. I may add that numerous portions of *Ichthyosaurus campylodon* have been obtained by Mr. Griffiths "about six feet lower down" than *Acanthopholis.*

EXPLANATION OF PLATE V.

*Acanthopholis horridus,* Huxley.

Fig. 1. *a.* Side view of one of the spine-like scutes: *b.* Front view of the same.
Fig. 2. *a.* A more depressed scute seen from above; *b.* viewed laterally; *c.* viewed from the hinder, or more raised, end.
Fig. 3. *a.* A still flatter scute seen from above; *b.* viewed laterally; *c.* viewed from the hinder end.
(The preceding figures are one-half the size by nature.)
Fig. 4. *a.* A tooth viewed from one side; *b.* with one edge turned to the eye; *c.* from above.—The outlines give the natural size of the tooth.

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## V.—On the Stratigraphical Position of *Acanthopholis horridus* (Huxley).

By Robt. Etheridge, Palæontologist to the Geological Survey of Great Britain.

PROFESSOR HUXLEY'S communication, relative to the discovery of a new Reptile in the Lower Chalk of the south of England, which he has called *Acanthopholis horridus,* may be rendered more interesting by a detailed description of its stratigraphical position and its associated organic remains, a matter of some importance in this case, as few, if any, higher reptilian remains have occurred in the Lower Chalk of either Europe or England; whereas in the Wealden group below the true Cretaceous rocks, and still lower, in the Oolites and Lias, many genera occur. The discovery by the Rev. W. Fox of a remarkable and allied reptile in 1866, from the Wealden beds of the Isle of Wight, named *Polacanthus* by Professor Owen, increases still more the interest of this new genus, and is another reason why it is well to understand its geological horizon.

The remains were found in the autumn of the past year in the lower part of the Chalk Marl immediately east of Copt Point, Folkestone. The beds of the Lower Chalk here are much disturbed and pushed out of place, owing, doubtless, to the unctuous nature of the Gault which underlies the sandy Upper Greensand; and the Lower Hard Chalk, owing to its great superincumbent weight, has slid over and here pressed up the Gault and Upper Greensand seaward, thus giving a faulted appearance along a line from east to west; it is, however, superincumbent pressure only that has produced the crumpling and apparently reversed dip of the Gault, Upper Greensand, and the lower members of the Chalk. The true position of the whole series is admirably exhibited and easily understood along the shore to the eastward under Lyddon's Spout, etc.

The sequence of the beds near Copt Point, where the Reptilian remains were found, was at first difficult clearly to understand, from the circumstance of their occurring between high and low water mark, and the denuding agency of the sea, along the strike, or exposed edges of the beds which dip north, or towards the cliff, is constantly destroying the soft Upper Greensand and yielding Lower Chalk.

I was, however, enabled clearly to determine the true place of the fossil, and also its associated fauna. From the same bed I listed no less than forty species, comprising *Amorphozoa*, *Echinodermata*, *Mollusca*, and the remains of another reptile, *Ichthyosaurus campylodon*.

At Copt Point the Gault may be about 100 feet in thickness, preceded by (when moist) the dark-green sandy Upper Greensand, which is from fifteen to twenty feet thick, and at the upper part cuts a bright copper-green colour. This Upper Greensand is immediately succeeded by the hard, dense, pale-grey Chalk Marl, which becomes nearly white when deprived of its moisture. It was in the lower part of this, and about eight feet above the Upper Greensand, that the remains of *Acanthopholis horridus* were found by Mr. Griffiths, portions of which ultimately came into Professor Huxley's possession through Dr. Percy: their affinities were immediately recognised, but the characters being different to any known genus no pains were spared to obtain as much as possible of the remaining skeleton, and, although in a fragmentary state, yet enough has been obtained to establish the genus.

My attention, on visiting the section, was immediately turned to the associated fossils, which clearly determine the age and position of the remains, and definitely fix it as belonging to the lower part of the Grey Chalk series, (the Chalk Marl with *Brachiolithes*) and the remains of *Ichthyosaurus campylodon* and *Saurocephalus lanciformis* occurred in the same bed, numerous teeth of both genera being found. Many well-marked species of *Cephalopoda,* peculiar to this lower zone of the Chalk Marl, occur in the same matrix, viz., *Ammonites Rothomagensis,* Brong.; *Am. navicularis,* Mant *Am. Mantelli,* Sow.; and *Am. varians,* Sow.; which last species has a wider range in time and space than the other three. The noninvoluted sinistral *Ammonitidæ,* represented by *Turrilites costatus,* Lam.; *T. tuberculatus,* D'Orb.; *T. undulatus,* Sow. (*Scheuchzerianus* Bosc.); and *Scaphites æqualis,* occur plentifully, accompanied by *Nautilus elegans,* Sow. and *N. pseudoelegans,* D'Orb; *Terebratulina striata,* Schloth. (*rigida,* Sow.), *Terebratula biplicata,* Broch.; *T. obesa,* Sow., were the only species noticed as coming from that particular horizon, *Pleurotomaria perspectiva,* Mant.; *P. rhodani,* Brong., the latter peculiar to the Lower Chalk, occurs but sparingly, and chiefly in the form of casts. The associated bivalves of the group *Asiphonida,* are *Ostræa carinata,* Sow.; *Plicatula inflata,* Sow.; *P. pectinoides,* Sow.; *Inoceramus mytiloides,* Mant.; *Exogyra, Pecten orbicularis,* Sow., and casts of other species; and only one genus of the *Siphonida,* viz., *Pholadomya decussata,* was observed amongst them. Of the *Echinodermata* fragments of *Goniaster Coombii* or *G. mosaicus,* Forbes; *Peltastes clathrata,* Aq.; *P. umbrella,* Aq.; *Discoidea subucula,* Klein; *Holaster subglobosus,* Leske; *Pseudodiadema* (*Diadema*) resembling *variolare,* but eroded; and an *Hemiaster*; also club-shaped spines of *Cidaris.* All these species occur in the Chalk Marl along the shore, and are obtainable from fallen masses. Several *Amorphozoa,* such as *Chenendopora fungiformis, Brachiolithes labrosus,* and another species, are plentiful in places. This singular genus of Ventriculites forms the chief mass of the lower part of the bed in which the Reptilian remains occur. *Vermicularia* is the only annelide noticed.

The above organic remains were found associated with *Acanthopholis* in the same matrix, and they tend not only to elucidate the contemporaneous or co-existing fauna, but also to give exactness to the determination of its age. Whether the habits of *Acanthopholis* resembled the *Scelidosaurus* of the Lias, or the *Hylæosaurus,* and *Iguanodon* of the Wealden, future research may more definitely determine. We cannot, however, fail to notice that in this new form another link is added to the persistency of type preserved through so long a period of time, and through those numerous geological changes which occurred during the deposition and succession of the lower, middle, and upper oolitic rocks, as well as the Wealden and Cretaceous formations. It is to be regretted that the skeleton should have been so dismembered, but the unyielding nature of the matrix, which is tough, much jointed, and possesses that conchoidal fracture peculiar to hard marly deposits, rendered it almost impossible to remove it in any other way than piece by piece, and it was so incorporated with the remains, that none but an experienced workman could have succeeded in relieving even so much as is preserved to us.

## VI.—Note on the Systematic Position of Graptolites, and on their supposed Ovarian Vesicles.

By Wm. Carruthers, F.L.S.

ANY observations which can throw light on the systematic position of the *Graptolitidæ* are of great importance. That these anomalous fossils are Zoophytes, in the wide sense of the term, is almost universally conceded; the difficulty is in determining whether they are cœlenterate or molluscoid. Those who have described the members of the family have almost invariably considered them to be hydrozoa, and it must be allowed that in general aspect they very much resemble *Plumularia* and *Sertularia*. But when their structure is examined it will be found that they widely differ from any known hydrozoon, and especially in that the entire polypidom is composed of the different polype-cells, without any distinct common canal. Sometimes the polypes rise from a common substance which extends along the whole of the celluliferous portion of the organism, but there is no constriction or septum at the base of the cells, cutting off this common substance from the individual polypes. This is the structure of *Graptolitus priodon*, Bronn. In other species the walls of each cell seem to be continued to the solid axis, as is the case most probably in *Graptolitus sagittarius*, L. and certainly in some of the species with a double series of cells, as *Diplograpsus folium*, His. *D. pristis*, His. and *D. cometa*, Gein. The mouths of the cells are frequently furnished with one or more long spines, as in some species of *Rastrites*, and in *Diplograpsus pristis*, His. In these characters the graptolites show a greater affinity with the polyzoa. Compare the genera *Scruparia* and *Bicellaria*. But there are some peculiarities which do not well agree with the living forms of either section of zoophytes. Among these may be mentioned first the prolongation of the solid axis in both the unilateral and bilateral forms beyond the celluliferous portion in the newer part of the polypidom, and then their free polypidoms, for neither the spines which terminate the older portion of some species of *Diplograpsus* nor the slender base of *Dendrograptus linearis*, Car., could be radicles, and the species of the genus *Graptolitus* have no indications of a hydrorhiza from the older extremity.

Any information as to the method of reproduction would greatly assist in forming an estimate of their affinities. In the November number of this journal (Vol. III. p. 488), Mr. H. A. Nicholson drew attention to some minute organisms from the graptolite shales of Moffat, which he supposes to be the ovarian vesicles of Graptolites. I have in my collection two or three distinct forms of these capsules, and I have considered (perhaps wrongly) the fossils figured by Mr. W. H. Baily in the explanation to sheet 133 of the Irish Survey, p. 12, as another form. Thinking they might be ovi-sacs, I have for many years been carefully looking out in my quarryings in the Moffat shales for any indication of the connection between the organisms and the graptolites. In shales where every fossil is almost always compressed to a mere film, and the remains are confusedly scattered over the surface of the laminæ, mere juxtaposition, without a traceable union, is of little importance. I believe the specimen figured by Mr. Nicholson, which was the only one he observed, is a case of mere juxta-position. If we are to be guided in our interpretation of these organisms by the structure and relation of parts in recent forms, it will be difficult to find an ovarian vesicle attached by a large mouth to the polypidom, or having the relation to two cells which is shown in Plate XVII. Fig. 3 (l.c.), and we do not know any hydrozoon which has "corneous 'gonophores'" that become "free swimming 'zooids.'" Supposing the minute fossils to be ovarian vesicles, we would be inclined to consider the elongated mucro to be the pedicel. The broad end is always very faint, indicating that the wall of the capsule was thinner at this place. Indeed the fossil remarkably resembles the gonophore of *Sertularia operculata,* L. except in the great difference in size. If it belonged to the graptolite, we should expect a similar relation to the supporting organism. In *Sertularia* the ovi-sac has a very simple structure. In the allied genus *Plumularia* the sac is composed of the polype-calls of a branch specially altered for this purpose, as was shown by Edward Forbes. It consequently occupies the position of the branch, but in *Sertularia* the sac rises from the surface of the common canal and does not interfere with the symmetry of the parts. I have never been able to detect in any graptolite the suppression of a cell, far less of a series of them, that would indicate their possessing a vesicle having the structure of those of *Plumularia,* nor have I seen on the polypidom of the fossil any scars that could have been produced by the fall of the capsule. The organisms that Hall found on a species of *Diplograpsus* have a very different aspect from those found at Moffat. He believes that the contents of the ovi-sacs were minute graptolites like the parent. He figures a small specimen very near to the mouth of a sac, from which he considers it has just escaped. This also would be anomalous in hydrozoa. In the volume of the Proceedings of the Royal Physical Society of Edinburgh, published in 1858, I figured a young specimen of my *Diplograpsus tricornis,* which seems to be the same species as that subsequently figured by Hall under the name of *G. Whitfieldii.* I have traced its growth from the youngest condition where the three spines were at the proximal end, and the slender solid axis at the distal, and only a delicate membrane expanded between without indication of cells. As the organism grew the cells appeared, and gradually developed around the free portion of the axis. I have noticed a similar growth in *D. pristis,* His., and I believe also in *D. cometa,* Gein., a beautiful species not uncommon in the Moffat shales. It would be an important observation if anything like these younger forms could be detected in the interior of a capsule, but in the hundreds I have examined I have seen no indication of their contents; and in the innumerable specimens of double graptolites which my hammer has laid open, I have never seen anything like what Hall has figured.

The oval or rounded bodies which Mr. Nicholson figures are most probably specimens of *Siphonotreta micula* which occur in these graptolitic shales. His description and figures, as far as they go, correspond with M'Coy's fossil, which I have found at Garple and elsewhere in Dumfriesshire.

## NOTICES OF MEMOIRS.

### I.—The Fossil Fish of Mount Lebanon.[1]

THE fossil fishes of Mount Lebanon appear to have been first noticed in the time of the Crusaders, and subsequently by the travellers Korte, Lebrun, Volney, and mentioned by Scheuchzer, in 1708. They were first scientifically described by Blainville, who noticed two species, and afterwards by Agassiz, Sir Philip Egerton, Heckel, and Pictet. New researches on these fishes by MM. Humbert and Pictet have been published at Geneva, illustrated by 19 plates. By these authors the fishes are considered to belong to the Cretaceous period, from the great number of Teleostean fish and the absence of Ganoids,—from a certain number of genera or groups which exclusively characterize the Cretaceous period—from the great number of extinct genera which give a special physiognomy to these faunas, such as at Hakel, the *Pseudoberyx*, *Petalopteryx*, *Coccodus*, *Aspidopleurus*, and *Cyclobatis*, and at Sahel Alma, the *Pycnosterinx*, *Cheirothrix*, *Rhinellus*, and *Spaniodon*, and lastly, from the fact that the genera which have living representatives are the most abundant at Lebanon, such as the types of the *Beryx*, the *Clupea*, and *Chirocentrites*, which are more or less eminently Cretaceous, or have their commencement in that period.

From a general comparison of the fish fauna of Hakel with that of Comen in Istria,—of the fauna of Sahel Alma with that of the Westphalian Chalk, and both of them with the Cretaceous fauna of England, the authors consider that the fishes of Lebanon belong to the Middle Cretaceous period.

In reviewing this fauna palæontologically, or in relation to the previous Jurassic and subsequent Tertiary periods, some interesting facts appear. Taking the classification of fishes by J. Muller, but three of his sub-classes have fossil representatives, the Elasmobranchs, Ganoids, and Teleosteans. The latter being generally considered to have first appeared in the Cretaceous period, but the genera *Tharsis*, *Leptolepis*, etc., are now recognised as Teleosteans, and related to the *Halecoides*,—fishes which possess in a high degree the normal characters of the class, and of which they represent somewhat the archetype. The Elasmobranchs are not abundant at Lebanon, the principal forms belong to sharks and rays. The Ganoids are not represented in this fauna, for the Hoplopleurides are not true Ganoids. The third sub-class, the Teleosteans, are the most important, and constitute nearly the whole of this fauna. Of this sub-class, the *Helecoides* contain nineteen out of fifty-one species;

[1] Nouvelles recherches sur les Poissons fossiles de Mont Liban, par MM. F. J. Pictet et A. Humbert, Geneva, 1866.

next in importance are the Ctenoids. The fish with pectinated scales present four types respectively, represented by the group of the *Beryx*, the *Pseudoberyx*, the *Pycnosterinx*, and *Platax*. These four types, very distinct at the present day, are found at their first appearance to have some characters in common, which become diminished or effaced in succeeding periods, so that they represent the base of four divergent rays, between which are intercalated all the families which have not existed before the Cretaceous epoch. Other Teleosteans, but much more rare, are also found at Lebanon, such as one or two *Sparoides*, one or two *Gobioides*, and a curious genus, *Petalopteryx*; and lastly, the *Hoplopleurides*, characterized by a series of scales arranged in longitudinal rows, form a group which at present are special to the Cretaceous period. Thus the fauna of Lebanon, like other Cretaceous faunas, presents relations to succeeding and scarcely any to preceding ones; the general character being the great diminution of Ganoid, and their replacement by many Teleostean fishes.—J. M.

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## II.—Coal Discoveries, and Primordial Fossils, in Nova Scotia, and New Brunswick.

[Extract of a letter from Principal Dawson, F.R.S., etc.]

While your attention in England is much occupied with questions as to the character of your coal-fields, ours in British America is excited by the constantly recurring discoveries of new and greater deposits, almost beyond our present power to utilise them. The great coal-seam of Pictou, thirty-eight feet in thickness, and accompanied by three other workable beds, having an aggregate thickness of nearly as much more, has long been known; but, until recently, its horizontal extent had been proved only over a very limited area. Within the past three years, an extension of these great beds, with only slightly diminished thickness, has been proved over five other properties, which must contain an aggregate workable quantity of at least one hundred and fifty millions of tons of good bitumimous coal, and there are the best reasons for believing that a much greater extension of these beds will yet be found. The capabilities of our other coal-fields in Nova Scotia and Cape Breton, are also almost daily receiving new illustrations, by the opening up of additional coal areas. Some of the new mines are being worked by companies in Nova Scotia or in Canada, but the greater part by companies in the United States. It seems strange that these deposits, near the coast, within ten days of England, and in a country where the means of subsistence are cheap, should not attract, to a greater extent, the attention of English capitalists, with the view of making them a means of extending British mining and manufacturing industry.

Little notice appears to have been taken in England of the very remarkable discovery, by Messrs. Matthew and Hartt, referred to in Prof. Bailey's Report, on Southern New Brunswick, and also in a paper by Mr. Matthew, in the Journal of the Geological Society, of a primordial fauna, equivalent to Barrande's "Etage C.," and to the English Lingula flags, in the slates of the vicinity of St. John, New Brunswick. Mr. Billings has recently examined a suite of these fossils, and perfectly agrees with Mr. Hartt, as to their age, which in his opinion will place them below the Potsdam Sandstone, and on the horizon of Salter's Menevian, and will bring for the first time into their true geological position the older slate series of Nova Scotia, Newfoundland, and New England. Mr. Hartt hopes soon to publish descriptions of these fossils, including no less than five species of *Paradoxides*, and seven of *Conocephalites*,

These and other important new facts, I shall endeavour to apply to the elucidation of the geology of the Eastern part of British America, in the new edition of my "Acadian Geology," now preparing for the press.

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### III.—Coal of Pictou, Nova Scotia.

THE coal-field above alluded to, now proposed to be worked, is called the Bear Creek Mine, and is considered by Dr. Dawson and Mr. Robb to be a continuation of the same coal seams as those opened out in the adjacent district, and known as the Albion and Acadian mines. The Pictou coal-field presents peculiar and exceptional characters, as well as local complexities of structure, which Mr. Robb considers to be due, first, "to the existence of folds or flexures in the older rocks previous to the deposition of the Coal-measures; causing irregularities of surface, which by determining the direction and intensity of currents, would produce a great diversity in the thickness and quality of the beds. And secondly, to the continuance of the same elevatory forces which have originated the folds, subsequently to the filling up of the troughs; and producing in the Coal-measures themselves a series of anticlinal and synclinal folds, with dips varying in direction according to the original trend of the rocks; and in amount according to the sharpness of the folds."

The Bear Creek mine comprises about 1080 acres, and has been found to contain four coal seams, the thickest being 19 feet, these beds, according to Mr. Robb, being identical with the Deep, Main, and McGregor seams of the Albion mines. The lowest seam or Frazer oil coal of those mines, yielding on distillation 200 gallons of crude oil per ton, has not yet been discovered at Bear Creek, but there is scarcely any doubt that it exists there. The aggregate amount of coal contained in the four seams discovered is estimated at 24 million tons, allowing for every deduction.

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### IV.—On the Discovery of Fossil Human Remains in the Lehm of the Valley of the Rhine at Eguisheim, near Colmar. By M. Faudel.

THE Lehm in which these human bones were found occupies the same stratigraphical position as the Lehm of Alsace, forming the upper part of the "Diluvial Beds." It is a marly deposit, of a yellowish-grey colour, composed of a mixture of clay, fine sand, and carbonate of lime. It contains in abundance those calcareous concretions called "Kupstein," or "Puppelestein" ("pierres en forme de petites poupées"), and has yielded also three characteristic shells: *Helix hispida*, Linn.; *Pupa muscorum*, Drap.; and *Succinea oblonga*, Drap.

Bones of a large stag (species undetermined), including an almost entire frontal bone measuring 18 centimetres transversely between the horns, were exhumed.

A fine molar tooth of *Elephas primigenius*, and a metatarsal bone of *Bos priscus* were found at the base of the deposit.

All the bones have completely lost their organic matter; their texture is chalky, they are of a white colour, and very fragile.

The human bones consist of a frontal and a right parietal bone, almost entire. They belong to the same skull, and of an adult individual of middle stature. They were found together embedded in the Lehm, and present the same white colour as the other bones, and must have undergone identical alterations in texture and composition.

The author's chief conclusions are that man lived in the valley of the Rhine contemporaneous with the fossil stag, bison, and mammoth, and that the appearance of man in the country would have been *previous* to certain movements of the earth, which took place after the deposition of the "diluvium," and which have given the ground its present physical configuration.—Comptes Rendus.

## REVIEWS.

I.—Quarterly Journal of Science. No. 13, January, 1867.

SEVERAL articles of general interest are contained in this Journal. The first, entitled, "*Sir Charles Lyell, and Modern Geology*," accompanied with a lithographic portrait, sets forth the claims of that philosopher to be considered as the "founder of Modern Geology," in the sense of his being the man who first clearly defined the principles of geological investigation, and is a review of his more popular works. The article is written in a clear, sound, and philosophical manner, and forms an essay on the progress of Geology, as well as an autobiographical sketch of its modern historian.

A second paper is on "*the Ignigenous Rocks, near Montbrison*," by Dr. Daubeny, a supplement to his previous paper (see Geol. Mag. Vol. III. p. 216) on the Antiquity of the Volcanos of Auvergne. The only igneous rocks observed in the neighbourhood of Montbrison consist of a compact basalt, with nests of olivine, a material which could only have been elaborated by the aid of great pressure, and under a different configuration of the surface from that now existing, and the author concludes that a vast antiquity must be assigned to these basalts.

Mr. A. R. Wallace contributes an article on "*Ice-marks in North Wales*," a review of Glacial Theories and Controversies; and Mr.

Hull a paper "*on the future Water-supply of London,*" with an account of the two great schemes for obtaining it, one of which was propounded by Mr. Bateman, and applies to North Wales, the other by Messrs. Hemans and Hassard, to the Lake-country. Taking a general view of the two plans, the author states that Mr. Bateman's has the advantage of shorter distance and smaller cost, while the rival one has the advantage of natural storage reservoirs, and of conferring a benefit on the inhabitants of South Lancashire. The paper is illustrated with a map.

Besides the usual Chronicles of the progress of Geology and Palæontology, Mining, Metallurgy, and Mineralogy, one on Archæology and Ethnology has been added, which will be interesting to many.

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II.—L'Homme Fossile en Europe. 1867. Brussels, *Muquardt*; Paris, *Reinwald*. By Chevalier H. Le Hon.

In the Geological Magazine for December last, we gave a very brief notice of this new book, which was at that time in course of being printed. It is now published, and forms a neat octavo volume of 360 pages, well illustrated with woodcuts and lithographic plates. One of the illustrations is a reduced copy of the representation on fossil ivory of the Mammoth, discovered by M. Lartet in Périgord (see Geological Magazine, Vol. III. p 480). M. le Hon considers it to be of much higher antiquity than all human traditions. He estimates the antiquity of man on our planet at about 30,000 years, and states that all the evidence seems to prove that man lived in Asia before inhabiting Europe; that towards the "Great Glacial Period" the climate of the southern part of Asia was less rigid than that of Europe, and the country more suited to the wants of the first men, whose dentition was frugivorous rather than carnivorous (?); and that during the glacial period Europe was separated from Asia, the two continents not having been re-united until after the departure of the waters. It was then, on the emergence of the land, that the first immigration of man towards the west (Europe) took place. M. le Hon's history ceases with the first usage of iron in the west of Europe.

M. le Hon's work will no doubt attain considerable popularity, as the author has rendered it comprehensible to all, by using the simplest language consistent with scientific accuracy; and although it is not of so general a character as that of our distinguished countryman, Sir Charles Lyell, being, as its title indicates, mainly confined to the ancient remains of man in Europe, yet it is extremely valuable and useful as a summary of the very numerous and scattered publications on this favourite field of enquiry in Europe. Some of the author's speculations show him to be a man of great ability and profound study, but we hesitate more in this country than in France, to enter far upon speculative grounds, preferring to 'feel our way' as much as possible before venturing beyond the region of facts.

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III.—Report on the Geology and Mineralogy of the South-Eastern District of the Colony of South-Australia. By the Rev. Julian E. Tenison Woods, F.G.S., F.R.G.S., etc. Adelaide. pp. 33, Map, and Section.

TO the colonists of the south-eastern portion of South Australia this pamphlet may probably be of interest, and possibly of use; but its utility would no doubt have been facilitated if the author had omitted his favourite discussions on the discrimination of Upper Miocene from Lower Pliocene. In Europe it is so difficult to pronounce on this question that the Austrian geologists, accustomed to study a remarkably complete series of such debateable deposits in conformable sequence, have, after years of patient endeavour, "given it up," and grouped them all together. How then can a single amateur geologist in one corner of South Australia dictate to the Geological Survey of Victoria, and perform for deposits so far away a feat apparently impossible to Hoernes and his colleagues in Europe? Mr. Woods has, in fact, obscured and rendered comparatively incomprehensible the really valuable material contained in his pamphlet, by his numerous digressions on this subject, and his misconceptions of the views of European authors, so that the "squatters" of South Australia will probably be found wanting in the patience required to read it through.

There is, however, one subject treated of by Mr. Woods, which requires more serious and laudatory mention, and this will be best given by an extract from p. 26. "The whole of the south-eastern district may, with the exception of a small fringe at the coast line, be considered as a table-land gradually rising towards the boundary of the province, near which it attains its greatest elevation. Like all table-lands it is full of basin-like depressions upon its surface, and is consequently drained badly. Lake-features, wherever they occur, are more often connected with table-lands, than chains of mountains; . . . and, . . . where the rainfall is small, and the elevations moderate, such depressions are an inconvenience instead of being of value. They are not deep enough to be navigable, and during the greater part of the year are no more than unwholesome morasses. This is precisely the case in the south-eastern district of South Australia, and what is worse, probably more than one-third of the best land in it is utterly unavailable in consequence." The table-land really consists of a series of terraces, the margins of which have a somewhat greater elevation than the land behind them, —hence the depressions, which Mr. Woods suggests might easily be drained by cutting channels for the water through the terrace-rims. This is all very true, for, as the author points out, the water would find its way into the creeks and gullies that intersect the country, and "the expense connected with the cutting is the only difficulty in the way of draining the district." When labour becomes cheaper and land more valuable, no doubt "something" will be done.

# REPORTS AND PROCEEDINGS.

Geological Society of London.—I. December 19, 1866.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The following communications were read:—

1. "On a new specimen of *Telerpeton Elginense.*" By Prof. T. H. Huxley, LL.D., F.R.S., V.P.G.S.

The specimen which was described in this paper had been broken into five pieces, exhibiting hollow casts of most of the bones of *Telerpeton Elginense.* It is the property of Mr. James Grant of Lossiemouth, and came from the reptiliferous beds of that locality, along with some highly interesting fragments of *Stagonolepis* and *Hyperodapedon.* The casts described by the author consisted of impressions of the bones of the skull, together with the lower jaw, and the teeth; of most of the vertebræ and ribs; of the greater portions of the pelvic and scapular arches; and of representatives of most of the bones of the fore and hind limbs; and it was stated that the characters of all these portions of the skeleton indicated decidedly Lacertilian affinities.

In describing these remains Professor Huxley discussed especially the bi-concave character of the vertebræ; the mode of implantation of the teeth, which he believed to be acrodont, and not thecondont; and the anomalous structure of the fifth digit of the hind foot, which presents only two phalanges (a proximal and a terminal), a structure which differs from that of all known Lacertilian reptiles, whether recent or fossil. His researches had led him to conclude that the animal is one of the reptilia, and is devoid of the slightest indication of affinity with the amphibia. In all its characters it is decidedly Saurian, and accords with the sub-order *Kionocrania* of the true Lacertilia; but the author had not been able to make sure that it possesses a columella. He also remarked that the possession by *Telerpeton Elginense* of vertebræ with concave articular faces does not interfere with this view, as although most recent Lacertilia have concavo-convex vertebræ, bi-concave vertebræ much more deeply excavated than those of *T. Elginense* are met with among the existing geckos.

Professor Huxley in conclusion drew attention to the interesting fact that *Telerpeton* presents not a single character approximating it towards the type of the Permian *Protorosauria,* or the Triassic *Rhynchosaurus,* and other probably Triassic African and Asiatic allies of that genus, or to the Mesozoic Dinosauria; and that whether the age of the deposit in which it occurs be Triassic or Devonian, *Telerpeton* is a striking example of a *persistent type* of animal organization.

2. "On a section at Litcham affording evidence of Land-glaciation during the earlier part of the Glacial period in England." By S. V. Wood, Jun., Esq., F.G.S.

The structure of the Lower Drift, and the limited area to which it is confined seemed to the author to indicate that the glacial conditions sustained by the area under consideration were chiefly those of land-ice, while its limited extent and rapid attenuation in all directions from the Cromer coast have led him to infer that only a small part of England was under water at the time. On the other hand, the great masses of chalk and of chalky débris that were carried into the marine sediment appear to indicate the presence, near at hand, of some terrestrial chalk-area from which they were detached, and he stated his belief that during this period much of the chalk of Norfolk was covered by a great glacier. In illustration of this view Mr. Searles Wood described a section at Litcham, in which the Chalk-with-flintbands is seen to become gradually more impure towards the surface, the flints becoming at the same time detached and scattered, this disturbance having been produced, in his opinion, by a force acting downwards from the surface, and becoming less powerful the deeper the section descends.

3. "On the evidence of a third Boulder-clay in Norfolk." By F. W. Harmer, Esq. Communicated by Searles V. Wood, Jun., Esq., F.G.S.

The author described a deposit of true boulder-clay, from nine to fifteen feet in thickness, resting on the chalk, and occurring at a slight elevation above the bottom of the valley of the Yare. It seemed to him to be distinct in age both from the till of the Cromer cliffs and from the much more recent boulder-clay, which caps the high land on each side of the valley; and he gave sections which appeared to prove that it is posterior in age, not only to the boulder-clay, but also to the plateau-gravel capping the middle drift, by the time necessary for the erosion of the deep valley in which it occurs.

Geological Society of London.—II. January 9, 1867.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair. The following communication was read:—

"On the age of the Lower Brick-earths of the Thames Valley." By W. Boyd Dawkins, M.A. (Oxon), F.G.S.

The Lower Brick-earths of the Thames Valley have been a fertile source of discussion since the year 1836, Dr. Falconer considering them to be anterior in age to the boulder-clay, Mr. Prestwich believing them to belong to the Low-level series of Quaternary deposits. The author divides the evidence upon this question into two heads—Physical and Palæontological. The sections at Ilford, Grays' Thurrock, Crayford, and Erith, evince the same sequence of deposits. At the bottom of all are the fluviatile brick-earths and gravels, whence the mollusca and mammalia are derived, and which are remarkable for the horizontality of their bedding and the even sorting of the component parts. Lying on the eroded top of these is a deposit—the trail of Mr. Fisher—of a highly confused nature, containing stones, often with their long axes arched, and never sorted by the action of water. It contains also many stones and boulders that could only have been floated to their present situation by ice. It is as remarkable for the contortion of its bedding as the deposits below are for their horizontality. On its uneven summit rests the surface-soil, which is the mere rainwash of the neighbourhood. These three deposits indicate three epochs: first, that of the brick-earths, in which the water was unencountered by floating ice; then that of the trail, which is probably a mere icewash formed under a glacial climate; and lastly, the rainwash, formed under temperate conditions. The date of the excavation of the Thames Valley being uncertain, and also the fact of the boulder-clay earth having extended into it being non-proven, it is possible that the trail, or icewash, may be the subaërial equivalent of the boulder-clay, and that consequently the brick-earths may be pre-glacial. The palæontological evidence is also very important in deciding their age. The presence of *Elephas priscus* and *Rhinoceros megarhinus* indicates the affinity of this group of deposits to those of pre-glacial age on the Norfolk shore, and to the foreign pliocenes. The tichorhine and leptorhine rhinoceros, on the other hand, point towards deposits of clearly defined post-glacial age. The beds under consideration are also as remarkable for the absence of some as for the presence of others of the pleistocene mammals. The pre-glacial trogonthere, *Rhinoceros etruscus, Elephas meridionalis, Sorex moschatus,* and *Cervus dicranios* are absent on the one hand, the entire group of post-glacial arctic mammalia on the other; and especially among these latter the reindeer. From these premises, it follows that the beds in question, as affording remains in part peculiar to the forest-bed of Norfolk and the pliocenes of France and Italy, and in part to the post-glacial deposits, occupy a middle point in time between the two, being more modern than the former and more ancient than the latter. For these reasons the author suggests the insertion of the group of deposits in the classified list of pleistocene deposits as follows: (1) Forest-bed of Norfolk—climate temperate; (2) Lower Brick-earths of the Thames Valley—climate temperate; (3) Glacial deposit—climate severe; Postglacial deposits—climate severe, but gradually becoming temperate.

The Geological Society of Glasgow opened its session on the 20th October, and the Edinburgh Geological Society on the 31st October. Both societies commenced their sessions with an address on "Scottish Geology, its Proofs and Problems," by David Page, Esq., F.R.S.E., F.G.S., President of the latter society.

In this address Mr. Page pointed out the most important facts arrived at in Scottish geology. Passing in review the various stratified systems, from the Laurentian up to the most modern and superficial deposits, and after briefly indicating what had actually been accomplished, he directed the attention of members to the yet unsolved geological problems around them deserving their study.

There is no fear that these societies will die out for want of a sumptuous bill of geological fare to attract them, and when the long summer days and fine weather come round, many of Mr. Page's disciples will be found hammering away at these knotty problems with a right good will.

At the monthly meeting of the Geological Society of Glasgow (15th November, 1866), the following papers were read:—

I. "Further observations on the Surface Geology of Glasgow." By Mr. James Bennie.

II. "On the Silurian Scenery of the Enterkin." By Mr. John Dougall.

THE MANCHESTER GEOLOGICAL SOCIETY continues, under the able presidency of E. W. Binney, Esq., F.R.S., F.G.S., to contribute a valuable series of papers on Geology, Mining, etc., which are printed and issued at frequent intervals. One of the most interesting papers communicated during last session is by John Plant, Esq., F.G.S., Curator of the Salford Museum, "On an ancient sea-beach on the Limestone Moors near Buxton."

About one mile south of Buxton, rises Grin Edge, a long ridge of limestone running north-west and south-east, in the middle of a broad valley formed by Axe Edge, Burbage Edge, Long Hill, and Black Edge on the west and north; and by a range of lower hills on the east and south, one of which is Harper Hill.

The highest point, called "the Tower," on Grin Edge, is 1,435 feet above the sea level; and the top of Harper Hill has a nearly similar elevation.

The north-western slopes of Grin Edge and Harper Hill have been scarped into great cliffs by the extensive quarrying of the limestone, carried on during many years.

The first operation in quarrying is to remove the turf and the thin layer of loam and clay, which covers the higher ground of the hills. In laying bare the southern slopes not far from the ridge of the hills, the singular character of this old sea-beach is exposed.

The surface of the undisturbed rock is seen to be worn into rounded, hollowed, and fantastic shapes, tolerably uniform in depth and size, and extending along a regular line upon the slope of the hills. The smooth hollows between these wave-worn stones are filled with loose shingle, scattered about as upon any rocky coast at the present day.

The lowest edge of this shingle beach generally ends in a line of bold craggy rocks, at the base of which are huge blocks of rolled stones lying upon a glacis or terrace of limestone, with a rough uneven surface, full of deep hollows and holes, such as are found on all rocky shores at a very low tide.

The craggy cliffs and rough rocks on the terrace are repeated at lower levels to the bottom of the valley, *not so the rocky beach and shingle.* The upper edge of this sea beach probably extends nearly to the crown of the hills, and would therefore have an elevation above the valley of about 400 feet.

The length of the sea beach exposed, is about half-a-mile on Grin Edge and fully that length on Harper Hill. Standing on the old sea beach at this latter place, and looking north-west across the valley to the long flank of Grin Edge, the levels of the two portions are seen to be identically the same above the bold craggy cliffs, and there can be no doubt that the whole range of the slope of these hills will be found marked by this beach and shingle line, whenever the turf and clay are removed.

The turf, soil, and clay together, rarely exceed twelve inches in thickness, covering the worn rocks and shingle of the sea beach. It is a pure yellowish clay, free from grit and pebbles, with scarcely any perceptible amount of lime in it. This clay fills the joints and cracks in the limestone, and occurs in pockets of considerable extent, as may be seen in the face of the quarries; but it yields neither shells nor fossils of any kind, unless the bones of the larger animals recorded as having been found in fissures filled with this clay are to be considered contemporaneous with its deposition.

No decomposition of the limestone seems to have taken place since the sea left the high moors of Derbyshire.

In the discussion which followed, the president, Mr. Binney, concurred in the view taken by Mr. Plant, that these were ancient sea beaches, and cited the discovery of marine shells on the western slope of Axe Edge, by Mr. Prestwich, who had obtained specimens of *Turitella*, *Tellina*, *Cardium*, and *Litorina* (all common on our present coasts) from a bank of sand more than 1000 feet above the sea.

The Liverpool Geological Society, so ably presided over last session by Henry Duckworth, Esq., F.L.S., F.G.S., etc., has printed in its annual report some excellent geological materials which, with the exception of the President's address, are chiefly provided by Messrs. R. A. Eskrigge, F.G.S.; H. F. Hall, F.G.S.; G. H. Morton, F.G.S.; Edward Nixon, Mining Engineer; and Dr. Ricketts, some of which have already appeared in this Magazine.

On the 16th October last, Mr. G. H. Morton, F.G.S., communicated an excellent paper, "On the presence of Glacial Ice in the valley of the Mersey during the Post Pliocene Period."

After describing at length the districts around Liverpool where Glacial striæ and ice-polished rocks have been observed, and the several directions in which they indicate the ice-streams to have flowed over the country, the author concludes:—

From the examination of the glaciated surfaces, and of all the circumstances connected with them, I consider that the existence and passage of a great bed of ice down the valley of the Mersey is the only theory that will satisfactorily explain the phenomena. I cannot enter here into all the geological observations that bear upon this interesting subject. But one of the most important is the total absence of that comprehensive extinct fauna which occurs in North Wales—at Cefn Caves, within twenty-four miles from the Mersey. About Liverpool the country seems to have been completely denuded, partly glaciated, and finally deeply covered with Boulder-clay, containing boulders almost entirely foreign to the neighbourhood, many of them being scratched, and all having probably dropped from melting ice-bergs, during a period of subsidence which followed that of elevation and glaciation.

Although at a greater elevation than 120 feet, no evidences of the existence of ice have been found, there is a possibility of their having been removed from off the highest land, by the denuding influences of the atmosphere, or by the sea, before being covered by the Boulder-clay, but whether that be so or not, the most careful search has been made without finding the slighest evidence of ice anywhere to the east of Liverpool, notwithstanding the great advantages presented by the very frequent excavations made for building purposes. If the ice were a glacier confined to the valley of the Mersey, its thickness in the centre was about 300 feet, but there is a possibility that ice covered the whole of this part of the country, and in that case it must have been much thicker.

At the meeting of this Society, on November 13th, 1866, R. A. Eskrigge, Esq., F.G.S., President, in the chair, the following papers were read:—

"On the Oscillation of Level during the Eocene Period on the Coast of Hampshire." By Dr. Ricketts.

"Notes on the Geology of Leicestershire." By G. H. Morton, F.G.S.

The Norwich Geological Society held its anniversary meeting on the 10th October, upon which occasion the Rev. John Gunn, F.G.S., President, and about thirty members, sat down to dinner. The President afterwards reviewed the various papers relating to East Anglian Geology which had occupied their attention during the past session. Among these was a paper on the Upper and Lower Crags by Mr. J. E. Taylor (one of the most energetic and able members of the Society); also an important paper by the President, on the "Anglo-Belgian Basin" (read also before the British Association at Nottingham).

The Trimmingham outlier of Chalk; the Norfolk Forest Bed; and many other interesting questions relating to Climatal changes, had been considered. Great diversity of opinion exists between Mr. B. Russell and Mesers. Gunn and Taylor as to the glacial theory. the former gentleman strongly protesting against a glacial epoch upon astronomical grounds, and the two latter defending it upon geological evidences. The result of these discussions is, that members consult "Lyell's Principles of Geology" and other good books of authority, and, best of all, go and make observations for themselves in the field.

## CORRESPONDENCE.

### LITHOLOGICAL NOMENCLATURE.

*To the Editor of the* Geological Magazine.

Dear Sir,—Neither you, nor your subscribers, will need any recommendations of mine upon the duty of exactness in scientific nomenclature. I am not, either, going to discuss the delicate question of the value of applying to stones the scale of minute specific distinctions. This attempt, made mostly by foreign geologists, has been rather hastily extended from classificatory sciences proper—Zoology, Botany, and Mineralogy—to rocks, although the ulterior scientific purpose to which that method is subservient and necessary in those sciences, namely, to ascertain how and to what extent such minute distinctions are fixed or derivative—can scarcely be said to exist in the philosophy of stones, our researches here having pretty well proven that the natural selection which predetermines the composition of rocks is of the most fortuitous nature. The interest in rocks turns upon other and broader points. Thus, not seeing how the system alluded to is essential to the pursuit of chemical geology, or of mineralogy in rocks, and fully experiencing how great an obstruction it may prove in general geology, it is only upon the faith that no labour is altogether in vain that I can have any tolerance for this new fashion—it may lead to some new development of our glorious science.

What I would wish to bring to notice is a glaring inconsistency in the use of a familiar English rock-term. In my description of a portion of the N.W. Himalaya, in the Memoirs of the Geological Survey of India, wishing to avoid ambiguity, I defined the sense in which I should use the words schist, slate, and grit. The sanction to which I appealed was, the *practise* of English field-geologists. Some friendly critic at home took me to task on this point.[1] Schist, as implying crystalline foliation (and not argillaceous rocks in general), was allowed to pass. I will not haggle with my objector upon a point of degree in the application of the word slate (and slaty) to subfissile argillaceous rocks, in which that character is not traceable to original lamination; true cleavage is due to pressure; and so is the imperfect, though important character I would designate as slaty. Upon my use of the word *grit* I received no quarter. I was perfectly aware at the time that this term was frequently used in a totally different sense to that of my definition; but, having served my apprenticeship in Great Britain, I was also pretty sure of my ground when I appealed for sanction to the practice of English field-geologists. During a recent brief visit to England, I did not omit to verify my position. It will, I think, be granted that the classified collections of the Geological Survey of Great Britain and Ireland are a good exponent of the authority I quoted. They are, perhaps, the only named collections in the kingdom that are not based upon a 'Krantzian' foundation. And in those collections the word grit is frequently, I believe even exclusively, used in the sense I gave to it. I am writing from the Jungles, so cannot refer to the numbers I noted in the printed catalogues of the Museums in Jermyn-street and in Dublin, and which bear the *imprimatur* of Professors Ramsay and Jukes, but the specimens are easy to be found among the transition rocks. These grits are very fine-grained siliceous rocks; they appear abundantly associated with slates: their composition and texture is such that in the midst of highly cleaved

[1] See Review of "Memoirs of the Geological Survey of India," vol. iii., Part 2, Geological Magazine, Vol. II. p. 310.

strata they present no trace of this structure; yet no one would think of calling them sandstones or quartzites. In their original state I can imagine them described as very light, friable clays. The literature of transition rocks (*e.g.* Professor Ramsay's recent Memoir on North Wales) may be consulted with the same effect as the Survey collections. In this field of observation practice seems unanimous upon the necessity of a class-name for the rock in question, and upon the appropriateness of the word *grit.*

On the other side of the argument are to be found all text-books, glossaries, and lectures. It is indeed probable, that if an impromptu show of hands could be called for, the geologists of England would agree that a grit is a coarse, sharp sandstone—an essentially different rock in all its characters and associations from that before described. It is not difficult to explain such an anomaly—nine-tenths of our geologists have done little or no work upon transition rocks; so that the occasion for the ambiguous use of the term has never occurred to them; the remaining minority could not, all of a sudden, revoke a familiar expression. I have yearly to fight this battle of the grits with new assistants joining the Indian Survey, and seldom with any good result. Naturally enough, with all the enthusiasm of youth for the respected teachers of the schools, they prefer the recent lessons of those high authorities to the representations of an obscure Indian; and, to my great discomfiture, the oral and printed instructions of those to whose field-practice I vainly appeal, are most frequently quoted against me. The unfortunate result is, that this broad discrepancy in our vocabulary is perpetuated in the annals of our work: those who are set to map and describe the Coal-deposits find this grit a very handy term, and use it triumphantly. It is with the conviction that my respected old masters, who know both sides of the question, will be more reasonable than their more recent pupils, and will at least drop one or other signification, that I venture to send home this appeal to them and to their judges, the geological public.

To aid in the decision I call for, I will add my own notions on the point at issue. The word *grit* was, I believe, introduced to us through the Millstone-grit, from a technological vocabulary in which we should find it applied as appropriately to a cellular trachyte as to a sandstone. By a true process of natural solution, it seems to have been applied to the rock I first described—to fill a real gap in our geological vocabulary. If this latter application of the word be abandoned, some new word must be coined or borrowed to take its place; whereas no such plea can be urged for the continual use of the word as applied to sandstone—there could be no difficulty in describing our Indian Coal-measures without a special name for one of the many varieties of sandstone that occur. Convenience should not be the umpire in such matters. Such a practice is unsystematic and confusing. What would a naturalist say to the phrase—a collection of dogs and quadrupeds? To me, the words "a series of grits and sandstones" sounds just as barbarous, when I know that the first word only means a common sandstone. If, in geology, we can as yet dispense with a voluminous categorical list of stones—as conveying no sense at all commensurate with the labour and the inevitable indistinctness attending such niceties of specific distinctions—it is all the more essential that our type-names and the terminology we apply to important characteristics should be well understood and carefully used. We are often told to practise what we preach: in matters of science, at least, we may adopt the easier and safer maxim to teach what we practise.

Yours truly,

HENRY B. MEDLICOTT,
Geological Survey of India, Calcutta.

CHOTA, NAGPORE, *December* 1, 1866.

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INUNDATIONS AND THEIR PREVENTION.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—Under this heading a writer in the *Pall Mall Gazette,* who signs himself X, recommends the construction of "artificial lakes" or "huge reservoirs" on each side of the Pennine chain, "which would have the effect of preventing inundations like those of last month in Leeds, York, Salford, etc." X gives this idea as an origination of his own. It is, however, Ellet's idea, and it was published for him by the United States Government, in a book of some 400 pages, in 1853. The book is entitled, "The Mississippi and the Ohio rivers, containing plans for the protection of the delta from inundation." The principles of this book are discussed in the last chapter of "Rain and Rivers," which is entitled "Ellet on the Mississippi." In reference to the late floods in France, X says, "In 1856 the Emperor addressed a letter to the Minister of the Interior on this subject, in which he pointed out that the first object was to ascertain the cause of these sudden floods, and suggested that they came from the rainfall among the mountains." And again, "Our experience in England seems to confirm the Emperor's theory that certain floods are chiefly caused by rain in mountainous districts." The Emperor's theory is as certainly true, and one would have thought as self-evident as that two and two, make four. And posterity will find it difficult to believe that in the 19th century such a truism could have been enunciated as a *discovery*! This so-thought *discovery,* however, is a most important step taken in advance when we consider the profound ignorance which prevails on the subject. And it will be of advantage to the entire world that the most enlightened, clear-headed, and energetic of its sovereigns has learned the first great A in the Hornbook of Rain and Rivers. Nor is it of slight importance that the Pall Mall megatherium has changed the tone of his roaring, and has taken to steal, and to promulgate as his own, doctrines, which he only yesterday attempted to controvert. He at least has the power to *publish* those stolen doctrines. His *own* idea on alluviums was that they were hatched out of *igneous* "nest-eggs," (*sic*) and it is really quite "a nice change" when X finds that *aqueous* causes *now* can "cover the productive soil several feet deep by stones, etc.," and proves that aqueous causes *have* been at this work for "*ages*," by the discovery of a subterranean Roman villa. But what are such floods and deposits as these compared with those of the Nile, Ganges, Mississippi, or Niger? It is something, however, that X and the Emperor, *ego et rex meus*, are now convinced that the late disastrous floods in France and England were simply the effects of rain, as "*the* flood" was of yore. But when my two illustrious pupils and the "*Correspondent*" attempt to remedy the effects of rain on rivers I recommend them to leave *woods* out of their consideration. Our respected grandmothers always "babbled" about them.—Your obedient servant,

George Greenwood, Colonel.

Brookwood Park, Alresford,
*December* 18*th*, 1866.

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## THE DEVONIAN ROCKS OF DEVONSHIRE, ETC.

*To the Editor of the* Geological Magazine.

Sir.—I do not wish to enter into a controversy on the Devonian delusion; I had rather let my own field work, and that of the Irish branch of H. M's. Geological Survey, speak for itself.

There are, however, some statements in Mr. Salter's letter, in your last number, which might mislead persons if they were allowed to pass without contradiction.

There is no unconformability between any parts of the Old Red Sandstone, either in the south-west of Ireland, or in South Wales.

The unconformability which Mr. Geikie and other of my colleagues have shown to exist in Scotland, between beds that have hitherto been called Old Red Sandstone, is of itself sufficient to prove that that term can only be retained provisionally for those groups till they are more thoroughly distinguished, and some of them freshly named.

In Ireland I adopted the local name of "Dingle beds" for the mass of red rocks that rest in apparent conformity on the Upper Silurian rocks, and are covered quite unconformably by the upper part of the Old Red Sandstone.

It is by no means certain, that these "Dingle beds" appear anywhere in Ireland, except in the Dingle promontory.

To the south of Dingle Bay, there is not the slightest trace of any unconformability in the Old Red Sandstone.

Some years ago I wished to know whether the dying away of the Old Red Sandstone in South Wales, from Herefordshire towards Pembrokeshire, was accompanied by any break in the veins; I examined the whole country, from the neighbourhood of Llandeilofawr and Llandovery, by Brecknock and Abergavenny to Pontypool, but could not detect any direct evidence of unconformability between the top of the Upper Silurian, and the base of the Carboniferous Limestone.

In North Devon I believe it will be possible to trace a boundary between the red rocks of Porlock, Minehead and Dunster, which are genuine Old Red Sandstone, and the grey slates, and variously coloured grits, and slates containing marine fossils above them.

I do not believe that any geologist will ever be able to trace a boundary in those slates and grits, so as to subdivide them into two clearly marked groups, such as Ilfracombe, Combe Martin, Marwood, Pilton beds, etc., until that is done by a good stratigraphical geologist, independently of all fossil evidence. That fossil evidence is not worth a rush in this case, because we are merely reasoning in a circle, drawing a boundary to suit the fossil localities, and then using the fossils to prove the correctness of the boundary. According to the results of my field work, (hasty and imperfect enough, doubtless in Devon, but still based upon the experience acquired by thorough and exhaustive work, carried on patiently for years in Ireland), the Old Red Sandstone of Porlock, Minehead and Dunster is brought up again by a great fault in the centre of North Devon, and forms a ridge, running from Morte Bay to Wiveliscombe, the Lynton, Combe Martin and Ilfracombe beds being part of the Marwood and Barnstaple beds.

If I am mistaken in this, then the central red ridge from Morte Bay to Wiveliscombe is different from anything we have in Ireland, and can be used to divide the grey slates of North Devon into an Upper and Lower group, still having the genuine Old Red Sandstone of Porlock, Minehead, and Dunster below them all, and the Coal-measures conformably above them all.

These Devonian rocks will then rest, like their contemporaries, the Carboniferous Slate in Ireland, between the top of the Old Red and the base of the Coal-measures, and will be the muddy and sandy representatives of the Carboniferous Limestone, with a somewhat different fauna, arising partly from difference of *habitat* and partly from difference of *province.* The contemporaneity of different assemblages of fossils in closely adjacent areas, which is the explanation of Barrande's Colonies, has not yet been sufficiently worked out or attended to. It has been the cause, not only of the Devonian delusion, as I have called it above, but of the confusion among the Cambro-Silurian series of Wales and elsewhere.

I, for one, cannot feel any confidence in the stratigraphical groups of these rocks, established merely to suit the supposed horizons of certain fossils, and not worked out by honest stratigraphical observations in the field.

Lastly, let me say that I seem to myself to have been endeavouring to fix the exact place of the so-called Devonian system instead of explaining it away. Yours,

J. Beete Jukes.

Dublin, *January 6th,* 1867.

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FORM OF THE GROUND AND FAULTS IN THE DRIFT.

*To the Editor of the* Geological Magazine.

Sir,—Allow me to correct a slight error which has crept into print, although not in the proof of my paper, in your January No. At page 9, line 5, for "became" read *become,* and for "sloping," in line 10, read *slope,* when it will be seen that (however ill expressed)

I refer to the old shape of the ground and not to the angles of the overlying deposits. At foot of page 10, for "Benluben" read *Benbulben.*—While writing I may mention, in connection with the subject of faults in drift, a suggestion, made with reference to those illustrated in Plate II. Fig. 8 of the above number and others, in Explanation Sh. 126, Mem. Geol. Survey, Ireland, to the effect that they might have been caused in tenaceous drift by the intersection of planes of separation inclined towards each other so as to meet along a line also inclined to the horizon: and enclosing wedge-shaped masses of the material which from passage of water or from being deprived of support at their larger ends by natural causes would slide into lower positions; subsequent denudation settlement, etc., exposing faulted sections and perhaps obliterating other marks of subsidence.

None of these drift faults or dislocations were found to penetrate the underlying (limestone) rock, but I have heard of one from my friend, Mr. Kinahan, which is said to fault both the Coal-measures and superficial deposits in the Castle Corner Field.—Wishing your Magazine the compliments of the season, I am truly yours,

A. B. Wynne.

London, *January* 1*st*, 1867.

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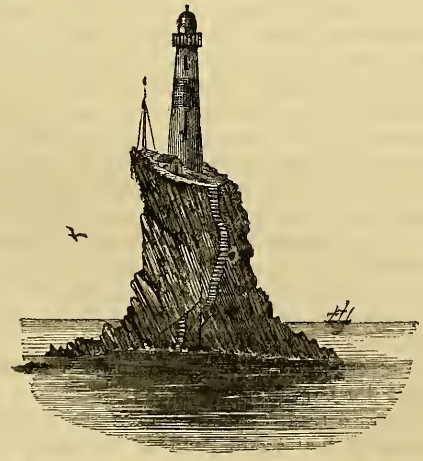
## DENUDATION AND THE FORM OF THE GROUND.

*To the Editor of the* Geological Magazine.

Sir,—My old colleague, Mr. A. B. Wynne, appears to have quite forgotten the S.W. of Cork and Kerry, when he says in the Geological Magazine, for January, 1867, p. 6, "Isolated rocky pillars upon hills, the very aspects of which suggest that the stone is being gradually disintegrated by rains." Does he forget the Skellings off the coast of Kerry; the Fasnet Rock (See Woodcut)



Fasnet Rock and Light-house, coast of Cork, with soundings of 40 fathoms, 6 fathoms from the rock off the coast of Cork, etc., all of which would be (according to the charts), if the land was elevated 1000 feet, "isolated rocky pillars on hills," and yet at the present day they are being formed by Marine action.

G. HENRY KINAHAN.

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FAULTS IN THE DRIFT AND "TRAIL."

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR,—Mr. S. V. Wood, jun., in your last number, questions the correctness of an observation made by me in the pit at the east end of Chillesford Church. He says, "The capping of Boulder-clay, which rests on the Chillesford beds at Chillesford, and which Mr. Fisher, in his paper read before the Geological Society, brought into his evidence of 'trail,' I believe is nothing but an oblique throw of the Upper Drift on to the Chillesford beds;" and his reason for this belief is, because "in a pit only a furlong and a half north of this section, there occurs one of the junction of the Upper and Middle Drift," showing signs of disturbance.

Such proximity of the Boulder-clay, *in situ,* would seem to be a requisite condition for the presence of trail derived from it, but I entirely deny that its being there in a disturbed state proves my explanation of its appearance at this spot to be wrong. The trail of Boulder-clay here lies in a dish, or trough, eroded out of perfectly horizontally bedded Chillesford clay. The trail is five feet thick in the centre, and thins out to nothing at its edges. The Chillesford beds occupy a thickness of nine feet beneath it. I saw no indications whatever of this small bit of Boulder-clay being let in by a fault; and I am not inexperienced in faulted clays and sands, knowing well all the Weymouth, Bridport, and Purbeck districts.

In reference to the subject of what I have called "trail," I take this opportunity of mentioning a fact, which I omitted to notice in my paper before the Society. It is, that I have in several instances observed in the New Forest, trail containing fossil shells derived from neighbouring fossil beds. Yet the out-crop of these fossil beds is not discoverable by any shells in the warp. They are either entirely dissolved or else converted into selenite. This shows that the agency, which transported the trail, acted to a depth, removed from the effects of ordinary atmospheric causes.

As regards faults in the Drift, there seems much difficulty in rightly distinguishing among these beds between true faults, arising from disturbance at a subsequent geological period, and the disturbances of deposition simulating faults, such as abound in the Norfolk cliffs. Erosion has often laid beds side by side, in a way which looks like faulting, and though unwilling to differ from Mr. Wood, who has so extensive an acquaintance with these deposits, I must confess that I suspect the instance at Bulchamp to be one of that character, because sand occurs beneath the Boulder-clay, seemingly continuous with that against which it abuts. It is unusual to meet with any true fault which does not alter the relative levels of stratification on either side of it. But I do not perceive that Mr. Wood attributes this effect to the supposed faults, either at Bulchamp or at Hitchin.—I am, yours faithfully,

O. Fisher.

Elmstead Rectory, Colchester.

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## ARE THE CORALLINE CRAG OF SUFFOLK AND THE BLACK CRAG OF BELGIUM CONTEMPORANEOUS DEPOSITS?

*To the Editor of the* Geological Magazine.

Dear Sir,—In 1864 I communicated a short paper to your excellent Magazine on the Crags of Suffolk and Belgium. I was led from a comparison of the lists of Mollusca, mainly, I confess, by the "percentage method," to associate the Red and Coralline Crags of Suffolk with the Yellow Crag of Antwerp, regarding the Grey Crag and Black Crag as anterior deposits. Mr. Godwin-Austen, in a most instructive memoir published in the Quart. Journ. Geol. Soc. No. 87, August, 1866, deals with the question of the Crags in a comprehensive and philosophical manner, rejecting conclusions derived from percentage calculations, and regarding rather the conditions and relations indicated by the nature of the deposits and general aspect of the fauna, which he has lately examined himself in Belgium. I have read this memoir with great pleasure and profit, and am quite prepared to regard the Grey Crag of Belgium as owing its apparent distinctness from the Yellow Crag to the presence of redeposited Black Crag fossils. But there is one point on which I would ask for further elucidation. Mr. Godwin-Austen says (p. 238), "The corresponding conditions on the English and Belgian areas of the Crag sea are the Red Crag and the Scaldésien (Yellow and Grey Crags); both are 'remanié' accumulations." "The Red Crag was from the break up of a neighbouring Bryozoan sea-zone, the Scaldésien from ooze depths. Any comparison of the fossil contents of the 'Coralline Crag' and of the 'Crag noir' must be subject to the consideration of differences which result from depth and condition of sea-bed." From this I gather that the Coralline Crag in Suffolk is considered to represent the Black Crag of Belgium, and to be contemporaneous with it. If this is the case (apart from the objection that the fauna of the Black Crag has an aspect so distinct from that of the three other Crags—explained by Mr. Godwin-Austen as the result of differences of depth), how is the occurrence of the teeth of species of sharks and Cetacea in a "remanié" condition in *both* of our Crags to be accounted for? Specimens of the teeth of *Carcharodon megalodon* and *Rhinoceros* in a worn condition have been obtained from the *base* of the Coralline Crag. No specimens of fish or Cetacean remains occur in our Coralline Crag in an unworn, unrolled condition as they do in the Black Crag. Whence, then, did the abundant "remanié" Cetacean and shark fauna of our Red Crag come? from what deposits are they derived? The answer which I have before suggested to these questions, which I do not think are considered by

Mr. Godwin-Austen, is, that the Coralline Crag was not contemporaneous with the Black Crag. The Black Crag is an older deposit of the Crag sea, which had its representative in Suffolk, and from which first the Coralline (in but very small numbers), and then the Red Crag, has derived its sharks' teeth and Cetacean bones, as have also the Yellow and Grey Crags of Antwerp. Though the conditions of the deposition of the Coralline Crag differ greatly from those of the Red Crag, it does not follow, without further evidence, that they were conditions contemporaneous with those under which the Black Crag of Belgium was deposited.

I have ventured to make these few observations, in relation to the views of so eminent a geologist, chiefly with the desire that some one may offer a better answer to my questions.

Very truly yours,

E. Ray Lankester.

Christchurch, Oxford, *January* 11, 1866.

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## THE LOWER CARBONIFEROUS ROCKS OF NORTH WALES.

*To the Editor of the* Geological Magazine.

Dear Sir,—In connection with this subject, it may interest Mr. Green and others of your readers if I subjoin an extract from a paper on the "Mountain Limestone of North Wales," read by me before the Oswestry Field-club, on June 4, 1861, and published in the proceedings of that Society.

"The Yoredale series, which, in Yorkshire, presents an alternation of beds of shale, limestone, sandstone, and coal, is not represented in North Wales. unless we regard the uppermost beds of limestone and shale and the lowest fossiliferous layers of Millstone-grit in our neighbourhood as occupying the same horizon, viz., lying between the limestone proper and the coarse and unfossiliferous grits."

Such was the suggestion I offered nearly six years ago, still I think it would be unwise to interfere with the nomenclature of the "Survey" in this respect, especially since the change in North Wales from calcareous to arenaceous matter is much more sudden and permanent than it is further north, and also while some Mountain Limestone fossils extend from the base of that formation to the top of the grit, yet at varying horizons along the belt these become associated with plants and other fossils of the Coal-measures. I would also observe that the top coarse beds of Mr. Green's section are very local in their occurrence, and give place in the neighbourhood to those of a much finer texture.—I am, Sir, yours truly,

D. C. Davies.

Coneygreen House, Oswestry, *January* 11, 1867.

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## MISCELLANEOUS.

Foliation of Metamorphic Rocks.—An interesting paper on the foliation in the gneiss and schist of Yar-Connaught, by Mr. G. H. Kinahan, has been read before the Geological Society of Ireland during the past year, from which it appears that the foliation in the metamorphic rocks of this district seems generally to follow some variety of lamination, and rarely the cleavage planes. Mr. Kinahan describes six varieties of foliation, one of which may follow the cleavage planes, while the five others follow the lamination; the parallel foliation being caused by parallel lamination; the oblique, by the oblique lamination; the spheroidal, by the spheroidal lamination; the crumpled, or wavy, by the crumpled lamination; and the curled, by the lamination that is round the nodules. An instructive case is cited of this structure in the townland of Killaguile, where the foliation of the schist curls round nodules of gneiss, the latter being found to be obliquely foliated.

Mining.—A series of lectures on mining by Mr. Warington Smyth, Pres. Geol. Society, are now being published in the *Mining Journal*, to which we would refer our readers interested in this subject, as they are carefully reported, and contain all the important points connected with that branch of our practical industry. Among the subjects at present described are the following: the various repositories in which useful minerals were to be looked for; the distribution and extension of mineral veins; the physical characters of vein-bearing rocks; the direction of veins; the shifts or dislocation of veins; the searching for veins, costeaning, hushiug, etc.; boring and the different kinds of implements employed; the various modes of breaking ground; blasting, and the kind and quality of the explosive agent; management and superintendence of mines, etc.

A New Dinosaurian in New Jersey.—Prof. Cope described the remains of a gigantic Dinosaur from the Cretaceous Formation (Greensand) of New Jersey. The bones consisted of portions of the lower jaw with teeth, and of the scapular arch, including supposed clavicles, two humeri, left femur, right tibia and fibula, etc. They were found by workmen, about two miles south of Barnesboro', Gloucester Co., N. J., in a bed which immediately underlies the green stratum, which is of such value as a manure. In size this creature must have equalled the *Megalosaurus Bucklandi*, and together with the *Dinodon*, constituted the most formidable type of rapacious terrestial vertebrates of which we have any knowledge. In its dentition and huge prehensile claws it closely resembled *Megalosaurus;* but the femur, resembling in its proximal regions more nearly that of the *Iguanodon*, indicates the probable existence of other equally important differences, and its pertaining to another genus. The author proposes the name of *Lælaps aquilunguis* for this new reptile. *Proc. Acad. Nat. Sc. Philad.*, 1866, p. 275.

Skull of Ziphius.—In the "Comptes Rendus" (August 6), Mr. Fischer records the discovery of the skull of a species of *Ziphius*, at Lantre, on the banks of the river Gironde. The presence of animal matter in the cerebral cavity proves the very recent death of the creature. If the determination be true, the fact of the existence of this cetacean at the present day is interesting, as hitherto the references of living animals to this genus have been rather doubtful. Species of *Ziphius* are well known to occur in the Crag of Antwerp, and Prof. Huxley has lately described a specimen of *Belemnoziphius* from the Red Crag of Suffolk.

The following extract from an Australian paper, will probably not only interest, but amuse our readers :—*The Coal Supply at Home.* The probable failure, at no distant date, of the supply of coal in England, was evidently absorbing much general interest when the last mail left. By a private letter, received by a gentleman in Newcastle, which we have been permitted to peruse, we gather, that serious apprehensions are felt by many scientific men that the supply of coal will run out in the course of a few years. The currently received opinion until lately was, that some fifty or sixty years would elapse before the supply in England became exhausted, but further investigation, it would appear, has caused several very eminent men to arrive at the conclusion that a much shorter time than that will practically exhaust the supply.—*The Newcastle Chronicle.*

## LINES ON A SCRATCHED BOULDER.

Tell me, Geologists, I pray!
What you mean by Boulder-Clay!
Does it consist of beds contorted,
Or layers of sand and clay assorted?
Is it unstratified or stratified?
Can each or either view be ratified?
Did it on floating Icebergs travel?
Or slide down Glaciers mixed with Gravel?
Is it this latter reconstructed
By Icebergs thawing when obstructed?
Is it Moraine Clay or Marine?
Or is it neither, but between?
Was the whole country capped with ice,
Which churned the rocks up in a trice?
Did wave, mysterious of translation,
Perform the work of denudation?
Can you declare, with voice emphatic,
Its stones and not your views erratic?
Could but the Boulder Clay or Till
Find words 'twould call you bolder still.

## OBITUARY.

Frederick J. Foot, M.A., F.R.G.S.I., Member Nat. Hist. Society Dub., C.E. Geological Survey of Great Britain, has been suddenly removed from amongst us by a melancholy accident in the early prime of life.

On the evening of January 17th, a number of people were skating upon the ice of Lough Kay, near Boyle, in Ireland Two of them having ventured upon a weak portion of the ice, it gave way, and they fell into the lake. Seeing their extreme danger, Mr. Foot came to their assistance, and in a noble effort to save their lives lost his own. They were both rescued, but he was drowned.

Mr. Foot was educated in Ireland, and having taken his degree and passed through the Engineering School at Trinity College, Dublin, where Geology forms part of the course, he became attached to this science, and was appointed by the late Sir H. T. de la Beche on the 1st of August, 1856, an Assistant Geologist to the Irish Branch of the Geological Survey. Although from this date engaged in the minute examination and active physical labour connected with his duties on the Survey, he found time to furnish a number of botanical and other communications to the Natural History Society of Dublin, and several others upon Geological subjects to the British Association, the Royal Geological Society of Ireland, the pages of the *Geologist,* and other periodicals.

Amongst the latter he recorded his discovery of an interesting group of Trappean rocks, at the Horses Glen, near Killarney, in a paper to the Geological Society of Dublin, in June, 1856. He described the Geology of the neighbourhood of Tralee to the Geological Section of the British Association at Dublin in the summer of 1857. Noticed some new localities for *Posidonomya,* near Ennis, in a short paper to the Geological Society, Dublin, January, 1859; and in another paper, "On a Recent Erratic Block," read before the same Society, in November, 1864; called attention to the recent transport of a block of limestone, two tons in weight, from a distance of fifty yards—floated by the ice of a severe winter, some years ago, from its bed in the Shannon to shallower water near the shore.

In June, 1863, he obtained from beneath a bog in the County of Longford the indented bones and horns of *Cervus megaceros,* which furnished the subject of a paper by Professor Jukes, read before the same Society, in December of the same year; and gave rise to much interesting discussion and ingenious speculation as to the cause of their being marked and indented.

During the meeting of the British Association at Cambridge, in 1862, Mr. Foot read a paper, "On the Geology of the Burren in County Clare," and also exhibited and described a botanical chart of that district.

In connexion with his employment on the Survey, he contributed wholly or in part thirteen small explanatory memoirs of the various extensive districts which he had examined, accompanied by several illustrations from his own pencil.

Amongst other results of his scientific observations may be mentioned communications to the Natural History Society of Dublin: "On the Botany and Marine Zoology of Clare," "On the Mammalia of the West Coast of that county," "On the Little Auk taken alive at Athlone," "On *Asplenium ruta-muraria*," "On flights of Swans seen in Roscommon and Galway, winter of 1863-4," and "On the occurrence of *Hymenophyllum Tunbridgense* in county Longford, and stations of *Cystopteris fragilis* in the (Irish) Midland Counties." In March, 1859, he discovered (and recorded in the proceedings of this Society) for the first time in Ireland, the lesser horse-shoe bat; and in company with the late Dr. J. R. Kinahan explored various Irish Natural History localities, the results of their labours forming interesting papers in the Proceedings of this Society.

He paid a good deal of attention to the meteorology of the places where he resided, and a paper by him "On a storm (called the Prince Consort Storm) which occurred on Thursday, October 29th, 1863, at Ballinasloe," was read before the Royal Irish Academy in the following month.

Being so much employed in Ireland, he had not many opportunities of extending his researches in other directions, but during short periods of leave of absence he made visits of observation to Scotland, Germany, Sweden, and Norway. Having returned from the latter country but a few months since, he intended to produce papers with illustrations containing his geological and botanical observations, illustrated by collections and striking sketches of physical features, etc. This design has been interrupted by his untimely death, at the age of 36, which has deprived science of an energetic and accurate observer; the Geological Survey of an able assistant, and left a widow and many friends to deplore his loss.

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At his residence, near Glasgow, on the 17th January, James Smith, of Jordan Hill, F.R.S., F.G.S., &c., &c., late President of the Geological Society of Glasgow. We shall give a notice of this eminent and veteran geologist in our next number.

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We regret to record the demise of a valuable scientific contemporary, "The Dublin Quarterly Journal of Science," edited by the Rev. Professor Haughton, F.G.S., etc., of Trinity College, Dublin. We have frequently noticed this work in our Magazine, and are extremely sorry to learn from the Editor, that it will not be published in future.

A New Journal of Comparative Anatomy, etc., is announced to appear shortly, edited by Professor Newton, and Mr. J. W. Clark, of Cambridge, and Dr. E. Percival Wright, of Dublin.

THE

GEOLOGICAL MAGAZINE.

No. XXXIII.—MARCH, 1867.

# ORIGINAL ARTICLES.

## I.—On the relative Ages of the Coast Boulder-clay of the Eastern Counties, and that on the Higher Ground.

By George Maw, F.G.S., etc.

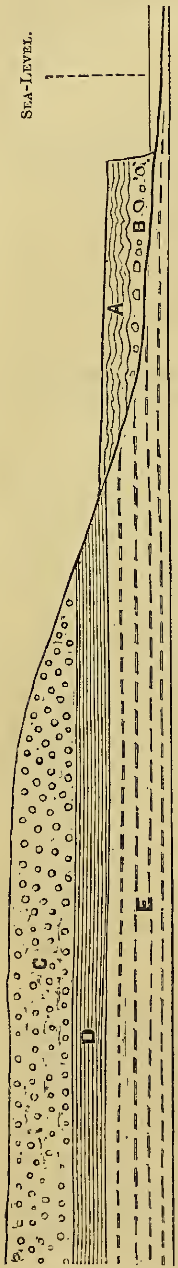
THE discussion on Mr. Boyd Dawkins's paper, "On the age of the Lower Brick-earths of the Thames valley," at the meeting of the Geological Society of London, 9th of January[1], induces me to submit a view of the relative ages of the Boulder-clays of the east of England, which seems to bring into harmony the views of Mr. Dawkins, and the physical evidence suggested in the discussion that seemed to conflict with them.

Mr. Dawkins' opinion that the lower deposits of Brick-earth at Grays' Thurrock, Crayford, and Erith were super-imposed by a Glacial deposit containing transported materials, was objected to on the grounds that they occur in a valley apparently excavated after the deposition of the Boulder-clay capping the high land to the north of London—implying an interval between the Muswell Hill Boulder-clay, and the supposed Glacial deposits of the Thames Valley, represented by the entire excavation of the valley, and the deposition of the Brick-earths and gravels, containing mammalian remains, underlying the Glacial beds.

The most obvious explanation seems to be the recognition of such an interval, and the object of the following remarks is to endeavour, by a comparison with the Glacial deposits of the Eastern Counties, to show its probability.

The Boulder-clay of the Norfolk and Yorkshire coast (A and B, Fig. 1), ranging from the sea level to a height of 50 to 100 feet above high-water-mark, is generally admitted to be of a different age to that (C) which forms the highest ground in Suffolk, extending inland over a great part of the Eastern Counties, and attaining a height of more than 200 feet above the sea. The two deposits differ considerably in physical character. That on the lower level, commencing at high-water-mark with tough clays (B), and transported materials, and graduating upwards at from 30 to 50 feet above the sea level, into highly contorted and quickly alternating

[1] See Geological Magazine, No. 32 (February) p. 79.




Explanation of Section. Fig. 1.

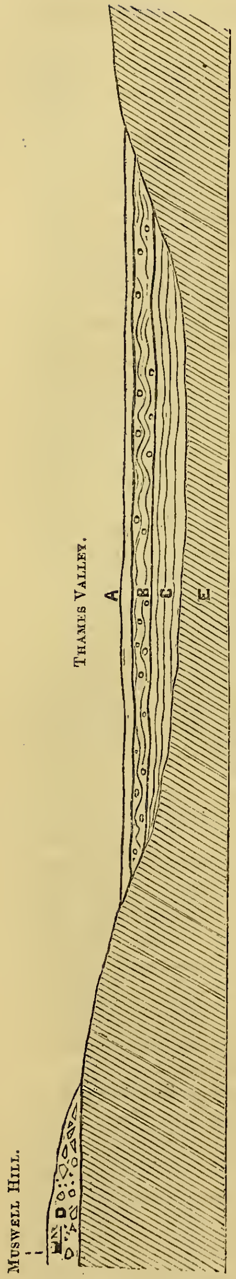
A. B. Low-level coast Boulder-clay. C. High-level Boulder-clay of Norfolk, Suffolk, and Bedfordshire. D. Sand and Gravel bed, underlying C.
According to the classification of Mr. S. V. Wood, jun., A. and B. Lower drift; D. Middle drift; C. Upper drift.

sand, silt, and clay beds (A.); the sandy or gravelly pervading over the clayey character in its upper part. The Boulder-clay on the high ground (C) has a range of from 150 feet (its base) to 220 or 230 feet above the sea, generally resting on a bed of sand and gravel (D) between which and the overlying clay there is little or no gradation or interstratification. The Boulder-clay itself, compared with that on the coast, is, throughout its mass, remarkably uniform in this character, and even in colour, generally free from sand beds. It is made up of clay and chalk detritus, and some transported materials, smaller and more even in size than the foreign matter of the coast Boulder-clay (A B), and remarkably uniform throughout the whole of its geographical distribution. The low-level Boulder-clay also seems to maintain its character through a wide geographical range, graduating upwards from very tough blue clay at the sea-level, into contorted silty and sandy beds, both on the east, as well as the west coast of England and Wales. I mention these facts rather fully to show the *probability* of the distinction and difference in age of the two deposits, and that each maintains a certain amount of uniformity of character and position. Mr. Searles Wood, jun., has fully recognised this, and assumes an order of succession from the lower to the higher clay, the latter of which he considers the more recent. This seems to rest on evidence not very definite, and I wish to suggest the possibility of another order of sequence, as affording an explanation of much that is otherwise difficult to understand, and as being quite as consistent with the observed facts, viz., that the Boulder-clay on the higher level is the more ancient, that on the coast having been deposited after its partial denudation. With respect to the difficulties that are opposed to Mr. Wood's views, one of the most prominent seems to be the analogy that may be drawn between the relative age of high and low-level river gravels and the relative age of the higher and lower Boulder-clays. In the case of river gravels, that on higher levels is generally admitted to be the more ancient, and there seems no substantial reason why the same sequence should not hold good with respect to the Boulder-clays.

Again, another difficulty, Mr. Searles Wood at p. 4 of his remarks in explanation of the map of the upper Tertiaries, says, "The Chillesford beds described by Mr. Prestwich, in 1849, as overlying the Red or Coralline Crags, pass up without the least break into the *Middle drift*, (D Fig. 1) and are evidently part of that division." Although the evidence on this point is scarcely decisive, I think the probability of the view taken by Mr. Wood is very strong. The bed Mr. Wood describes as "Middle drift," is the gravel underlying the high-level Boulder-clay (D. Fig. 1), and separating it from the Chalk, or in some cases from the intervening Norwich Crag. As far as my observations go the Chillesford Clay, both in Norfolk and Suffolk, is really part and parcel of the Upper Norwich Crag. In the well-known Crag-pit at Chillesford, this bed, containing deep sea Arctic shells (which at Norwich is almost immediately superimposed on the true Fluvio-marine Crag, both occurring at the base of the beds corresponding with the Chillesford Clay), lies in the midst, towards the base, of the Chillesford Loam and Clay; as the Boulder-clay Till of the Norfolk and Suffolk coast is unquestionably superimposed on the Norwich Crag, a difficulty at once presents itself in endeavouring to interpolate it in the Suffolk series *below* Mr. S. Wood's "Middle-drift." I know it has been assumed that the Chillesford beds are the representatives of the coast Boulder-clay, but there is nothing in its physical character, the thickness of its mass, or condition of its fossils, to support such an identification. At page 6 of Mr. Wood's paper, the difficulty in question seems to be recognized, and involves a statement of the hypothetical possibility of the Red Crag being newer than Mr. Wood's Lower-drift (or Coast Boulder-clay, A. and B. Fig. 1).

I believe there is no evidence of the direct superposition of the high-level Boulder-clay on that of the coast. If the higher clay was more recent than the lower, surely some cases would occur in which direct superposition was evident. But there is no coast section exhibiting the sequence of the high level directly over the low-level clay, with the intervening sand bed; there are very many instances of the coast Boulder-clay being capped with gravel, and of the Boulder-clay of the high ground being superimposed on a subjacent gravel bed; it must be admitted that these gravel beds correspond in height, and in many cases present the appearance of continuity, but proof of their identity seems to be wanting.

The Boulder-clay of the high ground of the Eastern counties, with its subjacent gravel-bed, presents much evidence of great antiquity; as has been shown by Mr. Salter and Mr. Wood, it has been extensively faulted with the Chalk, and it partakes of the general denudation contour of the country, most of the principal river-valleys having been cut through it deeply into the Chalk and Oolite. The small outlier at Muswell Hill (D. Fig. 2) appears to be the remnant of a more extensive deposit, the denudation of which




Explanation of Section. Fig. 2.

A. Surface soil. B. Glacial beds of Mr. Dawkins, (possibly corresponding with A and B of Figure 1). C. Lower Brick-earths of Thames Valley. D. Boulder-clay outlier at Muswell Hill, possibly corresponding with high-level Boulder-clay (C. Fig. 1). E. Lower Tertiaries and Chalk.

accompanied the excavation of the Thames valley. Now, if Mr. Dawkins' view is correct, that the Brick-earths and gravels occupying this valley are overlain by a later glacial deposit, the question at once suggests itself whether this can be more properly identified with the high-level clay of Suffolk, or the low-level Glacial deposits that occur *at its own level* along the coast. If it cannot be identified with the coast clay, you have, on Mr. Wood's views, the complicated difficulty of three distinct Boulder-clays of different ages.

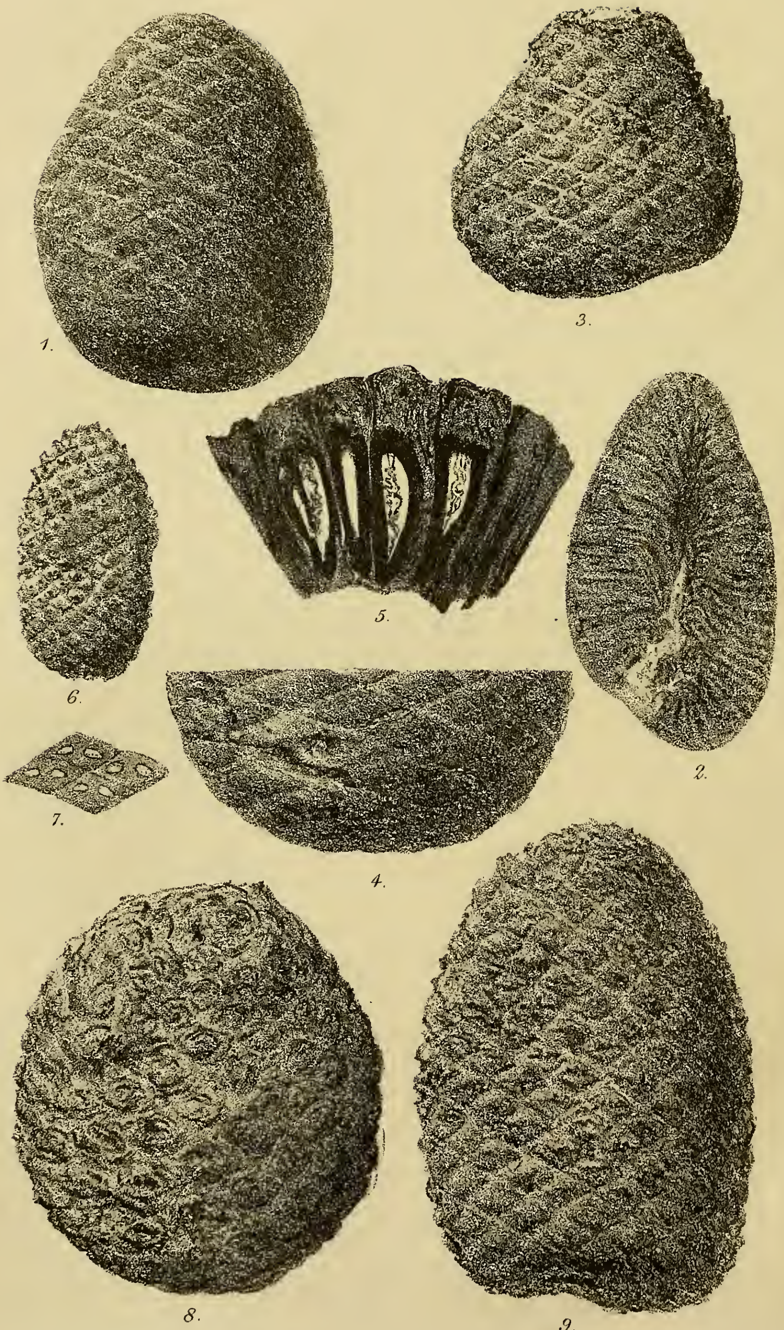
1st. Mr. Wood's "Lower drift," or coast Boulder-clay.

2nd. Mr. Wood's "Upper drift," separated from the first by clean gravel beds, ("Middle drift").

3rd. The glacial beds of Mr. Dawkins', overlying the beds that were deposited in the Thames valley, the excavation of which appears more recent than the deposition and partial denudation of the Muswell Hill Boulder-clay (D Fig. 2) which probably corresponds with Mr. Wood's "Upper drift," or high-level clay.

I do not mean to say that such a series of deposits during the Glacial period is impossible, but, without any direct evidence to the contrary; it seems preferable to take the simpler view, viz., that the beds of the Thames valley, containing transported materials, may be an inland extension of the Boulder-clay *on the same level*, fringing the coast, and that both of these were deposited *after* the deposition and partial denudation of the Boulder-clay on the higher ground.

Another point to be noticed is a frequent terrace-like structure of the Boulder-clay, fringing the coast, running straight inland till it meets with rising ground of older formation, against which it terminates as though its general level was the original surface of deposition; this character is not confined to any particular part of the coast, but presents itself, on both the east and west, wherever Boulder-clay occurs on the coast. Now if the Boulder-clay




E. Fielding, del. et lith. Vincent Brooks, Imp.

Cycadean Fruits, *from the* Secondary Rocks.

and drift of the higher ground is a more recent deposit it must originally have extended coastwise, and spread over the present low-level clay. It is strange, in this case, that no remnant of such super-position exists, and that the denudation, which must have removed the upper deposit, should have left the lower with such a regular platform-like structure throughout so great a range of *coast circuit.* I am not prepared to say that this could not have been the result of marine erosion, working at a higher level than the present coast-line; but taking other evidence into consideration it would appear that in this approximately level surface, we have the original surface of deposition, which took place in comparatively shallow water. Wherever the older rocks rise up to more than 100 or 150 feet above the sea level, the coast Boulder-clay "throws out," and instead of following the irregular basement line, and rising of its full thickness with the subjacent formation, it rapidly thins out to nothing, and is lost at a height of 100 and 150 feet above the sea level.

In the case of the inland deposit of Drift and Boulder-clay on the higher ground of the centre, and west of the country, it is difficult to directly identify it with that on the higher ground of Suffolk, Norfolk, and Bedfordshire. The various levels at which it occurs is remarkable, and can only be accounted for, either on the theory of unequal elevation, or from the whole having been progressively deposited during a submergence, in extent, equal to the altitude of the highest drift; but, as before observed, the general level of the terrace of clay, fringing the coast of Norfolk and Yorkshire on the east, and of Wales and Lancashire on the west, seems to point to an uniformity of age, and to distinguish it from the Boulder-clay and drift occurring at various higher levels, and it is with it, rather than that on the higher ground, that the supposed Glacial beds overlying the Brick-earths and gravels of the Thames valley may possibly be identified.

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## II.—On Some Cycadean Fruits from the Secondary Rocks of Britain.[1]

By William Carruthers, F.L.S. of the Botanical Department, British Museum.

(PLATE VI.)

Two of the Gymnospermatous Orders are represented by fruits found in Secondary strata, viz., *Cycadeæ* and *Coniferæ*; [2] no remains have been observed, as far as I know of any plant belonging to the *Gnetaceæ*.[3] There is satisfactory evidence of the existence of *Coniferæ* from the period of the Old Red Sandstone; but it is very doubtful whether the Palæozoic fruits and leaves which have been referred to *Cycadeæ* have anything whatever to do with that order.

[1] Reprinted (with some additional notes and alterations) from the "Journal of Botany" for January, 1867.

[2] For an account of the Coniferous Fruits, see Mr. Carruthers' papers in the Geological Magazine, Vol. III., p. 534, Plate XX. and XXI.; and "On Araucarian Cones," Vol. III., p. 249, Plate XI.

[3] Goeppert found a small fragment of what he believes to be an *Ephedra* in amber, which he has called *Ephedrites Johnianus.*

Fossil wood, leaves, and fruits, afford the means of determining the existence of vegetables during any geological period.

The trunks and foliage of *Cycadeæ* are so remarkable that fossil fragments of them can, as a rule, be determined with certainty. The trunks are generally short, and composed externally of the basis of the leaves, while internally they consist of a large medulla, either simple or traversed by numerous vascular bundles, and surrounded by one or more woody cylinders. The trunks from Purbeck, which Buckland named *Cycadeoidea*, specimens of which have also been found in the Oolite of Helmodale, Sutherlandshire, by Mr. Ch. W. Peach, and those from the Wealden, named *Clathraria* by Mantell, have all the characters of Cycadean stems. The leaves are remarkably uniform in the modern representatives of the order. With a single exception they are pinnated, hard, and woody, and the leaflets have fine, simple parallel veins. The genus *Stangeria* has paralled forked veins like those of a *Lomaria*, and we fear that this anomalous structure has induced palæontologists to place among the *Cycadeæ* some fossils which would more correctly be referred to Ferns. The cones of *Cycadeæ* are less frequent fossils than either the leaves or the stems. In a former paper (Vol. III., p. 535), I exhibited the characters by which Cycadean cones are distinguished from those belonging to the *Coniferæ*. I may here further add that the scales of the Cycadean cone have a much simpler arrangement than in that of *Coniferæ*. In *Cycadeæ* the scales are arranged either in a vertical series, as in the female cone of *Zamia*, or the secondary spirals consist of only two series, and the amount of obliquity in their direction is the same whether they wind to the left or to the right, as in *Encephalartos*.

Corda, in Reuss's "Die Versteinerungen der Böhmischen Kriedeformation," says he has never seen any real fossil Cycadean fruits, except the two that he there describes. These are *Microzamia gibba*, a female cone, unlike any recent Cycadean cone in having from three to six seeds supported by each scale, and *Zamiostrobus familiaris*, which from the form of the scales, and from having vascular bundles scattered through the medulla of the axis, he considers a true Cycad, and probably the male cone of the former species. Endlicher established the genus *Zamiostrobus* for a cone he believed to be Cycadean. But as I have formerly shown (l. c., p. 536), it was founded in error, and great confusion has since been created by making it the receptacle for cones, whose affinities could not be made out. Of the seven species now placed in the genus, I have shown four to be *Coniferæ*. What *Z. Fittoni*, Ung., may be or may not be, it is impossible to say from Fitton's drawing in the "Geological Transactions," 2nd series, vol. iv. t. xxii. f. 11. Fitton had a longitudinal section of it made, but he tells us (l. c. p. 349) that it "did not exhibit any indication of vegetable structure." In the British Museum there is a cast of a cone belonging to C. B. Rose, Esq., which corresponds remarkably with Fitton's figure. It was obtained from the Lower Greensand at Downham, near Lynn, Norfolk; but I believe the original specimen has decomposed, like so many pyritic fossils, so that it can throw no light on the matter. Corda, after a fresh examination of *Z. familiaris*, Ung., has shown it to be Cycadean; and the remaining species, *Z. crassus*, is most probably Cycadean, although the materials for its determination are not entirely satisfactory.

A singular fossil occurs at Runswick Bay in the Lower Oolite, to which Lindley and Hutton give the name of *Zamia gigas*. James Yates, Esq., and Prof. Williamson, have examined the structure of this plant. Prof. Williamson originally considered the "collar" (the so-called fruit of the fossil) as a series of protecting scales, beyond which the axis was prolonged to support a cone.[1] Mr. Yates, whose extensive acquaintance with *Cycadeæ* is well known, and who has greatly helped me in my investigations, not only with his advice but also by presenting his large collection of dried specimens of Cycadean stems, foliage, and fruit, to the British Museum, saw no indication of this cone in the numerous specimens he examined. He says, regarding this fossil,[2] that its pinnate leaves "have unquestionably a very close resemblance to the leaves of *Zamia*. But here the analogy seems to cease. The stem does not resemble the stem or the mode of growth of any recent species of *Zamia*, and a still greater difficulty presents itself in its fruit." Mr. Yates considers that the "collar" contains the fruit, and Prof. Williamson seems to have ultimately arrived at the same conclusion, for he says[3] the fossil contains two distinct forms of fruits. "The one, a curious scaly axis, prolonged in a peculiar pyriform manner, which latter part has been invested by a cortical substance, consisting of oblong cells arranged perpendicularly to the axis. This was probably the antheriferous portion. The second form consists of a concave disk. which has evidently terminated the woody axis, and been margined by a peripheral circle of radiating bracts. On the upper portion of each of these bracts are two small oblong depressions which may have supported two ovules." I have examined numerous specimens of this fossil in the British Museum, but have been unable to determine satisfactorily anything in regard to the precise structure of this anomalous fruit. It presents so many peculiarities unknown in the fruit of any modern Cycad, that for the present at least, and notwithstanding its Zamia-like leaves, I must consider it a doubtful Cycad.

The cones I am about to describe have several features in common, which show that they belong to this Order. They have all the simple arrangement, or phyllotaxis of the scales of the cones. The peduncle, when indications of it are present, as in *C. elegans* and *C. truncatus*, is larger than in Coniferous cones of the same size. The cones are converted into iron pyrites, a mineral condition unfavourable to the preservation of structure, but the arrangement of the mineral shows that the general direction of the parts of which the cone was composed was at right angles to the axis (Plate VI., Fig. 2.) A specimen from the collection of the late Robert Brown,

[1] Proceedings of York Phil. Soc, 1847, p. 46. [2] Ib. p. 39.
[3] Transactions of the British Association, 1854, p. 103.

which he had sliced, fortunately exhibits, to some extent, the internal structure. This fragmentary specimen is a portion of the base of a cone (Fig. 4), and the magnified section (Fig. 5) is perpendicular to the axis. The axis itself is wanting. The scales leave the axis at a right angle, except those at the very base, which slightly incline downwards. They have a thickened peltate apex, not imbricated, composed of loose cellular tissue. The longitudinal section necessarily shows a single seed connected with each scale. The seed had a thick testa, indicated by the thick dark line in the sketch. The contents of the seed have disappeared, leaving only the shrivelled-up tegmen still attached at the base of the seed, though apparently free at the apex. A rolled cone, four scales of which are represented at Fig. 7, has the apices of the scales nearly rubbed off, and exhibits the bases of the seed at their attachment to the scale; and this shows that there are only two seeds to each scale.

The recent genus to which these fruits are most nearly related is the South African genus *Encephalartos*. Associated with the cones at Brook Point are found trunks of *Clathraria*, of which, no doubt, they were the fruits. The form and structure of these trunks confirm the affinity of the Wealden Cycads to *Encephalartos*. In both, the trunks are tall and cylindrical, and the medulla is traversed by numerous vascular bundles.

As long as we are unable to refer these fruits to the species to which they belong, it is desirable that they should have provisional names by which they may be known. To prevent confusion, I will avoid Endlicher's generic name *Zamiostrobus*, and propose *Cycadeostrobus* as a suitable designation, giving no further definition to the genus, than that it contains fossils that are supposed to be the fruits of *Cycadeæ*.

1. *Cycadeostrobus ovatus*. Cone ovate; scales somewhat broader than deep. (Pl. VI. Figs. 1 and 2.)

The specimen of this cone, which is two inches long by a little more than one and a-half broad, is less compressed than the other specimens figured. It has been cut longitudinally through the axis, but does not exhibit any structure.

From the Wealden at Brook Point, Isle of Wight.

2. *C. truncatus*. Cone ovate, truncate, and widest at the base, narrowing upwards from the middle to its obtuse apex; scales about a third broader than deep. (Pl. VI. Fig. 3.)

There are three specimens of this cone in the British Museum, from the collection of Dr. Mantell. One specimen has the scar of a large peduncle. In another the scales are preserved in relief, and show that they had a tumid pyramidal apex.

3. *C. tumidus*. Cone, oblong-acuminate; scales about as broad as long, the apex rising into a tumid pyramid. (Plate VI. Fig. 6).

A single specimen of this distinct little cone, an inch and a quarter long by three-quarters broad, is in the British Museum. It is from Brook Point.

4. *C. elegans*. Cone ovoid, truncate below; scales nearly as deep as they are wide. (Plate VI. Fig. 9.)

There are two specimens of this cone in the British Museum, from the collection of Lady Hastings. They are two and a-half inches long, by one and a-half broad. The base is not only truncate, but somewhat indented, and there is the remains of a large peduncle, having a diameter of nearly half-an-inch. There is a third specimen in the Geological Museum at Jermyn Street.

From the Wealden, Brook Point.

5. *C. Walkeri.* Cone oblong; scales broader than deep.

This cone is figured by Mr. J. F. Walker, in the Annals and Mag. of Nat. Hist. ser. 3, vol. 18 (plate xiii. fig. 5), and described as a Cycadean cone (p. 384), two and a-half inches long and two and three-quarters in circumference. The specimen is evidently very much waterworn. Perhaps the specimen in the British Museum from which the four scales (Plate VI. Fig. 7) were drawn, belongs to this species.

From a phosphatic deposit in the Lower Greensand, at Sandy, Bedfordshire, probably of Wealden age.

6. *C. sphæricus.* Cone spherical; scales as deep as they are broad. (Plate VI. Fig. 8).

This cone is very much compressed and imperfectly preserved, but is evidently different from the others.

From the Oxford clay of Wiltshire.

7. *C. primævus.* Cone ovate; scales as broad as they are deep.—*Pinus primæva,* Lindl. and Hutt. Foss. Fl. Tabl. 135. *Pinites primævus,* Morris, Cat. p. 18.

The scales of this cone are six deep and six round. Each one is dilated at its extremity, and gradually thins away towards the axis.

From the Inferior Oolite at Burcott Wood and Livingstone.

8. *C. Brunonis.* Scales twice as broad as they are deep. (Plate VI. Fig. 4 and 5.)

The single specimen of this species is a fragment from the base of a large cone. It is from the collection of the late Robert Brown. The fragment is two inches in diameter. The very broad scales easily separate it from the other species.

Locality unknown.

9. (?) *Zamia crassa,* Lindl. and Hutt. Foss. Flor. t. 136. This is probably a Cycadean cone. The authors of the "Fossil Flora" decribe it as having "in transverse section numerous seeds lying below the thickened ends of the scales at a considerable distance from the thick axis." It is too imperfect to decide positively as to its affinities.

From the Wealden, at Yarenland, Isle of Wight.

There is a cast in white sandstone of a vegetable organism, probably Cycadean, but whether part of a trunk or of a fruit I am unable to determine, from Brora, presented to the Geological Museum, Jermyn Street, by Sir Rod. I. Murchison, Bart. I notice this here that I may suggest, to those who have an opportunity of visiting the Secondary deposits of the North of Scotland, how desirable it is to have additional specimens, so as to determine more accurately the remarkably interesting Flora of these beds.

EXPLANATION OF PLATE VI.

Fig. 1.—*Cycadeostrobus ovatus.*
,, 2.—Longitudinal section of same.
,, 3.—*C. truncatus.*
,, 4.—*C. Brunonis.*
,, 5.—Portion of a longitudinal section of same (twice the natural size).
,, 6.—*C. tumidus.*
,, 7.—Four scales of a water-worn cone, showing the bases of the two seeds under each scale.
,, 8.—*C. sphæricus.*
,, 9.—*C. elegans.*

*** I am indebted to my colleague, Mr. W. Carruthers, F.L.S., for the use of this Plate, which has already appeared in the "Journal of Botany," for January, 1867, together with the descriptions of the species which accompany it, to which latter the author has made several additional notes.—H. W.

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## III. Note on the late Colliery Explosions.[1]

By John Rofe, C.E., F.G.S.

The recent deplorable explosions in the Barnsley and North Staffordshire Coal Fields have again called attention to the coincidence of such terrible accidents with a sudden fall of the barometer, by which they are so frequently preceded, suggesting the idea that they may be to some extent connected as cause and effect, and perhaps the following facts may induce a belief that there is truth in the supposition.

Some years since (in 1848) my attention was called to a well at Whittingham, on a farm then and now occupied by Mr. John France, about four miles N.W. of Preston, in Lancashire, celebrated in the district as "the blowing well." This well was sunk for the purpose of supplying the farm buildings with water, but after going down about eighty feet in vain, the work was abandoned, and the well was covered with a large flagstone, with a hole through it for the chain used in placing it on the well. It was then noticed that the well answered the purpose of a weather glass, for whenever the barometer fell wind blew out of the well, and when it rose the draught was inwards, and with more or less force according to the rapidity of the change. The tenant occasionally put a tin horn into the hole in the flag and then the sound could be heard at a considerable distance.

Some time after this I had occasion to sink a well for a cesspool to get rid of the offensive residue from some chemical works. This was sunk about twenty-eight feet deep in dry loose sand, and it was arched over, leaving no opening but a pipe through which the liquid refuse was passed when required. This well acted in the same way as the above, as was soon made unpleasantly evident, for when the atmospheric pressure was decreasing, the air came from the

[1] This communication was sent to the Editor on the 10th of January. From the evidence since given at the Inquest on the Barnsley accident, it appears that the coal-owners provided a barometer and ordered extra firing in the upcast shaft when the glass fell rapidly, so that it seems the effect of rapid atmospheric changes was known, and, to some extent at least, provided for; but we still think Mr. Rofe's note deserving publication, as collateral evidence of the atmospheric action alluded to.—*Edit.*

well, loaded to a disagreeable extent with the offensive vapour from the cesspool. On continuing my observations with a barometer I found similar results to those at the "blowing well" at Whittingham.

These results, however, are exactly what, on consideration, would be expected. The air in the well, on any diminution of the atmospheric pressure, would necessarily expand and pass from the well, and on any increase of pressure the reverse must take place.

Now if we apply this reasoning to a coal mine, which, for the purpose of this argument, may be considered as merely an immense subterranean excavation, connected with the external atmosphere only by the up and down cast shafts, we should expect the air in the mine to expand when the atmospheric pressure is diminished; and if that expansion were sudden and great it would probably supply as much air as the upcast was passing, without drawing an equivalent quantity of fresh air through the downcast; and at the same time, by the diminution of the pressure, the gas generated or confined in the pores and fissures of the coal would be expanded or set free more rapidly, and thus cause an excess of gas in the air of the mine, which, if it meets with an open lamp, a smoker's pipe, or any other means of ignition, spreads death and destruction around.

It may, perhaps, be remarked, that if sudden variations of atmospheric pressure acted in this way there would be more explosions than there are; but, fortunately, these dreadful accidents require a concurrence of circumstances to cause them. There must be an excess of gas in the mine, and, *at the same time*, whether from accident or carelessness, a means of ignition. The chances are that these would be only occasionally concurrent, and then, only, explosions would take place.

The lesson to be drawn from these remarks is that coal proprietors should take especial notice of any considerable fall in the barometer, and at such times force an extra ventilation either by additional firing at the upcast, by a steam jet, or by any other means which their experience may suggest; but by some means or other they should increase the ventilation when any sudden diminution of atmospheric pressure takes place.

If there should be nothing new in the above remarks, I make no excuse for offering them, because the consequences of these explosions are so awful that it becomes the duty of every one to suggest any precautionary measures he may have reason to believe could, in any degree, tend to prevent them, even at the risk of exposing his ignorance of what may have been already carried into practice.

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## IV.—On some Fossils from the Lower Silurian Rocks of the South of Scotland.

By Henry Alleyne Nicholson, B.Sc.

(PLATE VII.)

THE Lower Silurian Rocks of the South of Scotland, below the level of the Wrae Limestone of Peeblesshire, though of great thickness, and little altered by igneous agency, have as yet yielded but few of the higher forms of animal life. Two species of a phyllopod crustacean,[1] (*Peltocaris aptychoides* and *P. Harknessi*, Salter), were discovered by Prof. Harkness, along with the first Brachiopod found in these deposits, the *Siphonotreta micula* of McCoy. Another crustacean of an allied genus, described by Mr. Henry Woodward,[2] and named by him *Discinocaris Browniana*, was discovered last year in the neighbourhood of Moffat, by Mr. D. J. Brown. Besides the above, there occur traces of the action of marine worms, and I have, in addition, found one, possibly two, species of *Lingula*, a thin-walled *Orthoceras*, or Pteropod, and some curious spine-like bodies, probably referable to crustaceans. With the exception of these scanty remains, the strata under consideration have yielded no fossils higher in the scale of existence than Graptolites. In no other British deposit do we, however, find a greater profusion of these beautiful and characteristic fossils, or a greater number of specific types. It is the object of this communication to describe certain new forms of Graptolites which have come under my notice, together with one remarkable genus, apparently allied to the *Graptolitidæ*, though probably representing a different order.

*Corynoides calicularis*, gen. nov. (Plate VII. Figs. 9-11). In the more anthracitic shales of Dobbs' Linn, and of Hart Fell, near Moffat, there occur certain singular fossils, for which I have adopted, at Prof. Harkness' suggestion, the generic name *Corynoides*, and have appended the specific title *calicularis*. These occur in the same state of fossilization, as do the Graptolites, viz., as flattened pyritous impressions, and though often occurring in considerable number, they present a great similarity to one another in size, and in their general characters. The stipe varies in length from one-third to half an inch, and has an average breadth of one-twentieth of an inch; the base, or proximal extremity, is provided with two small, slightly diverging spines or mucros (Fig. 9), which are wanting in other less perfect specimens, when the stipe terminates below by tapering to a point (Fig. 10). There are no cellules, the lateral margins of the stipe being perfectly plain; but the polypary expands at its distal extremity into a sort of cup or calyx, the free edge of which is divided into four or five equal or unequal teeth. There are no certain traces of any central solid axis, but the surface of the stipe is sometimes striated. From the above description it will be evident that *Corynoides* forms a simple hollow tube, probably corneous, provided with a single or double radicle or mucro, and developed distally into a cup-like "hydrotheca." Unlike the *Graptolitidæ*, proper *Corynoides*, has evidently been composed of a single polypite only, though it resembles the typical Graptolites, in having been apparently free and oceanic, and in the possession of a corneous or sub-calcareous test or polypary. *Corynoides* seems to be most closely analogous to some of the *Corynidæ* or *Tubularidæ* of our own seas, especially resembling such forms as *Coryomorpha*, in which there is but a single polypite. It cannot, however, be considered to be absolutely referable to the *Corynidæ*, since no known Corynid exists as a free-floating

[1] See Quart. Journ. Geol. Soc. Vol. xix., p. 87. [2] Op. cit., Vol. xxii., p. 503,

and independent organism, such as *Corynoides* seems undoubtedly to have been.

*Diplograpsus tubulariformis*, n. sp. (Plate VII. Figs. 12-15). This hitherto undescribed species seems to constitute a transition-form between *Corynoides* and the true Graptolites, being, however, itself referable to the latter, and belonging to the genus *Diplograpsus.* The stipe is flattened, simple, from one-third to half an inch in length, celluliferous on the two sides for a short distance above, and tapering gradually towards the base, so as to form a long, pointed, non-celluliferous portion or radicle, which occupies half or more of the entire length of the stipe. The axis is capillary, usually prolonged beyond the celluliferous portion of the stipe, and apparently double in its composition, as shown by its occasionally splitting at the summit. Celluliferous portion of the stipe from one-tenth to one-eighth of an inch in breadth, bearing from three to six cellules on each side, and terminating above abruptly by a straight or curved margin, which is usually fringed with terminal cellules. Cellules pointed, about eighteen in the space of an inch, forming a very acute angle with the axis (about 15 degrees); their upper portions more or less free; the upper margin of the denticle directed at right angles with the axis, or more or less downwards. In some of my specimens the broad and tapering radicle, which characterises the species, is present, but the lateral cellules are reduced in number (Figs. 13-14), or seem even to be altogether absent (Figs. 15), when the stipe terminates in a curved or straight celluliferous margin. The pointed denticles, which are seen in these cases, may possibly not be true cellules, but may be due to breakage of the stipe, and under any circumstances this form would appear to be only a variety. In the extreme cases, as in Fig. 15, there seems to be a close approximation to *Corynoides*. *Loc.*—Shales of Duffkinnel Burn, near Wamphray.

*Diplograpsus accuminatus*, n. sp. (Pl. VII. Figs. 16–17.) I have proposed this name for a species of *Diplograpsus,* which occurs pretty generally in the Dumfriesshire shales, and is certainly distinct from any described British species.

*Spec. Char.*—Stipe celluliferous on both sides; usually not more than half an inch in length, seldom reaching one inch; average breadth one-twentieth of an inch; tapering gradually towards the base, where it ends in a long and pointed radicle. Axis slender, capillary, often prolonged beyond the celluliferous portion of the stipe, for a quarter to half an inch. Cellules about twenty in the space of an inch, alternating distinctly with one another on the two sides of the stipe, and projecting as prominent teeth, the free extremities of which are generally acute and sub-mucronate, sometimes rounded off and obtuse. The cellules are usually one-third as broad as they are long; their outer margin is straight, or slightly curved, and their upper margin at right angles with the axis—sometimes directed upwards, rarely downwards. This species, when well-marked, as in Fig. 16, is easily recognized by its pointed radicle, which gradually becomes continuous with the body of the stipe, its small width, the few cellules in an inch, and the marked alternation of the toothed and angular denticles. These characters seem to me to entitle it to rank as a distinct species; but the genus *Diplograpsus* is in such an unsatisfactory condition, that it may eventually turn out to be a variety of some previously-described species. I have included some forms, in which the denticles are rounded, instead of angular, as the cellules distinctly alternate, and the stipe commences in a pointed radicle (see Fig. 17); but I doubt whether these are differences of variety or specific distinctions. *D. acuminatus* somewhat resembles *Graptolithus*, (*Diplograpsus*) *angustifolius*, of Hall, but is certainly distinct. It is also not unlike a species which occurs in the Skiddaw Slates, and has been doubtfully referred by Mr. Salter to *D. pristis.* Loc.—Dobbs' Linn, Duffkinnel Burn; Garple Linn, in Dumfriesshire.

*Didymograpsus anceps*, n. sp. (Plate VII. Figs. 18–20.) This peculiar form of *Didymograpsus* differs from all others with which I am acquainted, in the total absence, or very rudimentary condition, of the radicle or initial point. So much is this the case, that it might at first sight be considered to be merely a mono-prionidian Graptolite, accidentally bent; but this supposition is negatived by the fact that there occur numerous specimens, the branches of which are bent at the same angle and in the same way, while the serratures point in the same direction in both branches.

The frond consists of two stipes, coming off from a point, which is not, as a rule, marked by any radicle (Figs 19–20), though a minute mucro is to be discovered in some specimens apparently belonging to this species (Fig. 18). In these cases the mucro is internal, and the cellules are on the outer or convex side of the frond. Considering this as the normal position, the stipes bend downwards from their origin, including between them an angle of 20° or thereabouts, and extending in a straight or slightly curved direction for a greater or less distance. The stipes rapidly attain their maximum breadth (nearly one line), retaining the same dimentions, and showing no signs of terminating as far as seen—a length of two inches being reached in the larger specimens. Cellules, twenty-five to thirty in the space of an inch, their extremities rounded off, and their margins strongly curved, so that the denticles are separated by indentations, which are rounded at the bottom, and extend about half-way across the stipe (Fgs. 18*a*. 20*a*.) Sometimes there are minute pustules, or circular depressions in the centre of each denticle, where it joins the body of the stipe, but this does not seem to be at all constant.

This species is very easily distinguished, both by the absence of any prominent and conspicuous radicle, and by the peculiar form of the cellules, in which latter respect it differs from all British species, and closely resembles *Graptolithus* (*Didymograpsus*) *divaricatus*, Hall, which is found in the Hudson River Group. *Loc.*—Dobbs's Linn, near Moffat.

*Didymograpsus flaccidus*, Hall, Sp. (Plate VII. Figs. 1—3.) This exceedingly distinct and beautiful species appears to be identical with the *Graptolithus flaccidus* of Hall, which occurs in the Utica Slate, the American equivalent of our Upper Llandeilo Rocks. I am not aware that it has been before recognized as occurring in Great Britain, but I have found it in tolerable plenty in the anthracitic shales of Dobbs' Linn and Hart Fell, near Moffat. For its specific characters I may refer to Hall's description, (Graptolites of the Quebec Group, Supp. p. 143, Plate II., Figs. 17–19.)

*D. flaccidus* is at once distinguished from all other species of *Didymograpsus*, by the slender and flexuous stipes (Fig. 1), each of which may attain a length of nearly half a foot, without showing any sign of a termination. The cellules are on the convex side of the frond, the denticles angular or rounded. The mucro is on the concave side of the frond, sometimes short and obtuse, as in Hall's specimens ; sometimes, however, attaining a length of one-tenth of an inch. In most of the specimens in my possession, the margin opposite to the mucro is ornamented with three small spines (Figs. 2 and 3), one directly opposite to the radicle, and one springing from the apex of the first cellule on each side. On a cursory examination the entire frond may be confounded with *Graptolithus tenuis*, unless the presence of a radicle should be detected.

*Diplograpsus quadri-mucronatus.* Hall, sp. (Plate VII. Figs. 6–8.) This is another Utica Slate species, which I have found in the shales of Dobbs' Linn, though it is not of common occurrence. It has a considerable resemblance to *D. Whitfieldi*, Hall (Fig. 4), but is altogether a larger form, and is distinguished by the fact that each cellule is provided with two mucronate points, one arising from each angle, whereas, in the latter species, there is only one such mucro to each denticle. For the specific characters of *D. quadri-mucronatus*, Hall's description should be consulted. ("Graptolites of the Quebec Group," Supp. p. 144, plate xiii. figs. 1–10.)

*Diplograpsus Whitfieldi*, Hall, sp. (Plate VII. Figs. 4 and 4*a*.) I believe this species has usually been confounded with *D. mucronatus*, Hall, (Fig. 5), especially as they often occur together. The two are, however, distinguished from one another by good characters. In *D. Whitfieldi* the denticles are "shallow and angular," whilst the mucros are rigid, and maintain a persistent horizontal or slightly upward direction. In *D. Mucronatus*, on the other hand, the denticles are prolonged into slender and prominent teeth, furnished at their extremities with flexible spines, which have no constant position, but are twisted in every direction, (see Fig. 5*a*.) For the description of *D. Whitfieldi*, see Hall's Palæontology of New York, Vol. iii. supp. p. 516. *Loc.*—Common in the anthracitic shales of Glenkiln Burn, Dumfriesshire.

*Germs of Graptolites* (Plate VII. Figs. 21–24. The occurrence of minute bodies, possessing a graptolitic texture, provided with a corneous envelope, and differing in form from all known species of graptolites, was first investigated by Professor James Hall, to whom we owe so much of our knowledge of the *Graptolitidæ*. (See Palæontology of New York, vol. iii., supplement and "Graptolites of the Quebec group," pp. 33-35 ; plate B., figs. 12–19).

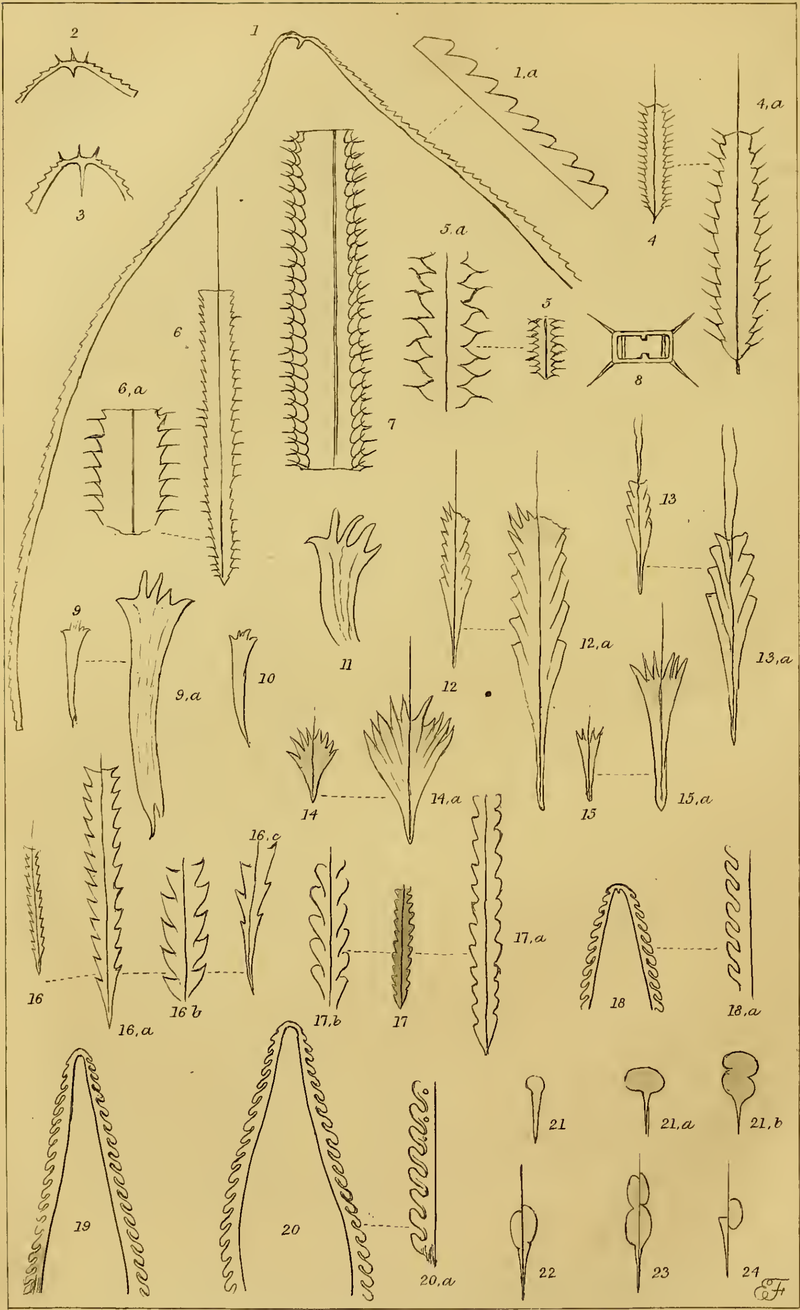
These curious fossils were considered by him to be the germs or embryonic forms of Graptolites, and there can hardly be any doubt as to the correctness of this conjecture. Numerous bodies, very similar to those described by Hall, occur in the graptolitic shales of Dumfriesshire,[1] and have, in all probability, a similar origin. It should be observed that the form and texture of these germs constitute a strong argument against the conclusion that the *Graptolitidæ* are *Polyzoa*, and support those who wish to place the Graptolites among the *Hydrozoa*, a view which is further sustained by the occurrence of forms like *Corynoides*, and by the discovery of bodies resembling "ovarian vesicles," as noticed by Hall and by myself, (see *op. cit. supra*, also the GEOLOGICAL MAGAZINE, October, 1866.)

It is, of course, in most cases impossible to refer the embryonic Graptolite to any known adult form; still, this can sometimes be done with tolerable certainty. Thus, in the anthracitic shales of Hart Fell, where *Diplograpsus pristis* is the predominant species, there occur innumerable germs, which in their more advanced stages appear referable to the above-mentioned species. Among these, three main varieties present themselves, which are probably, merely as many different stages of development. The first and youngest of these consists simply of a mucronate radicle, or initial point, sometimes slightly dilated at its distal extremity (Fig. 21). When further advanced the radicle is seen to be surmounted by an oval or heart-shaped mass (Fig. 21 *a*), which, as a further step, becomes gradually indented (Fig. 21 *b*), and is developed into the primary cellules. When next seen the radicle is inconspicuous, and the young form now differs from the adult in size only.

Another very common form, which is certainly referable to some di-prionidian species, consists of a pointed radicle, terminating in, or giving origin to, a solid axis, the lower part of which is embraced by two semi-circular lobes, which are so arranged as to alternate distinctly with one another, leaving the upper part of the axis bare (Fig. 22). When further developed, two additional lobes or cellules are superimposed upon the first, the alternation being still maintained (Fig. 23).

Other germs, again, appear to belong to mono-prionidian species. Like the last, these seem to commence simply as a pointed radicle. In the process of development a delicate solid axis is produced from the apex of the radicle, proceeding from one side of it, and not from the centre. From the base of this axis, and also on one side only, a small semi-circular lobe, or cellule, is developed, being applied partly to the axis and partly to the radicle (Fig. 24). No more advanced stages of these unilateral, or mono-prionidian, germs have as yet come under my notice.

[1] The first notice of these embryonic forms, as occuring in Britain, came, I believe, from Mr. W. Carruthers, who described and figured a small germ, which he considered to be referable to his *Diplograpsus tricornis*. (See Annals and Magazine of Natural History, Vol. iii. No. 13, p. 25).




LOWER SILURIAN GRAPTOLITES.

EXPLANATION OF PLATE VII.

Fig. 1. *Didymograpsus flaccidus* (Hall. sp.), nat. size.
1 *a*. Portion of the stipe of the same enlarged.
2. Portion of *D. flaccidus*, showing the radicle, with three small spines on the opposite margin.
3. Another specimen, with a longer radicle.
4. *Diplograpsus Whitfieldi* (Hall. sp.), nat. size.
4 *a*. The same, enlarged.
5. *Diplograpsus mucronatus* (Hall. sp.), nat. size. Introduced for comparison with *D. Whitfieldi*.
5 *a*. Portion of the same, enlarged.
6. *Diplograpsus quadri-mucronatus* (Hall. sp.), nat. size.
6 *a*. Portion of the same, enlarged.
7. Enlargement of a portion of *D. quadri-mucronatus*, after Hall, showing the two spines arising from each cellule.
8. Transverse section of the stipe of *D. quadri-mucronatus*, after Hall.
9. *Corynoides calicularis* (gen. nov.), nat. size. 9 *a*. The same, enlarged.
10. Ditto, with a single mucro. 11. Cup of *Corynoides*, enlarged.
12. *Diplograpsus tubulariformis* (n. sp.), nat. size. 12 *a*. The same, magnified.
13, and 13 *a*. Ditto, in which the lateral cellules are reduced in number. (Fig. 13) nat. size, and (Fig. 13 *a*) enlarged.
14 and 14 *a*. Rounded variety of *D. tubulariformis*, in which the lateral cellules are still further reduced in number. (14) nat. size, and (14 *a*) enlarged.
15 and 15 *a*. Another variety of the same, in which only the terminal cellules are left, nat. size, and enlarged.
16 and 16 *a*. *Diplograpsus acuminatus*, (n. sp.), ordinary form, nat. size and enlarged. 16 *b*. Portion of stipe of the same, enlarged. 16 *c*. *Radicle* of the same, enlarged.
17 and 17 *a*. Variety of *D. acuminatus*, in which the cellules are rounded, and very variable in shape, (*D. angustifolius* Hall. ?) 17 *b*. Portion of the stipe of the same, enlarged.
18. *Didymograpsus anceps* (n. sp.), with rudimentary radicle, nat. size. 18 *a*. Portion of the same, enlarged.
19 and 20. Ditto, without any apparent radicle, nat. size. 20 *a*. Portion of stipe, enlarged.
21 and 21 *a* and *b*. Germs of *Diplograpsus pristis*, enlarged.
22 and 23. Germs of a di-prionidian Graptolite, enlarged.
24. Germ of a mono-prionidian Graptolite, enlarged.

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## V.—On the Arenig and Llandeilo Groups.[1]

By the late H. Wyatt-Edgell, Esq., 13th Light Infantry.

The lower strata of the Silurian system are, as yet, but little known. The labours of Welsh and other geologists have brought to light the large fauna of the Lingula flags; but while the Upper Cambrian has thus been established and elucidated, the beds which lie immediately above it, namely the "Arenig group," and the Llandeilo flags, remain to be searched, and a great part of the respective fauna of each to be described.

The Arenig, or Skiddaw, group of Sedgwick forms the base of the true Silurian rocks; it immediately underlies the Llandeilo flags,

[1] This paper (originally read before the "Geologists Association," and published in their Proceedings in July, 1866,) was handed to the Editor of the Geological Magazine, in the autumn of last year, by the Rev. E. Wyatt-Edgell, with a request from his son (at that time in Ireland) that it should appear in this Journal. In addition to the author's own MS. corrections, the copy was obligingly corrected by Mr. J. W. Salter, F.G.S.—Edit.

from which it is totally distinct, although classed with them in Murchison's "Siluria." The name is derived from Arenig-fawr, Merionethshire, where the group is well shown and full of igneous rocks: from this locality Prof. Sedgwick and Mr. Salter obtained two of the characteristic fossils, *Calymene parvifrons* and *Ogygia Selwynii.* He recognized the beds as different from those above, and called them Arenig slates, considering them the top of his Festiniog group. (See "Introduction to Synopsis of Woodwardian Museum," London and Cambridge, 1855.) But the group was not well known as a distinct one, until the appearance of the last edition of Lyell's "Manual of Geology;" since then it has been established more completely by the lists of fossils given in vol. iii. of the "Memoirs of the Geological Survey." In England it is seen in the lead-mining district of the Stiperstones, Shropshire, underlying the Llandeilo flags of Shelve and Cornden Hill; here it is that Murchison more especially describes it under the name of Lower Llandeilo. It occurs again near St. David's Head, overlying the Cambrian, and passing upwards into the Llandeilo flags; here it was first recognized by Mr. Salter, who frequently cites this locality in his "Monograph of British Trilobites," now coming out. (See Palæontogr. Monogr.)

The distinctness of our group from the latter is evident when the fossils of each are compared. The character of the fauna varies as much as it does between the Llandeilo and the Caradoc—more so than between the Caradoc and the Lower Llandovery. This will at once be seen from the lists here given.

Arenig.—*Ogygia peltata*; *O. Selwynii; Calymene parvifrons; Æglina binodosa; Æ. grandis; Æ. caliginosa; Trinucleus Murchisoni; T. Gibbsii; Orthoceras Avelinei; Obolella plumbea; Orthis* sp. (Whitesand Bay); *Cucullella Anglica; Encrinites* (two).

Llandeilo,—Lower.—*Asaphus tyrannus; A. peltastes; Ogygia Buchii* var. *convexa; Calymene Cambrensis; Trinucleus favus; Lichas patriarchus*; *Bellerophon bilobatus; Helicotoma* sp.; *Lingula granulata; L. attenuata; Orthis striatula; Ctenodonta* sp.

Llandeilo,—Upper.—*Asaphus Corndensis; O. Buchi*, ordinary var.; *Barrandia* (*Ogygia*) *radians; B. Cordai; Calymene duplicata; Trinucleus fimbriatus; Cheirurus Sedgwickii; Ampyx nudus*; *Agnostus Maccoyi; Lingula Ramsayi; B. perturbatus; Murchisonia simplex; Modiolopsis inflata; Didymograpsus Murchisoni.*

The first fossil cited from the Arenig is from Whitesand Bay, near St. David's Head. It has recently been described by Mr. Salter under the name of *Ogygia peltata;* this description will be published, I believe, in the next volume of the Palæontographical Society.[1]

*Ogygia Selwynii*, the next on the list, is the most characteristic fossil of the Arenig, or Skiddaw, rocks. It is found both in the Stiperstones district and in North Wales, and serves to mark these beds, just as *Ogygia Buchi* does the Llandeilo flags. Associated with

[1] This paper was written in March, 1866. The volume referred to, has since been published.

it is the remarkable *Calymene parvifrons,* first described from Tai-hirion, near Arenig-fawr, but found since then in Shropshire. *Trinucleus Murchisoni* is from Cefn-y-Gwynlle, one of the Stiper-stone range of hills. *Trinucleus Gibbsii* is from Whitesand Bay. But the most notable genus of this group is the singular trilobite *Æglina,* of which there are other species besides the three here given. Having but seven body-rings, no rostral shield, and a large lobe-less tail, it is classed with the *Asaphus* family; but at the same time the circular glabella and elongated eyes seem to connect it with *Remopleurides,* one of the *Olenidæ.* It is eminently characteristic of the Arenig period, where it attains its highest development; and this genus may be looked upon as one of the patriarchs of Silurian trilobites, for it seems to indicate a passage from the numerous *Olenidæ* of the Upper Cambrian to the *Asaphidæ* of the succeeding era. Represented by one or two species during the formation of the Llandeilo flags, this genus fades away in the Caradoc. Of shells there are but few species as yet described. The best known are the *Orthoceras Avelinei* and *Lingula* or *Obolella plumbea,* which are not uncommon in the black shales of the Stiperstones. The latter species is the only one I know which is common to the Arenig and Llandeilo; even this is doubtful, for the *Obolella* found at Builth, and referred to this species, is not in every respect the same. There is an undescribed species of *Orthis* found at Whitesand Bay; *Cucullella Anglica* from the Stiperstones, the Bryozoa *Didymograpsus geminus* and *Graptopora* (*Dictyonema*) sp. ( ? *socialis*) Whitesand Bay represent the inferior mollusca. Two species of Encrinites, the one from Shropshire, and the other from the St. David's district, complete the lists of the more common fossils.

The Llandeilo series consists of two distinct strata, which I have before proposed to call Upper and Lower Llandeilo flags, the latter having nothing to do with the "Lower Llandeilo" of Murchison, more properly distinguished by Sedgwick, as Arenig.

It is strange that the existence of two beds making up the Llandeilo flags should never have been remarked before; for there is as much difference between the subdivisions, both in fossils and mineral character, as there is between the Upper and Lower Llandovery, which it has been proposed to call even distinct groups —not that, as a rule, the mineral character of beds is much of a criterion for their classification.

I have long thought that the true Llandeilo ought properly to be subdivided into two strata, but it was not until lately that I saw these occurring together, and so was enabled to determine which was the higher, and which the lower member of the series. Near Builth, in Radnorshire, there appear the Upper Llandeilo flags in the shape of black shales and fine white sandstone, lying conformably on the Upper Llandeilo, with the associated volcanic grit and bedded trap. This is seen in the section (Sheet No. 5) published by the Geological Survey, which crosses the shales and bedded trap of the Lower Llandeilo at the Carneddau hill, and the grit, black shales, etc., representing the Upper Llandeilo near Wellfield.

The Upper subdivision is also seen at Abereiddy Bay, Pembrokeshire, in the form of dark slate, and black shale with graptolites. (The two most common species found in this shale, viz. *Didymograpsus Murchisoni* and *Diplograpsus pristis*, occur also at Builth, where they mark the bottom beds of the Upper Llandeilo, just as they do at Abereiddy. This fact may be of importance.)

The Lower subdivision, on the other hand, occurs as sandy flagstones with large beds of limestone at Llandeilo, also at Narberth, Pembrokeshire; often it contains trap and volcanic deposits (mentioned before). In a section near Llandeilo, published in "Siluria" (p. 57), the Lower Llandeilo is made to overlie what I suppose is the Bala limetone of Bird's Hill. Perhaps it is faulted against it.

Besides the one near Builth made by the Geological Survey, there is a section of the whole Llandeilo group near Llangadock published in "Siluria" (p. 58). Here the *Upper* Llandeilo, full of Graptolites, is represented by shales thrown up into an anticlinal over the *Lower*, seen as bedded trap, flags, and limestone.

The characteristic fossil of the whole Llandeilo series is undoubtedly *Ogygia Buchii.* It is, however, of a greater size and commoner in the upper subdivision; in the lower it is represented by a smaller and more convex variety, with but eleven side-ribs to the tail. This variety was recognized by Mr. Salter some time since, and the name *convexa* was proposed for it.

*Asaphus tyrannus* and the nearly allied *Asaphus peltastes* are found everywhere in the Lower Llandeilo, associated with the variety of *O. Buchii* just mentioned. These, with *Calymene Cambrensis* and *Trinucleus favus*, are fossils quite peculiar to this zone, not found in the upper subdivision. *Lichas patriarchus* is a new species, of which my description was published in the GEOLOGICAL MAGAZINE for April, 1866, Vol. III. p. 160. The *Ophileta* or *Helicotoma*, mentioned in the list, is from Fairfach, near Llandeilo. *Lingula granulata* is a characteristic fossil of this stratum. *Orthis calligramma* is found in the volcanic grit near Builth, and *Orthis striatula* at Llandeilo and Narberth. Associated with *Asaphus peltastes*, is a small *Ctenodonta*, not uncommon in the limestone of Dynevor Park, Llandeilo; this completes the list of the common fossils from the Lower beds.

The genus *Asaphus* is represented in the Upper Llandeilo by the *A. Corndensis*[1] of Murchison, which is common at Gilwern, near Builth. This is the only species that I know of. The large many-ribbed variety of *O. Buchii* is eminently characteristic; curiously distorted specimens of it are found in the slates of Abereiddy Bay. The genus *Barrandia*, of which there will be four described species when the next volume of the Palæontographical Society appears, is peculiar to this zone. *Calymene duplicata* is a common fossil, and everywhere accompanies the ordinary variety of *O. Buchii.* *Cheiru-*

[1] *Asaphus Corndensis* belongs to the subgenus *Ptychopyge* of Angelin, which has certainly more the appearance of an *Asaphus* than of an *Ogygia.* The form of the labrum seems too variable in the *Asaphidæ* to be considered a generic distinction.—H.W.E.—(See Mr. H. Wyatt-Edgell's paper "On the Genera *Asaphus* and *Ogygia*, &c." GEOLOGICAL MAGAZINE, January, 1867, Vol. IV. p. 14.—EDIT.)

*rus Sedgwickii, Barrandia Cordai, Agnostus Maccoyi, Ampyx nudus,* and *Trinucleus fimbriatus* are found both at Builth and Abereiddy; *Trinucleus Lloydii* at Builth and Llangadoc.

Of shells, *Bellerophon bilobatus* is found both in this subdivision and the lower one. Abundant in the Caradoc, this shell lived into the Lower Llandovery period. *B. perturbatus* occurs in the slates of Abereiddy. A gasteropod, *Murchisonia simplex?*, has lately been found at Percerrig, near Builth.

From the same locality I have seen specimens of a *Lingula* very like *Lingula plumbea, Lingula Ramsayi* is a common fossil at Abereiddy Bay; and a species of *Modiolopsis*, called *M. inflata* by M'Coy, represents the lamelli branchiate shells.

The notes on the Llandeilo flags that I have here brought before the notice of geologists were made during a tour in South Wales. I will add that I think it more than probable that if the group be carefully examined in Shropshire and North Wales, the same distinction will be found to exist between the Upper and Lower subdivisions of it.

## NOTICES OF MEMOIRS.

### I. Palæontology of Asia Minor.

Asie Mineure. Description physique de cette contrée, par P. de Tchihatcheff.—*Paléontologie*, par A. D'Archiac, P. Fischer, et E. De Verneuil. 8vo. Paris, 1866. Ouvrage accompagné d'un Atlas grand in 4to. 18 plates.

THE geological portion of this work, to be completed in two volumes, by M. de Tchihatcheff, was intended to have been issued at the same time with the Palæontological portion, but the latter having been completed first, it was thought desirable to publish it at once, as a delay of even a few months might have been very prejudicial to it. The Geology is expected to be published in the course of the present winter.[1]

An introductory chapter on the "General Palæontological Results" is given by M. D'Archiac, who prefaces it with a historical sketch of the labours of previous investigators into the geology of this region, from the times of Strabo, Aristotle, and Theophrastes, until when, towards 1835, it was first scientifically explored by Messrs. Hamilton and Strickland, Spratt, Edward Forbes, Ainsworth, and Ch. Texier.

Devonian, Cretaceous, and Lower and Upper Tertiary formations occupy the greatest geographical area; Jurassic and Carboniferous strata have only been observed in a few and very restricted localities, while rocks of Silurian, Permian, and Triassic age have not at present been determined. Quaternary deposits are spread over the country in many places.

Devonian.—Beds characterized by fossils, mostly belonging to the Lower Devonian of Western Europe, are found in the North;

[1] Since writing the above the first volume of the "Geology" has been published; we shall notice it in a future number of the Geological Magazine, after the issue of the second volume.

among the species are:—*Homalonotus Gervillei, Rhynchonella Guerangeri, Spirifer macropterus, S. subspinosus, S. Davousti, Orthis orbicularis, Chonetes sarcinulata, C. Boblayei,* and *Pleurodictyum problematicum* Two species, *Orthis Gervilliei* and *Tentaculites ornatus,* are Silurian forms.

In the South, the presence of *Rhynchonella boloniensis, Spirifer Archiaci, S. Seminoi, Chonetes nana,* and *Productus subaculeatus,* would seem to indicate rocks of Upper Devonian age.

Of the 49 Devonian species, 37 are found in the rocks of the North, and 21 in those of the South.

Carboniferous.—The Carboniferous, like the Devonian formation, is developed in two widely distant localities, each of which presents a distinct horizon.

In Anti-Taurus (E.), have been found *Productus semi-reticulatus, P. Flemingii,* and *Spirifer ovalis,* which, though a very scanty fauna, suggests the representative of the Carboniferous Limestone; and on the shore of the Black Sea, in Paphlagonia, are coal-strata, which have yielded *Lepidodendron caudatum, Sigillaria Candollei, S. Schlotheimii, Stigmaria ficoides, Calamites Suckovii,* and *C. dubius.*

Jurassic.—Four species of Ammonites (*A. tortisulcatus, arduennensis, plicatilis,* and *tatricus*), discovered in the grey limestones of Galatia, seem to indicate an extension of the Oxford-Clay horizon, which is one of the most constant of the Jurassic formations.

Cretaceous.—Yellow limestone, in the Province of Pont, with *Orbitoides, Pecten quadricostatus, Exogyra Pyrenaica, Ostrea vesicularis, O. larva,* and *Otostoma,* represent the Upper Chalk of the West of Europe, and their identity, both zoologically and lithologically, with beds in the same parallel at the foot of the Pyrenees, is remarkable. White limestones, in Bithynia, with *Inoceramus Lamarckii, Ananchytes ovata,* and *Terebratula semiglobosa,* represent the white Chalk. The presence of *Rudistes* denotes the constancy of that zone.

Tertiary.—*Lower Tertiary.*—The white and grey limestones of Thracia, Paphlagonia, and Cappadocia have furnished 164 species of Invertebrata, of which nearly half have also been found in the Lower Tertiary Deposits of Western Europe, and intermediate points.

A Crustacean (*Ranina Tchihatcheffi*) represents a type constant at this level in Europe, and probably also in Egypt and in India, as well as in the West Indies. Two large species of *Cerithium* are met with, but no small specimens. The absence of species of *Fusus* with prolonged canals, of *Pleurotoma, Turritella, Buccinum, Murex,* and the rarity of *Voluta* and *Mitra,* are noteworthy facts. The principal gasteropods are *Terebellum, Ovula, Natica, Sigaretus, Hipponyx,* and *Phasianella.*

The bivalves constitute a striking analogy with those of Europe.

Bryozoa are extremely rare; Echinodermata less so; a few species of Corals have been met with at some localities.

Thirty-eight species of Rhizopods occur, one only of which (*Nummulites Viquesneli*) is peculiar; 25 species of this genus have been found.

*Middle Tertiary.*—Deposits of this age occur on the borders of the

Mediterranean (South Coast). 116 species of Invertebrata have been determined, but their examination does not point to any particular horizon in Europe. 72 of the species are also found in Touraine, Aquitaine, Languedoc, Provence, Italy, the Vienna Basin, and Germany. Bryozoa are rare. Among the Corals are 5 species of *Heliastræa*, and of the Rhizopods, 2 species of *Operculina* predominate.

Seven species of plants (Monocotyledonous Phanerogams) have been determined, whose analogues are already known in the Middle Tertiaries of Styria, Croatia, and Switzerland.

*Tertiary Lacustrine Deposits* of different ages occur; the fauna of the whole comprise 33 gasteropods and 6 acephala; forms identical or closely related, are still living in the East.

QUATERNARY.—The absence of all vertebrate remains in these deposits renders their precise age uncertain; they do not however appear to be of very great antiquity. Many microscopic organisms occur, among which are many Naviculæ and Pinnulæ. All these deposits are believed to be freshwater.

The above observations are translated from M. D'Archiac's Introduction, and we may add that the Palæozoic Fauna is described by M. De Verneuil, and the Flora by M. Ad. Brongniart; the Secondary and Lower Tertiary Fossils are described by M. D'Archiac; the Middle Tertiary Fauna by M. Fischer, and the Flora by Dr. Unger; the Upper Tertiary and Quaternary Fossils, by M. Fischer.

H. B. W.

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## II.—NOTE ON THE AFFINITIES OF THE *BELLEROPHONTIDÆ*. By F. B. MEEK.

[PROC. CHICAGO ACAD. SCIENCES. Vol. I., 1866.]

THE family *Bellerophontidæ* (of McCoy) includes a most interesting group of extinct shells, almost, if not entirely confined to the Palæozoic rocks. If we exclude the little Cretaceous genus *Bellerophina* (the relations of which to this group may be at least regarded as very doubtful), and include *Porcellia*, the range of the family will be from the Lower Silurian to the Trias.

Mr. Meek recounts the various opinions in regard to the affinities of this ancient type of Mollusk, entertained by Von Hupsch, Montfort, Defrance, D'Orbigny, McCoy, Deshayes, De Koninck, and others. In 1844, Prof. De Koninck, who viewed these shells as Gasteropods, placed them in the Scutibranchiate order of the Prosobranchiata—regarding them as *Emarginulæ*, with a greatly extended, and strongly involuted apex.

In 1864 a new fossil genus, *Tremanotus*, was described by Prof. Hall, and placed as the type of a sub-genus under *Porcellia*, but such a striking resemblance does it bear to *Bucania*, that Mr. Meek is of opinion that it should be placed under that genus; it only differs from it in the peculiar and interesting character of having along the middle of the dorsal side a row of isolated, oval siphonal openings; while it differs from *Porcellia*, not only in that important character, but in the greater thickness of the shell, and its strongly dilated mouth. And, from the fact that the genus *Bucania* is so nearly allied to *Bellerophon* that few Palæontologists regard it as generically distinct, it must be manifest that these three types must go together, wherever we place them. Now as there are no examples, so far as known to the author, of a shell with isolated siphonal openings, except amongst the Prosobranchiate Cephalopoda,—for instance, the *Haliotidæ, Fissurellidæ* and *Pleurotomariadæ*—it indicates, for the family, a position near the *Fissurellidæ* and *Haliotidæ,* and between these groups and the *Pleurotomariadæ.*

## REVIEWS.

1.—Principles of Geology, or the Modern Changes of the Earth and its Inhabitants, considered as illustrative of Geology. By Sir Charles Lyell, Bart., M.A., F.R.S. 10th and Entirely Revised Edition. In two vols. Vol. I. Illustrated with Maps, Plates, and Woodcuts. London, John Murray, 1867.

OF all the Books upon the natural sciences, written within the present century, we may safely affirm that none have had so great an influence upon any particular subject as has Sir Charles Lyell's "Principles" upon the progress of geology.

In evidence of the avidity with which the teachings of this great master have been received, we need only state that from its first appearance in January 1830, to June 1853, the "Principles of Geology" had run through nine editions, and it had, by 1838, become the parent of another work, now equally well known, "The Elements of Geology." This thriving child of so good a stock arrived last year at its sixth edition. And, this year, Volume I. of its parent's Tenth Edition was cut by many an anxious inquirer after truth. Nor is this all the family with which Sir Charles Lyell's "Principles" has been blest; for, in 1863, he issued another most welcome volume, entitled the "Antiquity of Man," which enjoyed a privilege (shared by few efforts of penmanship, we imagine,) of three editions in one year. Lyell's "Principles" has been so often reviewed, that it is unnecessary to do more than notice some of the more important additions and modifications which one would expect to find in it, as nearly fourteen years have elapsed since the publication of the last edition. That consisted of one volume of 835 pages, whereas the first volume of this new edition contains in itself no less than 671 pages. The actual increase, as regards corresponding chapters in the last edition is about 275 pages, but a part of this is due to the use of larger type.

The chapter on the progressive development of organic life has been entirely re-written. In speaking of the introduction of man, the author states that "little or no progress has been made in discovering fossil remains which indicate any inferiority in the cerebral development of man in the paleolithic era."

A new chapter on the proofs of former vicissitudes in climate, derived from the study of the Secondary and Primary fossiliferous formations, has been added. In it the author discusses the theory of an excess of carbonic acid in the air during the Coal-period. He regards as delusive, inferences deduced from the fact, that there is ten times more carbon in a solid form in the ancient Coal-measures than is now contained in the atmosphere. The atmosphere now receives large supplies of carbonic acid, by gaseous emanations from the interior of the earth; but, wherever peat is forming, the process is seen by which carbon is first extracted, by the powers of vegetation, from the atmosphere. Mr. Darwin attributes the small quantity of peat formed in parts of South America to the absence of species of plants fitted for its production. The abundance of coal, therefore, in certain districts may have arisen from the peculiarity of the vegetation, and of a climate which retarded decomposition, rather than from any peculiarity in the atmosphere which enveloped the globe in the Carboniferous period.

In a special chapter the author has considered how far former vicissitudes in climate may have been influenced by astronomical changes, such as variations in the eccentricity of the earth's orbit; changes in the obliquity of the ecliptic, and different phases of the precession of the equinoxes. Mr. Croll's suggestion as to the probable effects of a large eccentricity in producing glacial epochs is fully discussed, and the question is entertained whether geological dates may be obtained by reference to the combined effect of astronomical and geographical causes.

In the chapter on the phenomena of Springs, the author notices the discovery of live fish in some artesian wells, sunk in the Sahara. They were brought from a depth of 175 feet, and were not blind, like those of Adelsberg, but had perfect eyes.

The antiquity of the delta and alluvial plain of the Mississippi is discussed, with reference to new facts brought to light during the survey of Messrs. Humphreys and Abbot. Sir Charles had estimated that the accumulation of the whole delta-deposits must have taken 67,000 years; but the former gentlemen, in the course of their survey, came to the conclusion that the quantity of water annually discharged by the Mississippi, had been greatly underrated; consequently the number of years required for the growth of the whole delta would be reduced to about one-half, or to about 33,500 years. In the same chapter are discussed the researches of Mr. W. H. Bates and Professor Agassiz on the delta of the Amazons, and of Mr. Fergusson on that of the Ganges.

A chapter on the action of tides and currents, contains an account of Captain Spratt's observations in the Mediterranean. His survey shows how different parts of an inland sea, and the adjoining ocean, may have different temperatures at a moderate distance from the surface, in consequence of submarine barriers. The range of aquatic species inhabiting the waters at various depths must evidently be in no small degree dependent on such continuous submarine ridges.

An illustration of the stone-capped earth-pillars of Botzen, in the Tyrol, adorns the cover. It is from a drawing by Sir John Herschel, and is also introduced, as a woodcut in the letter-press, to show the distinction of the power of rain from that of running water.

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## II.—Monographs Published by the Palæontographical Society: Vol. xix. 1866.

THIS fasciculus of Monographs, and parts of Monographs, is supplied to the members of the society as the volume due for 1865; thus, the issue of annual volumes is now only one year behindhand. This volume comprises:—1. Part of a Monograph of the Foraminifera of the Crag, by Messrs. Jones, Parker, and Brady. 2. Part I. of Dr. Duncan's Monograph of the British Fossil Corals; second series. 3. Portion of Mr. H. Woodward's Monograph of the British Fossil Merostomata (Pterygotus, etc.). 4. Part VII. No. 1, of Mr. Davidson's Monograph of the British Fossil Brachiopoda. Thirty-five plates richly illustrate the numerous fossils described in this volume.

The first of the Monographs, above-mentioned, is concerned with a group of organisms, extremely abundant in the fossil, as well as in the recent state, but which had not hitherto been the subject of any of the Palæontographical Society's Monographs. We not only welcome this memoir, but rejoice to see that there is an intention to give the Cretaceous, and the Liassic Foraminifera also, a place in this fine repertory of British Fossils, according to the Society's List of Monographs in Preparation.

To those who have a definite notion of the value these low-classed and variable *Microzoa* have in palæontological geology, the Introduction to the Monograph of the Foraminifera of the Crag will afford good data for conclusions, in its concise account of the groups peculiar to the several zones of the Crag; and the Monograph itself (as far as it is brought out) evidently aims at supplying the zoologist, as well as the geologist, with both special and general information about these minute shells, supplementing to a great extent, the elaborate and broadly treated description of the Arctic and Sub-arctic groups of recent Foraminifera, by Messrs. Parker and Jones, in the "Philosophical Transactions" of 1865, to which this Monograph makes frequent reference, The bibliography and comparison of the so-called genera and species appear to have been especially cared for; and the results are remarkable, both, in the long lists of synonyms, such as could only be offered to the public in the works of a Society, and in the bold and systematic compression of numerous individual and varietal forms around very few types. After all, in the elaborate lists, showing relationship, distribution, and relative abundance and size, 102 species and noticeable varieties are enumerated as having been found in the Crag of Suffolk, chiefly by Mr. Searles Wood, whose name is indissolubly associated with the Crag and its fossils.

Dr. Duncan offers his Monograph on the Fossil Corals as a Supplement to the great Monograph by Messrs. Edwards and

Haime; and he prefaces it with an "Introduction," comprising a clear, concise, and systematic account of the anatomy, reproduction, physiology, and classification of the Recent, Tertiary, and Secondary Stony Corals, based on the works of Edwards and Haime. The exactitude with which the essential characters of the fossil Corals are here pointed out, and distinguished according to a definite terminology, will be thankfully recognised by many a naturalist and geologist. Several new Tertiary Corals, chiefly from Mr. F. Edwards's collection, are fully and methodically described, in strict, technical, and therefore unmistakeable language.

Mr. H. Woodward also stamps his Monograph on the Pterygotus, Eurypterus, and their allies, with exactness of terminology, completeness of classification, and fullness of bibliographic history; and all this will be of great use in the further progress of his Monograph, of which only a small portion now appears.

The laborious and conscientious care in working out the history and relationships of the known British Silurian Brachiopods, for which Mr. Davidson's Monograph is remarkable, is characteristic of that palæontologist, as is well known, by those who have gone through his other Monographs,—or rather, the other Parts and Volume of this his great Monograph of the British Brachiopoda. The obscure specimens from Silurian slates, schists, and other squeezed, distorted, and altered strata, have passed, like hieroglyphic cartouches and semi-defaced medals, from dynasty to dynasty, from name to name, until the care and erudition of one enthusiast have been brought to bear on all and each, definite notions of their real alliances have been settled, and perfect illustrations of all the series made visible on one set of plates. The loving care with which every feature in shape and ornament, wrinkles, pimples, network, etc., have been delineated by Mr. Davidson himself, in these twelve plates (part only of the Silurian series), is testified plainly. The painstaking research, and reproduction of everything worth recording that the various authors have written about the specimens whereon they founded the species that Mr. Davidson treats of, is only equalled by the good sense, caution, and perspicuity of his descriptions. Besides its own Bibliographic Introduction, the Monograph is preceded by a "Classification of the Silurian Rocks," by Sir Roderick Murchison—being a succinct account of the history of discovery, and order of sequence, from that eminent geologist's own point of view.

As very many must necessarily value the Monographs, published by the Palæontographical Society, for the illustrative figures, as much as for the descriptions, we feel called on to remark that there is no falling off in the drawing or printing of the plates. George West has given the Foraminifera, in his plates, a real natural aspect, that no high-finished artificiality of the mere lithographer can attain to. Mr. De Wilde has evidently succeeded in mastering the features and structure of Corals. Mr. Fielding's Pterygoti are boldly, carefully, and naturally drawn. Lastly, Mr. Davidson's Brachiopods are wonderful reproductions of the original specimens, and of their details, enlarged; and with them are several copies of sketches by former observers, to complete the history of the whole.

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III.—The Quarterly Journal of the Geological Society, Vol. XXIII. Part I. (No. 89, February 1, 1867.)

COSMOPOLITAN, as usual, the Geological Society's Journal comprises memoirs and notices of facts from many parts of the world. First, Professor Huxley describes some bones of large Dinosaurian Reptiles, from South Africa. The *Euskelesaurus*, so called, because he had good legs to stand on, had a femur nearly three feet long; another such reptile is termed the *Orosaurus*. Both are from "Mr. Bain's Stormberg Beds," of the Stormberg, near Aliwal, and probably higher in the geological series than the Karoo beds, with *Dicynodonts*. Second, From Australia, the Rev. W. B. Clarke sends an account of all the fossils of Secondary Age (Jurassic), that he has seen or heard of; and, in a postscript to his paper, he adds further evidence of *Glossopteris Browniana* being really Palæozoic. Third, Dr. Duncan, chiefly by means of a fine series of corals collected by Mr. Charles Moore, in South Wales, compares the beds beneath the Lias in Britain, with their equivalents elsewhere, and defines them as the "Infra-lias," divided into—*a*. (Upper), the Southerndown, Sutton, and Brocastle limestone, etc.; *b*. (Middle), Ammonites-planorbis Zone, etc.; *c*. (Lower), Avicula-contorta, or Rhætic series. It is a pity to see, throughout this memoir, on the Infra-lias Coals of South Wales, the word "Astrocœnia" mis-spelt. Fourth, Mr. H. Woodward follows with a bibliographic, classificatory, explanatory, and descriptive paper on the Xiphosures—that is *Limulus*, *Belinurus*, *Hemiaspis*, *Bunodes*, *Pseudoniscus*, *Exapinurus*, and a new genus *Prestwichia*; their relationship to *Eurypterus* and *Pterygotus* is especially treated of. Fifth, Dr. Duncan describes some Cretaceous Echinoderms brought from Mount Sinai, by the Rev. H. Holland. Sixth, Mr. Hawkshaw, on the geology of a part of Egypt. Seventh, Mr. J. Curry, on the Drift of the North of England, gives useful facts. Eighth, Mr. J. W. Flower has found, near Thetford, in Norfolk, some prehistoric flint instruments of the same form and fashion as some from St. Acheul, in France, as the great ugly woodcuts strongly show. 9. Lastly, (excepting some miscellaneous matter), Professor Williamson describes a well-figured Cheirotherian foot-print from Cheshire, which shows evident marks of a true scaly skin.

In this varied group of observations many will find much to learn, and with regard to "Homotaxis," in particular, the reader will find materials for grave consideration.

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IV.—Meteorites, Aërolites, and Falling Stars. By T. L. Phipson, Dr. Sc. &c. 8vo. pp. 240, 1866. London: Lovell Reeve and Co.

THE author of this little work has endeavoured to bring together, in a popular form, the latest observations that tend to explain the phenomena of shooting stars. The various terms in use for these bodies, such as meteors, fireballs, falling stars, meteorites, etc., he considers to be identical meteoric phenomena, only seen under different circumstances, and from different positions.

The attention of meteorologists, mineralogists, and other men of science, was first directed to this subject by Chladni's treatise on the probably celestial origin of the mass of iron discovered in Siberia by Dr. Pallas. This treatise was first published in 1794, and two months after his views received a remarkable confirmation, by the fall of a shower of stones at Siena, in Italy, on the 16th of June, 1794. Between the years 1794 and 1802 three other well-observed falls took place, and in this latter year, the first analysis of an aërolite was made by Luke Howard, and published in the Phil. Trans. of the Royal Society. Descriptions of the fall of all the most important aërolites are briefly given, together with analyses of many of the stones, which exhibit the similarity in composition of these bodies. The various theories proposed to account for these phenomena are also briefly described. Had the author procured a later edition of the "Catalogue of the Meteorites in the British Museum," than that published in December, 1863, for his compilation, he might more correctly have represented its present condition. There have been at least three, if not four, editions of this catalogue published since December, 1863, the last of which bears the date October 1st, 1866, and shows the collection to contain 350 specimens, representing 236 distinct falls. Among several other similar inaccuracies we select the following:—Of the great fall at L'Aigle, Normandy, on the 26th of April, 1803, he states, "A specimen, weighing two pounds two ounces, may be seen in the British Museum. The catalogue says, nine specimens weighing 5 lbs. 2 oz. 260 grs. Again, of that of Chantonnay, La Vendée, France, he says, "There is a sample weighing one pound four ounces, in a collection at the British Museum," whilst the catalogue states that there are three specimens of the collective weight of 2 lbs. 15 oz. 287 grs., or nearly three pounds. Also, at page 191, referring to the remarkable fall at Butsura, India, we read, "Five meteoric stones, which fell on the 12th of May, 1861, near Gootka, in India, and weigh together upwards of thirty pounds, being joined together by their uncoated surfaces, fit so exactly into one large uniformly crusted mass, that, according to Mr. Herschel, two fragments only are wanting at the angles; and these five stones were found from two to four miles apart." This description is certainly a very loose one. The weight of the whole, when found, exceeded fifty-one pounds; the total weight of the parts, now in the British Museum collection, according to the catalogue before quoted, is 41 lbs. 13 oz. 137 grs. The other portions of this aërolite are deposited in the Calcutta Museum. From a very interesting paper on this fall, by Professor Maskelyne, in the Philosophical Magazine for January, 1863, which Dr. Phipson does not appear to have consulted, and from the specimens and models themselves, it will be seen that but three of the fragments had uncoated sides. That which fell at Bulloah, was broken into four or five pieces on striking the ground, only two of which were saved, and one side was not coated, viz., that which fitted the uncoated side of the Piprassi specimen. The remainder of the fractured surfaces are perfectly crusted, but not uniformly, as it is thicker on the original surface than on the fractures. This fall is most instructive. It is one of the few recorded cases of disrupted fragments of an aërolite, travelling a considerable distance through the earth's atmosphere, without fusion taking place on the disrupted sides.

At the end of the book a list of public and private collections is given. The collection of R. P. Greg, Esq., of Manchester, has been disposed of, and is now deposited in the Museum at Calcutta. The weight of the larger of the two masses of meteoric iron found at Cranbourne, near Melbourne, Australia, which is exhibited in the British Museum, is about 8,200 pounds, or over 3 tons 13 cwt. The smaller mass was exhibited in the International Exhibition for 1862, before being deposited in the National Collection, but was soon afterwards sent back to Australia in exchange for the larger one.

In Chladni's useful catalogue of recorded falls of aërolites, published in vol. xxxi. of the "Annales de Chimie et de Physique," 1826, we find the following:—"1680, 18 Mai Pierres a Londres, King." Dr. Phipson has quoted this, and, in a foot-note, remarks that he has not been able to procure a copy of Mr. Edward King's work, which is entited—"Remarks upon Stones said to have fallen from the Clouds." This book is in the library of the British Museum, and the stones referred to by Chladni, as having fallen in London, were hailstones! We give Mr. King's own words: "On the 18th of May, in the year 1680, some hailstones are recorded to have fallen in London, near *Gresham College;* which were seen and examined by the celebrated *Dr. Hooke;* and were some of them not less than two inches over, and others three inches." It is a pity Dr. Phipson did not expend more care in the production of this little book; but we must accept it as, at present, the only work giving a general *résumé* of the origin, progress, and present state of aërolitic knowledge. A really good book upon this subject would indeed be welcome, at a time when the interest excited by the wonderful "Star-shower" of November last has not yet ceased.

## REPORTS AND PROCEEDINGS.

Geological Society of London.—I. January 23, 1867.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The following communications were read:—

1. "On the occurrence of Consolidated Blocks in the Drift of Suffolk." By George Maw, Esq., F.L.S., F.G.S.

As a contribution to the evidence on the geological position of the blocks of saccharoid sandstone scattered on the surface of many parts of the Chalk-districts, which appear to have been derived from several formations of different ages, the occurrence was recorded of large isolated masses of consolidated sand and gravel in the Drift intervening between the Chalk and Boulder-clay of the high ground of Suffolk. Many of the masses are several tons in weight. Although they occur at a general level they do not form a connected band; loose Drift, out of which they were evidently composed, forming a horizontal continuation of their strata. The drift is largely charged with Chalk-detritus, which also occurs in the softer blocks; some of the blocks are extremely hard and compact, and in these the sandy agglomeration seems to have given place to a crystalline structure; but the hardest of those found *in situ* were resolvable into sand by the action of hydrochloric acid, and appeared to be merely held together by a calcareous cement.

A block resting on the Red Crag near Woodbridge was found, on analysis, to contain no lime, excepting a small quantity in the form of silicate.

The springs in the gravel-bed at Crowfield, near Coddenham, are chalybeate, containing in solution Lime and Iron, which are precipitated on standing, and much carbonic acid is evolved from a well sunk through the gravel; the author considered that the carbonic acid may have been the solvent agent in forming the calcareous cement, and that the first stage of the consolidation of the blocks of saccharoid sandstone may have been by the agency of calcareous matter; and he referred to the possibility of lime in solution, when in contact with silica, giving rise to silicate of lime, a very small proportion of which would form a powerful cement in agglutinating siliceous particles together.

2. "Notes on some Chemical Analysis of variegated Strata." By George Maw, Esq., F.L.S., F.G.S.

The author gave the results of some analyses for the determination of Iron in the light and dark parts of variegated Slates, Sandstones, and Marls, the colour of which is due to oxide of iron, and in which the variegation appears to be disposed independently of mechanical arrangement. The analysis in each case exhibited the fact that the lighter blotches, spots, and stripes contained a smaller portion of the colouring oxide than the average mass, a proportion which implies an actual difference in the percentage of the metallic iron, and which could not be accounted for by any mere difference in the state of its combination. This shows an actual departure of a part of the colouring oxide out of the colourless patches, and a dispersive process which seemed to be the very reverse of the segregation of nodules of Carbonate of Lime and Carbonate of Iron out of a clayey matrix. Among the forms of variegation referred to were: (1st) that resulting from the segregation of dark blotches out of a lighter matrix, the evenness of colour of which does not appear to have been materially affected by the withdrawal of a part of its colouring-matter; (2nd) that resulting from the segregation of dark blotches out of a lighter ground, each of which is concentrically surrounded by a distinct and well-defined zone lighter than the general ground; (3rd) strata variegated with light blotches containing a smaller proportion of colouring-matter than the general ground, but not arranged concentrically round a darker nucleus; (4th) the variegation of coloured strata with both light and dark blotches, containing respectively a smaller and larger proportion of the colouring oxide than the general ground, but which are not arranged, as in the 2nd case, concentrically with each other.

The following specimens were exhibited:—

Examples of variegated slates, marls, and sandstones; fragments of consolidated blocks from the Drift of Suffolk; and of Sarsen stones, from Avebury, Wiltshire; Upper Tertiary fossils collected by the Rev. C. Mozley in Iceland; and two Flint Implements from Canada; exhibited by George Maw, Esq., F.G.S., etc.

Hardened Chalk and Drift from Hertfordshire; exhibited by W. Whitaker, Esq., B A., F.G.S.

Specimens of Staffellite from Nassau; exhibited by H. Buerman, Esq., F.G.S.

Geological Society of London.—II. February 6, 1867.—Warington W. Smyth, Esq., M.A., F.R.S., President in the Chair. The following communications were read:—

1. "On the Jurassic Fauna and Flora of South Africa." By Ralph Tate, Esq., F.G.S.

In this paper the author gave descriptions of the undescribed fossils in the Society's Museum, obtained from the following secondary deposits of Cape Colony, in ascending order:—

(1.) *Karoo Beds.*—These strata, containing *Dicynodon* and *Iridina*, have yielded a flora which was stated to present close analogy with the plants of the Coal-formations of Burdwan and Nagpur, India, and the Newcastle Coal-field, New South Wales. The characteristic plant in each of these deposits, and in the Karoo Beds, is a *Glossopteris.* The author regarded the age of the Karoo Beds, from their position and organic contents, as approximating to that of the Trias; and he described from them species of the following genera:—*Glossopteris, Phyllotheca, Dictyopteris, Rubidgea,* n. g., and *Atherstonea,* n. g.

(2). *Phytiferous Beds of Geelhoutboom.*—The flora of this deposit is characterized by the presence of *Palæozamia, Arthrotaxites, Asplenites, Pecopteris, Sphenopteris,* and *Cyclopteris,* several species of which are comparable with certain others from the Oolitic series of Europe, and of the Rajmahal Hills, India. One species, *Asplenites lobata,* Oldh., is common to South Africa and India.

(3). *Marine Limestones, etc., of Port Elizabeth Province.*—The great mass of the fossils from this series are bivalves; and the extreme rarity of Cephalopoda, Polyzoa, Echinoderms, and Corals, was stated to call to mind the conditions of life which prevailed during the deposition of the upper members of the Lower Oolites in England. The generic grouping is such as occurs in the Jurassic series; and though no genus represented in the South African fauna is peculiar to the Jurassic rocks, yet the following give a marked Oolitic facies to them: *Belemnites* (*Canaliculati*), *Actæonina, Alaria, Neritopsis, Pleuromya, Placunopsis, Isastræa,* etc. Four species were referred to European forms, viz., *Trigonia Cassiope,* d'Orb., *T. Goldfussi,* Ag., *Serpula filaria*, and *S. plicatilis*; but a very large number of the African shells have their representatives in the Lower and Middle Oolites of Europe, and their equivalents in India.

2. "Further remarks upon the relation of the Chillesford Beds to the Fluvio-marine Crag." By the Rev. O. Fisher, M.A., F.G.S.

The author dissented from the interpretation of two pit-sections, one on Aldringham Common, the other near Henham Park Farm, given by Mr. Searles Wood, in his paper "On the structure of the Red Crag." Mr. Fisher admitted that the former is at a higher level than the Thorpe Crag-pit, and the latter than the Wangford Crag; but he denied that the loam on Aldringham Common is Chillesford clay, and was doubtful whether even that at Henham Park Farm belongs to that deposit. Granting, however, that the loam in the latter case is really Chillesford clay, the author stated that it is probably carried under the Wangford Crag by a northern dip. Thus he considered that neither of these sections contains indisputable evidence of the superposition of the Chillesford clay to the Fluvio-marine Crag. He also expressed a doubt of the crag at Bulchamp being a continuation of the Wangford bed, and stated that it much more resembles the Mya-bed as seen at Yarn Hill. If this interpretation be correct, Chillesford clay might occur at Henham Park Farm, intermediate between the Crag of Wangford and the Mya-bed at Bulchamp.

Geological Society of London.—III. Annual General Meeting, February 15, 1867.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair.

The Secretary read the Reports of the Council, of the Library and Museum Committee, and of the Auditors. The continued prosperity of the Society, and the sustained annual increase in its numbers, were stated to be especially satisfactory.

The President announced the Award of the Wollaston Gold Medal to G. Poulett Scrope, Esq., M.P., F.R.S., F.G.S., etc., in recognition of the highly important services he has rendered to geology by his examination and published descriptions of the volcanic phenomena of Central France, and by his works on the subject of volcanic action generally throughout the world; and in handing the Medal to its distinguished recipient, he bore personal testimony to the accuracy of his descriptions and the soundness of his conclusions; and observed that, however much theoretical views may change with the advance of our science, he felt assured that Mr. Scrope's name would remain linked with the study of this important class of the agencies which modify the surface of the earth. Mr. Poulett Scrope, on receiving the Medal, expressed his gratitude to the President and Council for this recognition of his early labours. The President then stated that the balance of the proceeds of the Wollaston Donation-fund had been awarded to W. H. Baily, Esq., F.L.S., F.G.S., to assist him in the preparation and publication of an illustrated Catalogue of British Fossils; and, in Mr. Baily's absence, placed it, together with a diploma to that effect, in the hands of Sir R. I.

Murchison, Bart., K.C.B., etc. Sir Roderick Murchison, in thanking the Council on behalf of Mr. Baily, remarked upon the conformity of this particular award to the design of the late Dr. Wollaston in establishing the Donation-fund.

The President then proceeded to read his Anniversary Address, in which he discussed some of the most important contributions to Lithology and Mineralogy during the past few years, prefacing it with biographical notices of lately deceased Fellows, Foreign Members, and Foreign Correspondents, among the most distinguished of which may be mentioned William Hopkins, Esq.; the Rev. Dr. Whewell; P. N. Johnson, Esq.; G. W. Featherstonhaugh, Esq.; James Smith, Esq., of Jordan Hill; Charles Maclaren, Esq.; Parkin Jeffcock, Esq.; Prof. H. D. Rogers; Prof. Nils de Nordenskiöld; Dr. A. Oppel, Señor Casiano di Prado; Dr. C. T. Gaudin; M. Deslongchamps.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—*President:* Warington W. Smyth, Esq., M.A., F.R.S. *Vice-Presidents:* Sir P. de M. G. Egerton, Bart., M.P., F.R.S.; Sir Charles Lyell, Bart., D.C.L., F.R.S.; J. Carrick Moore, Esq., M.A., F.R.S.; Sir R. I. Murchison, Bart., K.C.B., F.R.S. *Secretaries*: P. Martin Duncan, M.B.; John Evans, Esq., F.R.S. *Foreign Secretary:* R. A. C. Godwin-Austen, Esq., F.R.S. *Treasurer:* Joseph Prestwich, Esq., F.R.S. *Council:* Prof. D. T. Ansted, M.A., F.R.S.; H. W. Bristow, Esq., F.R.S.; P. Martin Duncan, M.B.; Sir P. de M. G. Egerton, Bart., M.P., F.R.S.; Earl of Enniskillen, D.C.L., F.R.S.; Robert Etheridge, Esq., F.R.S.E.; John Evans, Esq., F.R.S., F.S.A.; David Forbes, Esq., F.R.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; J. Gwyn Jeffreys, Esq., F.R.S.; Prof. T. Rupert Jones; Sir Charles Lyell, Bart., D.C.L., F.R.S.; Edward Meryon, M.D.; John Carrick Moore, Esq., M.A., F.R.S.; Sir R. I. Murchison, Bart., K.C.B., F.R.S.; Robert W. Mylne, Esq., F.R.S.; Joseph Prestwich, Esq., F.R.S.; Prof. A. C. Ramsay, LL.D., F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; Captain T. A. B. Spratt, R.N., C.B., F.R.S.; Alfred Tylor, Esq., F.R.S.; Rev. Thomas Wiltshire, M.A., F.R.A.S.; Henry Woodward, Esq., F.Z.S.

Geological Society of Glasgow.—The monthly meeting of this Society was held on the 17th January, in Anderson's University.—the Rev. H. W. Crosskey, Vice-President, in the chair.

The following papers were read:—

1. Notes on a Chilognathous Myriapod, and some Fossil Crustacea, from the Coal-measures of the West of Scotland. By Henry Woodward, Esq., F.G.S., F.Z.S. of the British Museum. (Communicated by the Secretary.) The author noticed the discovery by Dr. Dawson, of Montreal, in 1852, in the Joggins Coal-field, Nova Scotia, of a Chilognathous Myriapod, *Xylobius Sigillariæ*, found in the interior of the stump of an erect fossil tree, which also contained the remains of a reptile, and a land-snail; and then proceeded to describe a similar insect, discovered about two years since by the late Mr.

Thomas Brown, of Stewarton, in the Upper Coal Measures of Kilmaurs. It occurs in a nodule of ironstone, coiled up somewhat in the form of the letter J, and is about two inches in length. Each segment of the body (of which there are upwards of thirty) bears a slightly raised wart, which indicates the position of the tracheal openings, while to the sternum of each segment a pair of slender feet appear to have been articulated. These feet can distinctly be seen to be composed of several articuli, as in the recent Myriapoda. No soft-bodied annelide would be preserved in this condition, the body-rings of worms which the author had examined from Solenhofen, for example, being indicated rather by a stain upon the slab than by any actual *relievo* evidence of their presence, as shown in the Kilmaurs specimen. It may therefore be concluded that this fossil possessed a chitinous exo-skeleton, sufficiently firm and strong to leave the impress of its numerous and well-marked articuli in the soft clay in which it was entombed. Mr. Woodward stated that without further evidence it would be rash to describe this fossil as specifically distinct from that discovered by Dr. Dawson; but it was important to record this instance as the *first* discovery of *Xylobius* in Britain. Preserved with it, in the same nodule, are a perfect pinnule and several fragments of a Fern, the *Pecopteris abbreviata* of Brongniart. It is extremely interesting to find this presumed terrestrial Myriapod, both here and also in America, associated with land vegetation. The evidence of land-conditions to be derived from associated fossils, must not, however, in this case be too strongly relied upon, as in the same bed of nodular ironstone are likewise found King-crabs and other undoubted *marine* organic remains.

The second portion of the author's paper (which will be published, with accompanying plates, in the next part of the Society's Transactions) was devoted to the re-description (1) of *Belinurus trilobitoides* and *Prestwichia rotundata*, two species of Limuloid Crustacea, also found in the nodular ironstone of Kilmaurs, from examples of which he had been enabled to detect several important structural characters not previously noticed; and (2) *Pygocephalus Cooperi*, Huxley, from the same locality. In conclusion, he stated, having frequently observed, in the examination of various genera and species of fossil crustacea, that certain species *in dying* always appear to have assumed a particular position. Certain others, after death, appear always to break up in a systematic manner. *Ceratiocaris* is generally found in the Upper Silurian of Lesmahagow, with its tail in its mouth. *Trimerocephalus*, in the Devonian of Newton, always has its head directed towards its tail, and detached. Again, one species of Crustacea always occurs with the dorsal aspect exposed upon the matrix; another as invariably presents the ventral. Thus the specimens of *Pygocephalus* present the ventral aspect exposed to view, whilst the dorsal adheres as firmly as possible to the matrix.

2. On the Sections of Igneous Rocks on the Rye, Ayrshire. By Mr. R. Whyte Skipsey.—Mr. Skipsey described the three principal sections which are observed in descending the bed of the stream,

between the Howrat Toll-bar and the lofty escarpment of Carboniferous limestone a short distance above the town of Dalry.

3. Notes on some Sections in the Old Red Sandstone and Ballagan Series in Dumbuck Glen. By Mr. John Young.—Mr. Young stated that the sections exposed in Dumbuck Glen belong to the Old Red Sandstone, and to a series of thin-bedded limestone strata, locally known as the Ballagan beds, from being typically developed at the Spout of Ballagan, near Strathblane. The latter are by some geologists considered to be of Carboniferous age, and by others as belonging to the Old Red Sandstone. The only evidences of organic remains yet found in them are fragmentary fish scales, plants, and annelide impressions.—*Glasgow Herald*, 19th January, 1867.

Literary and Philosophical Society, Manchester. January 8th, 1867. Edward Schunck, Ph.D., F.R.S., etc., President, in the Chair. Mr. Binney, F.R.S., F.G.S., exhibited two remarkable fossils, discovered by Mr. Joseph Tindall, of Thomas-street, Huddersfield, in the Lower Coal Measures near that town. One was an insect, and, according to Mr. Tindall, belonged to Dr. Dawson's genus *Xylobius* and probably to his species *Sigillariæ*. It was found in an old deep mine at Cooper Bridge, and is the first instance of a specimen of that genus having been met with in England.[1] The other bore some resemblance to the pupa-state of a Coleopterous insect, not much unlike the pupa of a nut-weevil or some such insect. It was found in the Cinderfield Dyke Pit, at Bradley, near Huddersfield. These specimens give us evidence of the former existence of insect life during the Carboniferous epoch which a few years since we should scarcely have expected; but after the discovery of a fossil spider in the German Coal-measures, scarcely to be distinguished from a recent genus, we must expect great additions to be made to the Carboniferous *fauna*, as doubtless the rich and luxuriant vegetation of that remote period would afford food and shelter for numerous insects.—Proceedings—Lit. and Phil. Society. —Vol. vi.—No. 8—Session 1866-7.

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## CORRESPONDENCE.

### THE LATE MR. F. J. FOOT.

*To the Editor of the* Geological Magazine.

Sir,—Will you allow me to correct some inaccuracies in your obituary notice of my late lamented colleague, Mr. F. J. Foot.

The date of his appointment to the Survey was August 1st, 1854, not 1856.

Sir Henry De la Beche died on April 11th, 1855, but continued his annual visits to Ireland to the last, and I well recollect his expres-

[1] A specimen of *Xylobius*, discovered two years ago, at Kilmaurs, near Glasgow, by the late Mr. Thomas Brown, was described by Mr. Henry Woodward, before the Glasgow Geological Society, on the 17th January, 1867.—See Report of that Society, at p. 130 of the present Number—Edit.

sions to myself of satisfaction at Mr. Foot's style of work, in the autumn of 1854, when we were all together in the neighbourhood of Bantry Bay.

There is no mention in your notice of Mr. Foot's paper "On the Distribution of Plants in Burren, Co. Clare." This paper is published in Vol. xxiv. of the Trans. R. I. Academy, and is accompanied by a map, which shows at once the precise localities where several rare and interesting plants occur, and the relation between their geographical distribution and the geological structure of the district.

When mentioning Mr. Foot's share in the production of thirteen of our small memoirs called Explanations, it should have been added that his name also appears as sole or joint surveyor on thirty sheets of our published maps, and seven sheets of sections.

I am happy also to say that the reading of his paper, containing his botanical and geological observations on a part of Norway, will not be interrupted by his death. The paper, with its illustrations complete, is now in my hands, and it will have been read at a meeting of the Royal Dublin Society before this letter can be published in your next number.—I am, Sir, your obt. servant,

J. Beete Jukes.

Geological Survey of Ireland,
51, Stephen's Green, Dublin,
*4th February*, 1867.

Note.—We are requested by Mr. J. Beete Jukes to make the following corrections to his last letter which appeared in the February Number of this Magazine, p. 87. At line 10 from bottom of page 87, for "break in the *veins*," read "break in the series;" at page 88, line 4 from top, insert a full stop after "Pilton beds, etc.; delete full stop in line 5 from top, and substitute comma.—Edit.

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## ON DENUDATION AND THE FORM OF THE GROUND.

*To the Editor of the* Geological Magazine.

Dear Sir,—Had my friend, Mr. Kinahan, bestowed equal attention upon the passages immediately following that which he quotes from your January number, or its plates, he might, perhaps, have gathered therefrom that I had not forgotten such instances as the coast islands of Cork and Kerry. The inference would have been more evident than that, because these islets are now acted upon by the sea, isolated pillars of rock must have been formed by marine denudation. Inverting the case he puts, and supposing any rain-worn pinnacle depressed to form an island, it follows that this situation might sometimes prove but little or nothing with regard to the formation of "isolated rocky pillars" by subaerial or marine denudation.

Leaving aside elevation and depression, as remotely connected with the cases in point, some of the island rocks named are of so great a height (about 600 ft.), that the sea can only reach their most denuded portions in the form of rain-like spray, and it will be admitted that rain does sometimes occur on that coast.

I have heard, indeed, that a water-butt was washed by storm breakers from a considerable height (about 350 ft), near a lighthouse on the Great Skellig, yet could not rely upon an uncorroborated report as proof of the vertical distance at which the sea can occasionally act upon the weather side of a lofty rock. Its agency in forming some isolated pinnacles has not been denied.

Truly yours, A. B. Wynne.

London, *February 5th*, 1867.

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## FISH IN THE DEVONIAN (NOT OLD RED) ROCKS.

*To the Editor of the* Geological Magazine.

Sir,—As there is still much misapprehension afloat as to the value of the fossil evidence in the case of "Devonian *versus* Old Red," it is desirable to clear up any doubtful points. I believe it is admitted pretty generally that the greater part (not all, of course, of the so-called Carboniferous shells, crinoids, &c., in our Devonian lists are erroneous identifications, made upon very imperfect specimens. At least I can answer for this in the greater part of those which have come under my review (see the revised names in the lower gallery, Museum P. Geol. Jermyn-street, and their catalogue); and Mr. Davidson has shown us the same thing in his careful monograph of the Carboniferous Brachiopods. There are a few exceptions, and, of course, these multiply in the highest beds.

But what about the Fish? It has been shown by many authors that Old Red fish occur in Devonian strata, and Devonian shells in Old Red Sandstone; and in a memoir laid before the Geological Society (Quart. Jour. Geol. vol. xix., p. 474, *et seq*), some years back, I endeavoured to collate these scattered evidences, and add others from personal survey, which would show that the *Upper Devonian* fossils were found in *Upper Old Red* rocks; *Middle* Old Red fish were found in *Middle* Devonian; and, to complete the evidence derived from fossils, a *Cephalaspid*, from the undoubted *Lower* Devonian of the Rhenish provinces shewed that *Lower* Old Red meant Lower Devonian. In the absence of any physical evidence that the strata are not contemporaneous, it seemed to me that these fossil data were sufficient for the affirmative side of the question.

But it is argued by some that *Coccosteus*, found in the Eifel and in Russia with the shells, is, with us, as much an Upper as a Middle Old Red form. And, moreover, that while *Holoptychius* (an undoubted upper Old Red fossil), has been found in the N. Devon rocks in its proper place. *Phyllolepis* has occurred in the lowest portion of the S. Devon series, near Torquay. Does any one know exactly where the specimen is on which this decision is founded? It used to be said that at Polperro, in Cornwall, in the Lower Devonian beds, fish were common. Professor M'Coy determined these to be sponge remains. Has any competent authority seen the *Phyllolepis*, and is the locality certain?

J. W. Salter.

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## GRAPTOLITES OF THE MOFFAT SHALES.

*To the Editor of the* Geological Magazine.

Sir.—I shall be glad if you will afford me a portion of your space to reply to certain statements advanced by Mr. W. Carruthers, in his paper on the "Systematic position of the Graptolites, and their supposed Ovarian Vesicles," contained in the last number of your Journal. In the first place, Mr. Carruthers is of opinion, that the attachment of a supposed ovarian capsule to the stipe of *Graptolites Sedgwickii,* as figured by me (Geol. Mag., Vol. III. Pl. XVII. Fig. 3), is a case of mere juxtaposition. It is very possible that this view may ultimately be proved to be correct, and one certainly would, *a priori,* and from analogy, be inclined to believe that the mucro should constitute the organ of attachment. On this point I do not feel justified in expressing any strong opinion; but I may remark, *en passant,* that I did not state that I had observed this apparent connexion in one specimen only. What I did state was, that I had never observed this phenomenon except in the case of *G. Sedgwickii*; and, in point of fact, I have seen it in three specimens of this Graptolite, though never in any other; and in the two, which I did not figure, the position of the mucro could not be made out.

It is undoubtedly true that in the majority of cases, there are no external indications, or scars, which could have been produced by the fall of a capsule. Still there *are* cases in which marks exist, which are possibly due to this cause. Thus, Hall has described pustuliform elevations at the bases of the cellules in *Graptolithus nitidus,* and in *G. divaricatus,* both *Didymograpsi*; and I have observed similar pustules, or, in some cases, pits, at the base of the cellule of *Didymograpsus anceps,* recently described by myself, from the Moffat shales. These may be the cicatrices of ovarian capsules, as vaguely hinted by Hall, but on this point I would be understood to express myself merely hypothetically, and with all due caution.

Then Mr. Carruthers concludes that the rounded and oval bodies, without an evident external mucro, which occur in numbers along with the perfect mucronate capsules, must have been mistaken by me for specimens of the small Brachiopod, the *Siphonotreta micula* of Mc Coy. On this point I can only say, that I have collected dozens of the *Siphonotreta,* in various localities in Dumfriesshire, and I have examined a most extensive suite of the rounded bodies in question, in every state of compression and preservation, and I can safely assert, that it is impossible that any palæontologist, possessed of ordinary powers of observation, should fall into an error so gross. I never met with any case in which there was the need of a moment's hesitation, and a careful examination will almost always detect the mucro, at some point or other, within the circumference of the capsule. I therefore repeat the assertion, that the rounded bodies are simply the bell-shaped mucronate capsules, compressed from above, downwards instead of laterally. In this view, I am fully supported by the authority of Prof. Harkness (than whom no one is more thoroughly acquainted with the Graptolitic rocks of

Dumfriesshire, and their contained fossils), who both examined my specimens, and himself collected a number, in a visit which he paid with me to Moffat last summer.

Leaving the subject of the ovarian capsules, Mr. Carruthers appears to think that the *Diplograpsus Whitfieldii* of Hall is identical with the *D. tricornis* described by himself. This, however, is certainly not the case, the two being distinguished, amongst other differences, by the obvious character that the former is provided with but a single mucronate radicle, whilst the latter is furnished with three. I have found *D. Whitfieldii* at Glenkiln Burn, in Dumfriesshire, but I am not aware of its occurrence having been noticed elsewhere.

It seems to me that Mr. Carruthers is likewise wrong in the assertion, that *Diplograpsus pristis*, Hisinger, is provided with spinose or mucronate cellules. I should speak more positively on this point, but I am not able to refer to the original figures by Hisinger, and can only judge from the various figures in Hall, and from McCoy's description. Certainly I have myself never seen a single specimen in which this was the case, and I should be inclined to suggest (not having seen the specimens upon which Mr. Carruthers has founded his statement), that he has probably mistaken for *D. pristis*, specimens of the *Diplograpsus quadri-mucronatus* of Hall. I have found this beautiful species not uncommonly in the Moffat shales, and when compressed in certain directions, it presents but a single row of spines, thus coming closely to resemble the ordinary form of *D. pristis*, and differing chiefly in the mucronate cellules.

I am, Sir, Yours, etc.,

Henry Alleyne Nicholson.

Edinburgh, *February 6th*, 1867.

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## MR. MAW, PROFESSOR JUKES, AND OTHERS ON DENUDATION.

*To the Editor of the* Geological Magazine.

Dear Sir,—Since the appearance of my articles on the origin of Escarpments and Valleys (Geol. Mag. April and July 1865; Feb. and Sept. 1866), you have given insertion to an array of contributions more or less in favour of subaërial denudation. As I find a full reply would not come within any reasonable compass, in your Magazine, and as several observations have been made which render silence on my part no longer desirable, would you kindly find room for a few brief remarks.

*Planes of Marine Denudation.*—As on this point I have been misunderstood, permit me to remark that in asserting that the sea is not a levelling agent, I, of course, meant that the sea only planes down its bed to an extent proportionate to the amount of flat surface presented by the land at any given time. This planing down process is far from universal. It is nearly absent in Archipelagos, and on continuous coast-lines it requires a very slow, uniform, and unintermittent rise or fall of the land. Table-lands, with surrounding *declivities* or escarpments, are planes of marine denudation, and so are plains surrounded by *acclivities* or escarpments, unless a mere difference of level can give a claim to a different origin. Mr. Wynne (Geol. Mag. Jan. 1867, p. 10), admits the marine denudation of plains. Mr. Maw goes much further, and agrees with me in attributing all straight and level surfaces, including terraces with adjacent cliffs or escarpments, to the planing action of the sea. I venture to proceed a step still further, and ask why should an extensive level surface be called a plane of marine denudation, while a flat-bottomed vale (not the effect of deposition) is excluded from the designation? Mr. Maw, in admitting that all, or even the majority, of hollows, with terraced cliffs or uniformly scarped sides, have been *modified* by the sea, concedes, as could easily be shown by sections, that the sea, in many cases, has had a considerable, if not the greatest, share in the process of denudation. The extreme sub-aërialists, who attribute all inland *strike-following* cliffs[1] and escarpments to the atmosphere, are consistent in referring the formation of planes to the same agency.

*Transverse Gorges and Longitudinal Valleys.*—Professor Jukes, in a truly philosophical spirit, sets limits to his theory by admitting that *undulating surfaces* (Geol. Mag., May 1866, p. 234), *sea-ward* or *outside hill-slopes* (Exp. to Irish G. S. Maps, sheets 124 and 125, p. 6), and *gaps or passes upon the crests of ranges of hills*[2] (Quart. Journ. Geol. Soc., June 1862, p. 391), are the result of marine denudation. I have lately been led to agree with this distinguished geologist, in attributing long and narrow river-valleys on the sides of table-lands and mountain ridges, to fluviatile erosion. I likewise think it probable that the transverse gorges, which connect longitudinal valleys, may have been partly excavated by streams flowing down *once* continuous slopes, though the abruptly commencing and fresh-looking sides of these gorges would seem to point to a farther and more recent excavation by marine currents. These longitudinal valleys and basins, which are not open plains, and which often occur in what must once have been land-locked situations, appear the more mysterious the more frequently they are contemplated. Their outlines are generally so smooth, and horizontally continuous, and their recesses so curvilinear, as to preclude the idea of any process of rutting down by pluvial runlets which must have conformed to the slightest local variation in the denudability of rocks, while in many instances they appear to have been swept so clear of all detrital traces of the excavating agent,[3] as to forbid our referring them to rain and frost, which must have left numerous indications of their slow, intermittent, and irregular mode of action. It must have been a wholesale denudation, and not a denudation by instal-

[1] Mr. Topley (Geol. Mag., Oct. 1866), makes some statements in reference to the escarpments and sea-cliffs of E. Yorkshire, which, if necessary to the support of the subaërial theory, show that this theory is not applicable to many parts of the S.W. of England and other districts, where the sea, in making cliffs shows a tendency to follow the strike, and where many inland cliffs run obliquely to the strike. Numerous instances might be brought forward did space permit.

[2] Professor Jukes clearly includes *ravines and narrow winding valleys* crossing watersheds.

[3] This was long ago shown by Sir R. I. Murchison.

ments. Large bodies of water in the shape of marine currents, or "waves of translation," caused by sudden elevations,[1] ought not, I think, to be rejected as a cause, until their inadequacy has been clearly shown.[2] Should the theory of great bodies of water be ultimately found untenable, then equally great bodies of moving ice would, I think, furnish a more satisfactory explanation than rain.

*Water-worn cliffs, pillars, and rock-surfaces.*—Since I first directed attention to traces of sea-action on certain inland rocks, several geologists have shown an increasing disposition to limit their confidence in atmospheric denudation. Admitting that rain acts powerfully on arable fields, roads, exposed beds of sand and gravel, and soft rocks, I asserted that pure rain-water has little or no influence on hard rocks (in this, I now find, I was forestalled by Colonel Greenwood); that the preservation of glacially smoothed and striated surfaces demonstrates the inadequacy of mere rain to denude hard rocks: that if ice-marks have endured, it is reasonable to look for marks left by the sea; that they may be found on inland cliffs, and rock-pillars, which present smoothed[3] and rounded forms, or which have been left with angular projections, where the adjacent blocks (of equal hardness) have been displaced or removed;[4] that the summits, ridges, and sides of many hills, present marks which are facsimiles of those now in course of being formed by the sea; that these marks may be distinguished from the effects of glaciation, by their consisting of a succession of small hollows, ridges, round, oval, or elongated pot-holes, or short grooves, indicating the gyratory or *to-and-fro* action of stones in water. I have found these phenomena not only on Mynydd Gader, at a lower level than the glaciated surfaces lately discovered by Mr. Wallace (Quart. Jour. of Sc., Jan., 1867), and on elevated natural pavements of limestone near Minera, but on the Mendip Hills, where the smooth and almost polished pot-holes are very numerous and striking. Mr. Plant (Geol. Mag., Feb., 1867, p. 81) has lately discovered an old sea beach on the lime-

[1] Such as must have resulted from these *sudden* upstarts of the sea-bottom, which are indicated by the *transverse horizontality* of many systems of terraces now at considerable altitudes above the level of the sea. (See account of Raised Beaches near Llangollen, in Geol. Mag., Sept. 1866, Fig. 13, in the plate, which furnishes a very inadequate representation.)

[2] It is remarkable that such submarine troughs as Captain Beechey's "Ditch in the North Channel" should not have been more particularly examined with reference to denudation.

[3] In Geol. Mag., Nov. 1866, p. 518, Dr, Lindström thinks I have mistaken glacial grooves for wave-marks. An inspection of the locality would, I think, convince any unbiassed geologist that they occur in situations, and are associated with phenomena, such as shallow pits and caves, which furnish a strong presumption against a glacial origin.

[4] Mr. Wynne, in asserting that it is impossible to distinguish between rock-pillars formed by the atmosphere, and those formed by the sea, unintentionally ignores the validity of that dualogical reasoning on which geology is founded. Even dynamically considered, there can be no doubt that the effects of a slow vertical agency can be easily distinguished from phenomena produced by the lateral undermining, and to-and-fro action of the sea. Mr. Kinahan, in answer to Mr. Wynne, has brought forward a convincing illustration of the marine origin of rock-pillars (Geol. Mag., Feb., 1867, p. 89).

stone moors, near Buxton, with similarly-worn rock-surfaces, and with the addition of loose shingle, and a covering of clay, *not* derived from the limestone rock, which rock, he tell us, has suffered *no* decomposition since the sea left the locality. Since I first wrote on this subject Mr. Pengelly has announced his discovery of *Pholas*-borings in limestone cliffs, at considerable altitudes above the present sea-level, and others have brought forward facts, which not only show the absence, or limited extent, of subaërial disintegration, but prove that the sea was, at least, the last denuding agent to which the surface of the land has been subjected, ice at high altitudes excepted.

D. Mackintosh.

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## DENUDATION OF VALLEYS.

*To the Editor of the* Geological Magazine.

Sir.—Every one who lives amongst the hills, as I do, on the Cotswolds, who has his eyes open, must discover parallel cases to those described by Mr. Hull, in your October number; *i.e.*, valleys commencing on high ground and descending to the sea, some having rivers, others being dry. Being only a field-geologist I have no theory to support, but study facts, and have my opinion, which I am ever ready to alter when truth requires it.

The valleys in the Cotswold Hills that I am acquainted with are depressions in the Oolitic beds, they have a basement of clean Oolitic gravel, with the edges taken off, but not formed into pebbles, proving that it has never been subjected to coast or tidal action, or long continued attrition. Some of these valleys begin at the crest of the Oolitic range, now elevated one thousand feet above the sea, and gradually descend the south-east slope of the Cotswolds until they reach the summit level of the Thames, four hundred feet above the sea; others are more local, descending from ground, five to six hundred feet above the sea.

It is clear that the dry valleys cannot owe their origin to river-action; and the river-valleys are only channels, which receive the springs of the Fullers-earth or local clay beds. The action of these rivers is never a denuding one, even when in flood, little solid matter being carried off. It is, therefore, impossible to conceive that these extensive valleys are the result of river-action, We know that the Oolitic matter once formed a sea bottom, nearly, or quite level, and that it is now elevated one thousand feet above the sea-level. It may be assumed to have been lifted up one thousand five hundred feet, and it is impossible for this to have taken place without cracks in the surface, and being unequally elevated, and tilted to the south-east during its elevation, sea currents must have run in these cracks, and here we have an enormous power at work, quite sufficient for the denudation that has taken place; and action of this kind and degree will account for the cleanness of the gravel bottoms of these valleys.

In the great estuary of the Thames, all these Cotswold valleys, wet or dry, terminate, with one exception, which runs into the Severn. I may add, we have no fresh water deposits in our valleys.

Yours, Thos. C. Brown.

Further Barton, Cirencester.

## OBITUARY.

Jacques Amand Eudes Deslongchamps was born at Caen, in Normandy, on the 17th of January, 1794. His parents were poor, and imposed upon themselves severe privations in order to afford to their son a liberal education. At the age of eighteen he had so much distinguished himself through his medical studies and examinations, that he was appointed an assistant-surgeon to the frigate "La Gloire." In 1812 he became surgeon-assistant-major to the Military Hospital of Caen, but soon afterwards left the navy and went to Paris, in order to complete his medical studies, and to take his degree of Doctor of Surgery. During his sojourn in Paris, medicine was not, however, his only study, for comparative anatomy, botany, and physiology had occupied much of his time, and of those sciences he made himself eminently proficient, as well as in the art of drawing. When in Paris he became intimate with Cuvier, and his young mind was so deeply impressed by the wonderful discoveries of Mammalian remains brought to light through the genius of that celebrated naturalist, that on his return to Caen he lost no time in exploring the many quarries that surrounded his native town. Great, indeed, was his surprise and delight when he found them replete with fossil remains of all kinds; and the discovery of a specimen of *Teleosaurus Cadomensis* so elated him, that from that time comparative anatomy and palæontology became his chief and favourite studies. At Caen he met Lamouroux, and with him studied the corals, and was one of the contributors to the "Encyclopédie Méthodique," as well as of the "Dictionnaire des Sciences Naturelles." He was the chief founder both of the Museum of Natural History of Caen (of which he was honorary curator), and of the Linnæan Society of Normandy, and has for years been the principal contributor to its transactions. In 1825 he succeeded Lamouroux as Professor of Zoology to the Faculty of Sciences of Caen, and on the 22nd of October, 1847, was elected Dean of the said Faculty, which chairs he retained till the day of his death. No professor could be more popular or more respected, and he inspired his pupils with a true love of science; indeed his noble mind was constantly bent on doing good, and in affording relief and encouragement to all those who were in need of his aid or advice. So important and varied were his researches and publications, that he was universally recognized as one of the most eminent palæontologists of his day. He published many excellent memoirs and monographs of the Fossil Mollusca which occur in the Oolitic and Liassic deposits of Normandy, and those which treat of the genera *Pleurotomaria, Plicatula, Turritella, Trochotoma, Eligmus,* etc., are particularly remarkable. He also devoted considerable attention to the *Brachiopoda*, and we are indebted to him for a French Translation of Davidson's "General Introduction" to that group, as well as for the establishment of the genus *Argiope*. But his most important publications relate to the Crocodilian remains of Normandy.

Honours of all kinds were heaped upon him. He was a corresponding member of the Institute of France, and of numerous other academies and learned societies. A chevalier and officier de la Legion d' honneur, and a medallist of St Helena. In 1861 he received a silver medal from the Minister of Public Instruction. In 1863 a gold medal was presented to him as a reward for the first portion of his admirable work on *Teleosaurus*, and in 1864 another gold medal was awarded to him by the Academy of Sciences of Rouen. He was also a foreign member of the Geological Society of London.

About two years ago he had the great misfortune to lose the sight of one of his eyes, and the other having been much impaired, the calamity produced on his ever active mind a feeling of deep depression. On the 15th of November last he assisted at the inaugural opening of the session of the Faculty of Sciences of Caen, where his worthy and distinguished son was occupying his chair as professor of Zoology. Feeling his end fast approaching, his last few days were spent in dictating to his son what was still necessary in order to enable him to complete the great work on the Fossil Crocodilian remains of Normandy, upon which he had laboured during so many years. Remembering the compliments paid him by the Geological Society of London, he desired that his last great work should be dedicated to that society. On the 17th of January, 1867, he expired, aged 73 years and one month, deeply regretted by his numerous friends and admirers.

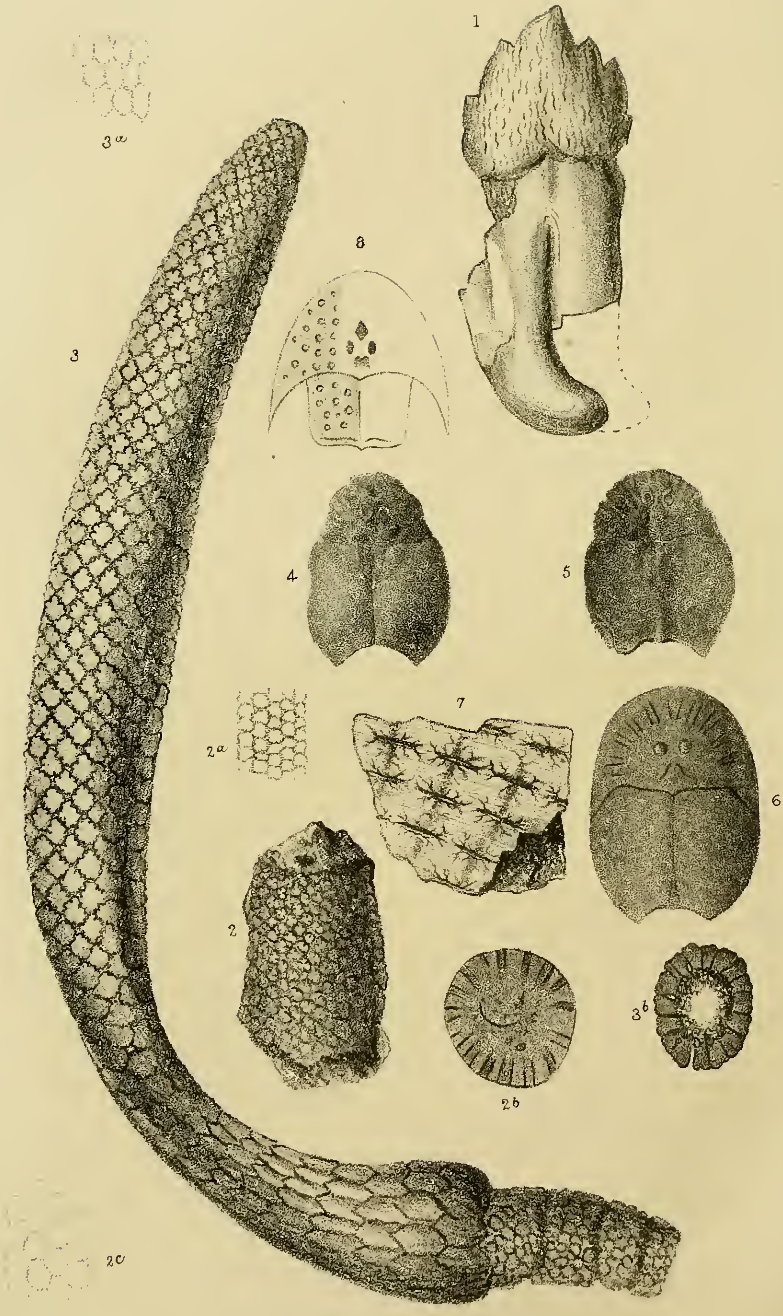
James Smith, Esq., of Jordan Hill, near Glasgow, F.R.S., F.G.S., whose death we announced in the last number of the Geological Magazine, was born in the year 1782, and died on the 17th January, 1867, in the eighty-fifth year of his age. He was educated in the University of Glasgow. From his earliest years he had a taste for yachting, and it was said at one time he was the only yachtsman in the West of Scotland for many years. In 1806 he made a voyage in a very small vessel of about twelve tons, which accommodated himself and his companions, the late Professor Milne and Dr. Ure, and in this voyage, which lasted several weeks, they went as far as the Isle of Skye. In a subsequent voyage, a few years afterwards, he discovered the vitrified fort on the Burnt Island, in the Kames of Bute, and published an account of it in the transactions of the Edinburgh Antiquarian Society. He subsequently served as an officer in the Renfrewshire Militia, and was on duty at the Tower when Sir Francis Burdett was imprisoned there. After the peace he visited France and Italy, in which latter country he resided for some time, occupied chiefly with the study of the Fine Arts. About the year 1830 he began to take an active interest in the affairs of the Andersonian Institution, which acquired a fresh life under his auspices, and continued to prosper under his presidency. He was the founder of its Natural History Museum. The very complete collection of Scotch coins attached to the museum was formed and presented by Mr. Smith. His first geological paper, entitled, "An indication of Changes in the relative Levels of Sea and Land in the West of Scotland," was read to the Geological Society of London on November 16th, 1836. This was followed by a series of papers on the same subject, read before the Geological and Wernerian Societies. His last paper to the Geological Society was read in February, 1862. These have now been published in a collected form, entitled, "Researches in Newer Pliocene Geology." Glasgow, 1862. The importance of Mr. Smith's original researches can hardly be over-estimated by geologists of the present day, evincing, as they do, not only changes in the relative level of land and sea, but also great climatal changes, as indicated by the remains of various organisms now extinct within the British seas, and which he was the first to point out as occurring in these raised beds, and as being of an Arctic character. Sir Charles Lyell, Mr. Geikie, and other recent writers on these deposits, all acknowledge the very great importance of Mr. Smith's observations in this department of geology, which, as Mr. Geikie truly states, were destined ultimately to cast much light on the complex history of the superficial accumulations of the country. The importance of these and subsequent researches have entitled Mr. Smith to be considered by many as the father of Post-pliocene geology. Mr. Smith resided for several years in the south of Europe, and published papers on the geology of Madeira, on the tertiary formations of Lisbon, and on the structure of the rock of Gibraltar.

Among the services rendered by Mr. Smith to the cause of scientific inquiry and research, special mention is due to his labours in the field of Scripture criticism and interpretation, which are connected with this period of his life, as it is in this department that he has acquired his most extensive, and what will probably be his most lasting reputation. In an essay on the "Sources of St. Luke's Writings," he gave evidence of an acute and scholarly cast of mind—though, from the difficult and somewhat speculative nature of the subject, different opinions will doubtless be entertained respecting the particular view advocated in the essay, and the measure of success with which the investigation is conducted. But in regard to another and more laborious line of inquiry—that relating to the voyage and shipwreck of St. Paul—there can scarcely be said to be any difference of opinion among competent judges, and theologians of high name and of various countries have united in their commendation of the eminent ability and skill displayed by Mr. Smith in his treatment of the subject. Mr. Smith was a member of the Geological Society of France, and was the President of the Geological and Archæological Societies of Glasgow.—J.Y.

Robert Dick, of Thurso, though a hard-working man all his life, had such an irrepressible love for natural history, and so employed his leisure hours, that he earned for himself a well-merited fame in scientific circles. He died at Thurso on the 17th of December last. We are glad to be able to present our readers with a short account of a man whose memory ought not to be lost. Mr. Dick was a native of Fifeshire, but went to Thurso when young. He learned to be a baker, and some time afterwards commenced business on his own account. During his apprenticeship Mr. Dick exhibited a taste for natural history. He would then spend even more than his spare hours in local explorations, and every work on botany and entomology was eagerly borrowed or acquired, and was read and studied with the greatest avidity. But it was when he became a journeyman, and especially when he arrived at the position of being his own master, that he devoted himself with the most singular earnestness to the study of science, spending many nights in the open air, and being on many occasions for several days and nights engaged in the investigation of the district, which in the end brought him into possession of a museum of fossils and botanical and entomological specimens, which has been the admiration of the multitudes of *savans,* from Sir Roderick Murchison downwards, who have been privileged to see it. Among the people of Thurso and neighbourhood Mr. Dick was long looked upon as partially insane; but, as time rolled on, opinions gradually changed. By-and-by it began to be whispered that men of great influence were visiting the mad Thurso baker; and when it was found that in the meetings of the British Association for the Advancement of Science he was honourably mentioned, and that even Sir Roderick Murchison had been receiving lessons from him—some of his illustrations being drawn on the walls of his workshop and his implements of trade—the opinion changed, and Thurso people took pride in naming the great scientific baker of their town. It was during his entomological and botanical explorations that Mr. Dick began to cultivate a taste for geology. By-and-by he became as deeply in love with it as with those other sciences, and in the end he acquired a wonderful acquaintance with the science, and was in frequent communication with the late Hugh Miller, Sir Roderick Murchison, and other geologists. His long and wonderful travels in the district, and his extraordinary painstaking investigations and researches have resulted in the accumulation of one of the most interesting collections of specimens to be anywhere seen. It is understood he has left the collection to the Thurso Natural Science Association, established last year, which will thus be in possession of a museum that many will covet. At a special meeting of this association, a letter from its president, Sir G. Sinclair, was read, in which he says—"The extent and variety of his scientific acquirements were incredible, and almost unexampled. He knew as much of many sciences as most professors knew about one. When my very distinguished friend, the Duke of Argyll, honoured me with a visit, he lost no time in repairing to Mr. Dick's abode, and was most cordially received; but neither on that, nor on more than one similar occasion could I succeed in prevailing on Mr. Dick to breakfast or dine with me. His unassuming modesty was as conspicuous as his wonderful knowledge." A resolution was moved by Mr. Docherty, seconded by Mr. Galloway, and unanimously agreed to, to the effect that "The members of the Thurso Natural Science Association are of opinion that means should be taken to mark the respect in which he was held, by raising some suitable memorial to his memory." It was further resolved that the Association should request the Chief Magistrate to convene a public meeting of the inhabitants of the town for the purpose of taking steps to carry out this object.

## MISCELLANEOUS.

New Species of Plesiosaurus.—A fine addition has recently been made, by purchase, to the remains of *Plesiosauri* in the British Museum—a collection already rich in the larger species of the genus. The specimen is from the Lower Lias, near Charmouth, and was obtained by E. C. H. Day, Esq., F.G.S., the fortunate discoverer, in the same locality, of the large specimen of *Plesiosaurus rostratus*, described and figured by Professor Owen, in the "Palæont. Soc. Mon. for 1865. The fossil has been skilfully developed from its matrix by Mr. Isaac Hunter, of Charmouth. The entire skeleton measures nearly fourteen feet in length, and has almost all the vertebræ in their natural sequence and position, a few only of the caudal series being displaced. The neck, which is slightly curved, is long, and gradually tapered to rather slender proportions at its connection with the head. A large portion of the cervical, and the whole of the dorsal vertebræ, with their spinous processes, and the ribs have been partially cleared from the rock in which they were embedded; thus giving an upper and under view of the skeleton, which is placed in a frame, with its ventral surface towards the observer. A plaster cast of the dorsal region, which would otherwise have been hidden, has been made and fixed above the specimen, to show the continuity of the series of vertebræ, which are entire, having their lateral processes and neural spines attached; the ribs are also preserved. This ventral view shows well the very large, perfect, and strong sternal and pelvic bones with their broad surfaces, for the attachment of the powerful muscles of the paddles; these are, however, imperfect, for, of the numerous bones of which they were composed, only the right humerus and femur, and portions of those of the left side are preserved. The head, which has lost the anterior portion of the muzzle, was, with a part of the neck, turned over when the animal was deposited in the mud of the Liassic sea, and is, therefore, seen from above. It is much larger in proportion than in *P. homalospondylus*, Ow., or *P. dolichodeirus*, Conyb., but not so large as that of *P. rostratus*, Ow. The neck is much longer than that of the latter species. The present specimen has been named by Professor Owen *Plesiosaurus laticeps*.—W.D.




G. Massee del.t et lith. M & N. Hanhart imp

TO ILLUSTRATE PROF. M.c COY'S *and* MESS.RS W. CARRUTHERS'
& E. RAY LANKESTER'S PAPERS

THE

# GEOLOGICAL MAGAZINE.

No. XXXIV.—APRIL, 1867.

## ORIGINAL ARTICLES.

### I.—On the Occurrence of the Genus *Squalodon* in the Tertiary Strata of Victoria.

By Frederick M'Coy, F.G.S.

Professor of Natural Sciences in the University of Melbourne, and Palæontologist to the Geological Survey of Victoria.

(PLATE VIII. Fig. 1.)

As confirmatory of the Miocene age assigned by me, on other palæontological grounds, to the Tertiary sands on the Southern shores of Victoria, containing the *Trigonia semiundulata* (M'Coy),[1] I think the accompanying figure (Plate VIII., Fig. 1), of the natural size, of a molar of an Australian species of the mammalian genus *Squalodon*, may be of interest.

The species is smaller than any of the American Eocene Zeuglodonts, or the Maltese Miocene *Squalodon Melitensis*, and it differs from them all in the great proportions, length (or depth), and imperfect bifurcation of the root. In the latter, and all other characters, it most nearly agrees with the *Squalodon Grateloupi* of von Meyer, from the French Miocene beds near Bordeaux.

The specimen figured was found by Mr. Wilkinson in the sandy Miocene Tertiary beds of Castle Cove, Cape Otway, coast of Victoria, and is now in the National Museum at Melbourne. I have great pleasure in naming this important fossil after that zealous young geologist, attached to the field-branch of the Geological Survey of this colony.

*Squalodon Wilkinsoni*, (M'Coy).

*Description of Specimen.*—One of the molars having a compressed semi-elliptical crown, 9 lines high, base 11 lines, and $5\frac{1}{2}$ lines thick; length of bilobed root 1 inch 9 lines; middle cusp bent moderately backwards; anterior convex edge irregularly serrated and divided into two unequal cusps, the smaller about one-third from the top of that edge, the larger at about one-third from the bottom; posterior shorter edge divided almost equally into three large cusps, the lowest smallest, the two upper nearly equal, and much larger, being about half the width of the middle cusp. Surface longitudinally marked with coarse, rough, very irregular sulci, and small granular, angular ridges, and striæ. Root bilobed below the upper half inch, with incurved end.

[1] See Geol. Mag., Vol. III., No. xxix., November, 1866, p. 481.

## II.—On an Aroideous Fruit from the Stonesfield Slate.

By Wm. Carruthers, F.L.S., of the British Museum.

(PLATES VIII., Figs. 2 & 3.)

I OWE my acquaintance with this interesting fossil to Mr. S. Stutterd, who kindly forwarded it to me for my inspection. It is from the Stonesfield Slate, and is preserved in limestone, but is only a cast formed in the matrix left in the rock after the organism itself had disappeared. The core had been hollow, or composed of a more speedily perishable material than the parietes, and so it rapidily disappeared, permitting the empty axis to be filled with fragments of shells and calcareous sand. Externally, the cylindrical fossil is formed of sub-quadrangular peltate plates, with irregular undulate dentate margins, the projections of each of which fit into the undulations of the surrounding plates, and are arranged in linear series. A transverse section (Plate VIII. Fig. 2*b*.) shows each of these external plates to be the closed termination of a short tube, that has in the transverse section a hexagonal form. These tubes are filled in with a darker material, which, unfortunately, is without structure, and any determination of the affinities of the fossil must depend entirely on the external form, and the arrangement of the parts. Of necessity, these are defective and unsatisfactory materials; nevertheless, the fossil seems to me to present so remarkable an appearance, and so close an approximation to a portion of the inflorescence of an Aroideous plant, that I do not hesitate to refer it to this family; and I entertain the hope that one result of this notice and the accompanying figure may be to draw some attention to the fossil, which seems to be by no means rare, and so supply the means for more completely establishing its affinities.

The *Aroideæ* are monocotyledonous plants, with numerous naked flowers on a solitary spadix. The female flowers are at the base of the spadix, and the male above, sometimes separated by a series of neuter organs from the female, and often surmounted by a free flowerless termination of the spadix. The plants of the family are chiefly natives of the tropical and warmer parts of the earth, many of them being arborescent and of considerable size, clinging to trees by means of aërial roots which they freely send out. The majority of these large tropical species have the cells of the anthers buried in the substance of a very thick connective, and the apices of the stamens forming peltate shields which cover either the whole of the spadix above the female organs, as in one large tribe, or only a portion of it, leaving a naked appendage beyond the flowers, as in the other section.

On the plate (Plate VIII. Fig. 3) we have figured a spadix of a species of *Xanthosoma*, the lower portion of which is covered with the pistils, the middle by the neuter organs or imperfect stamens, and the upper by the true stamens. A comparison of the fossil with the recent plant will show how remarkably they agree. The axis of the spadix of *Xanthosoma*, in growing, becomes hollow, as seen in the transverse section (fig. 3*b*.); the condition of the fossil shows that in this respect its structure was similar (fig. 2*b*.). The walls of the stamens extend into the interior as far as and in a similar manner to what is found in the fossil; and the apex of the stamens has a similar undulating and irregularly quadrangular aspect. The fossil specimen which I have had cut transversely and longitudinally has belonged either to an unripe spadix, in which the stamens were not fully developed, or to the neuter portion of the spadix, in which the imperfect stamens never produce anthers.

The genus *Xanthosoma*, to the structure of which the fossil most nearly approaches, consists of several species of large leaved herbs that are natives of humid localities in tropical America.

I shall place the fossil in Kutorga's genus *Aroides*, which he established for what he supposed was the spathe of an Aroideous plant, in preference to establishing a new genus for it. It is desirable to establish such comprehensive genera that may include the fruits of an Order, when these are found isolated and often fragmentary, and consequently without the means of determining the affinities of the whole organism to which they belong. I have much pleasure in naming the fossil *Aroides Stutterdi*, and thus associating the species with the name of Mr. Stutterd, whose intelligent acquaintance with the fossils of the beds to which it belongs enabled him to appreciate its importance.

Besides the specimen figured, there is a second specimen in Mr. Stutterd's collection, and there are two fragments in the Oxford Museum. I am indebted to Professor Phillips for an account and sketch of one of his specimens, and a notice of the other. The specimen I have figured is the only one which exhibits the form of the fossil, the others consisting only of the outer surface exposed upon the surface of the stone.

### EXPLANATION OF PLATE VIII., FIGS. 2 AND 3.

While the general aspect of the fossil, and of the spadix of the recent plant are well given in the plate, the artist has overlooked the arrangement of the component parts. I have consequently had added portions of both, twice the natural size, and showing the true arrangement of the stamens.

Fig. 2, *Aroides Stutterdi*.—2*a*. A few of the sub-quadrangular apices of the stamens. 2*b*. Transverse section. 2*d*. Form of the tubes in a longitudinal section of the fossil.

Fig. 3, Spadix of *Xanthosoma*.—3*a*. A few of the apices of the stamens. 3*b*. Transverse section of the spadix, near the apex.

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## III.—On the Genus Cheirolepis, from the Old Red Sandstone.

By James Powrie, Esq., F.G.S.

This well known genus of Old Red Sandstone Fishes was first named and described by Agassiz in his great work, the "Poissons Fossiles," vol. ii. page 128. It is there classed with the Acanthodean family, which it somewhat resembles in the character and structure of its small rhomboidal scales; and also (according to Agassiz), in possessing *Branchiostegal rays*. This characteristic, however, as will afterwards be shown, appears to me to be founded on a misapprehension of the true nature of a series of elongated plates, situated below the lower jaw, which seem peculiar to this genus. The many points in which it very widely differs from the Acanthodeans induced the late Hugh Miller to suggest its removal altogether from them; and a distinct family, which he names *Cheirolepini*, is formed for its reception by Pander. Professor Huxley, in his Introductory Essay on the classification of the Old Red Sandstone Fishes, in the Tenth Decade of British Organic Remains, published in connexion with the Geological Survey, perhaps the most useful contribution yet made towards elucidating their nature and affinities, fully agrees with Pander, in the necessity of this step, and indicates, for the reasons there stated, the probability of its being "the earliest known form of the great sub-order, the *Lepidosteidæ.*" Prof. Huxley, however, states that "the opercular apparatus and the Branchiostegal rays were not observed by Pander, nor have I seen indubitable evidence of their characters;" but, seemingly, trusting to the accuracy of Agassiz's description, in narrating the points in which it diverges from the sub-order *Crossopterygidæ*, he enumerates as one, its possessing "no jugular plates." In this he seems to me in error, some specimens in my possession showing, what I can consider only to be, true principal and lateral jugular plates, although certainly not so distinctly preserved as in most of the Old Red Sandstone genera having these appendages.

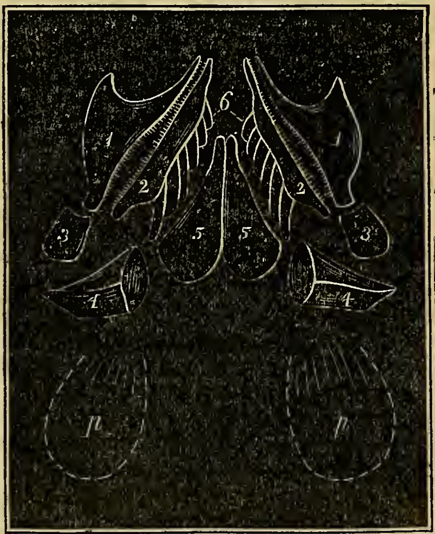


Fig. 1.—Diagram of Head-plates of *Cheirolepis* (ventral aspect).

In *Cheirolepis* the head is undoubtedly covered by osseous plates, being somewhat similar in this respect to *Osteolepis*, *Diplopterus*, etc., but in all specimens I have yet examined these are so imperfectly preserved, and so much displaced, that the true form and relative position of the whole cannot be accurately ascertained. The collection of the late Mr. Patrick Duff, of Elgin, which, since his death, has passed into my hands, contains one or two very fine specimens of *Cheirolepis Cummingiæ*, in one of which the fish is laid on its back, the ventral surface being thus exposed; and, although in it the plates covering the under portion of the head are not perfectly preserved, yet they appear to me sufficiently so to show two principal, and a space which may have been occupied by lateral, jugular plates (See Woodcut, Fig. 1); the lateral plates are not sufficiently preserved in any of my specimens of this species to admit of restoration, but a specimen from Gamrie, in my cabinet, exhibiting a number of the head plates of *Cheirolepis uragus*, has the lower jaw with a number of elongated narrow plates proceeding from its under margin, much resembling those given by Agassiz in his figure of this species, ("Poiss. Foss.," vol. ii. plate 1 *c*, fig. 1.) These I presume are what he describes as Branchiostegal rays, but which, I have little doubt, correspond to the lateral jugular plates, not uncommon in ganoid fishes (Fig. 2). I have, also, introduced these in Fig. 1, which is a

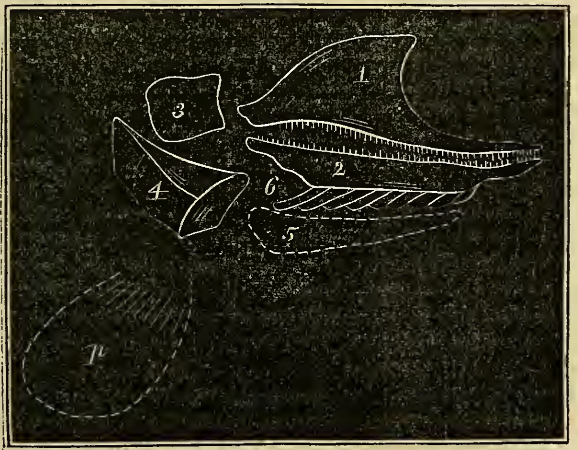


Fig. 2.—Diagram of Head-plates of *Cheirolepis* (side view).

tolerably correct copy of the under head plates, as exhibited in the first mentioned specimen. The numbers are the same in both figures.

The upper jaw (1), as described by Huxley, is a large bone, having its posterior superior margin rounded, its posterior half increasing in depth anteriorly, when it suddenly narrows, exhibiting a concavity, affording space for the orbit, and, seemingly, a number of orbital ossicles, and terminating anteriorly in an elongated narrow bone, somewhat bent upwards, the under margin being slightly concave posteriorly, and exhibiting an equally slight concavity forwards; this bone, however, seems to me to have consisted of the maxilla, and likewise of a supra-temporal bone, completely anchylosed to the maxilla. The lower jaw (2) is moderately stout posterior y, showing a rather prominent condyloid process, and tapering anteriorly. Both the upper and under jaws possessed a single row of rather long, slender, conical, but unequally sized teeth, as described by Agassiz. A slightly elongated, nearly rectangular plate, rather narrowed anteriorly, and having the posterior angles rounded, situated immediately behind the upper maxilla, may have represented the operculum (3); this plate is, however, imperfectly preserved. A stout, rather short, coracoid (4) may be described as consisting of these parts;—a strong ovate umbonate plate, a quadrilateral elongated plate, proceeding upwards from the posterior half of the ovate plate, nearly at right-angles to its major axis, and a triangular plate, fitting into the space between the anterior half of the former, and the anterior margin of the latter; these three appear to have consisted of only one bone, the seeming divisions being occasioned by a ridge between the two latter, and a depression between these and the first. Of the two principal jugular plates (5) one is entire, the other only partly preserved; they are rather small, elongated and triangular in form, having their median sides straight, the lateral outer margin slightly concave, and the posterior edge rounded convexly; one of these plates, imperfectly preserved, is shown in Agassiz's figure above referred to. The space between the principal jugular plates and the lower jaw seems to have been occupied by a number of elongated lateral jugular plates (6), these plates or rays increase in length, but decrease in breadth posteriorly; their exact number I cannot give, but there had been at least eight or ten of them. There is no vestige of a median jugular plate preserved, but from the position and size of the principal jugular plates it seems probable that such may have existed. Other cranial bones are exhibited in my specimens, but too much displaced and imperfect for description. The other characteristics of this genus are too well known and too accurately described by Agassiz, and others, to require notice here.

In his "Poissons Fossiles" Agassiz figures and describes two species of *Cheirolepis*, viz.: *Cheirolepis Trailli* (vol. ii. p. 130, pl. 1 *d*, and pl. 1 *e*, fig. 4), and *Cheirolepis uragus* (vol. ii. p. 132, pl. 1 *e*, figs. 1, 2, 3), and in the "Poissons de Vieux Grès Rouge," he adds another, *Cheirolepis Cummingiæ* (p. 45, pl. 12). In the "Annals of Natural History" for 1848, Professor McCoy indicates, and in the work on British Palæozoic Fossils, by him and Prof. Sedgwick, he describes and figures three other species which he names *Cheirolepis macrocephalus* (p. 580, pl. 2 D, fig. 3), *Cheirolepis curtus* (p. 580, pl. 2 D, fig. 1), and *Cheirolepis velox* (p. 581, pl. 2 D, fig. 2).

Several reasons occasion very much seeming variety in fossil fishes, which, in reality, are identical; and in determining genera, and more especially species, these require to be well weighed and carefully considered; whilst, without going into the *questio vexata* of the indefinite variation of species, it is, I believe, now allowed by all naturalists, that species vary to a very considerable extent. That this cause has sadly hindered our list is well exemplified in Mr. Davidson's magnificent Monograph of British Brachiopods, published by the Palæontographical Society, in which he reduces the number of reputed species from the Carboniferous formation from not less than 260 to 120, and of these 20 are new to the British strata. This cause may affect fishes less than the more lowly organised mollusca, but even in fishes it must always be taken into account.

I shall indicate only two of the many causes, which may seemingly introduce very considerable divergence, where none really exists.

(1) The character and nature of the matrix in which the fossil is imbedded.—This very considerably, and, perhaps, chiefly affects the external markings of the more minute parts of the animal,—such as the head-plates, scales, etc. As a good illustration of this, I may mention the figures of the small Acanthodean Fishes, from Farnell, in Forfarshire, (most accurately described by Sir Philip Egerton), in the Tenth Decade of British Organic Remains, drawn by Dinkel, than whom none has more experience, or better knowledge of such work. The scales of *Acanthodes Mitchelli,* and of *Diplacanthus* (*Ischnacanthus*) *gracilis*, are figured with a granular ornamentation; better specimens prove them to have been perfectly smooth. The ornamentation on the scales of *Climatius scutiger,* as thus given, is totally unlike that which their inner surface really possessed, while the outer was perfectly smooth. No blame can possibly be attached to the artist for this, the mistake being entirely occasioned by the nature of the matrix in which these fishes were preserved.

(2) The state in which the body of the animal was when silted up very considerably affects its apparent form.—Had decay advanced to a certain stage, the generation of gases, and similar causes, tend to give a very exaggerated form to the creature, while the pressure to which it may have been subjected after being entombed, must have considerably increased its distortion. Especially is this the case with most of the Palæozoic Fishes, their dermal covering and appendages being almost the only portions preserved. Hence the comparative size of the head (from displacement of the head-plates), and depth of the body, often seem to vary much in the same species; the size of the fins, also, from being pressed together, and imperfectly preserved, in some appear smaller than they really were, while in others they are exaggerated from being unduly pressed out. That this is the case is attested by the fact that a confused mass of scales, bones, spines, &c., is so often the state in which complete Fishes are found.

Had Professor McCoy sufficiently taken these and other reasons into account, I am much inclined to believe that many of the new species introduced by him would have been omitted altogether, while others would merely have been noticed as seeming varieties. Never having yet had an opportunity of examining the specimens on which his species of *Cheirolepis* are founded, it is impossible for me to speak at all confidently regarding them, but, from his descriptions, and the seemingly very accurate figures given in the work referred to, as well as from having examined some other specimens named by him, I have little hesitation in stating my conviction that none of these are well founded. Sir Philip Egerton (Quart. Journ. Geol. Soc., Lond., vol. xvi.) considers two of them founded on imperfect data—*Cheirolepis curtus* being from an imperfect specimen of *Ch. Cummingiæ*; the seeming larger size of the head and obliquity of the mouth being occasioned by "dislocation of the cranial bones," and the apparent shortness of the trunk and smaller tail being owing to the "concealment of the nape, by some of the dislocated members, and mutilation of the extremity of the upper lobe of the tail." The only other distinctive characteristic given by McCoy, is the tuberculated scales. This, it seems to me, might probably have been occasioned by the nature of the matrix. *Cheirolepis macrocephalus,* founded on its proportionately larger head is shown by Sir Philip to be merely *Ch. Trailli,*—a squeeze having "thrown down one ramus of the lower jaw, and forced the pectoral arch from its normal position;" hence the seemingly larger head. *Cheirolepis velox* is, however, considered by Sir Philip sufficiently marked to constitute a new species. It is described as differing from the others in its smaller head, more slender body, and larger fins,—all three characteristics, as already stated, are very apt to vary from the state in which they may be preserved; and on comparing a well-marked specimen of *Ch. Cummingiæ,* in my possession, in which, however, the head is imperfect, with the figure of *Ch. velox,* given by McCoy in the "British Palæozoic Fossils," they correspond so exactly in every respect, except that in my specimen the depth of the body is, perhaps, slightly greater, that I cannot but believe them identical. The position, size, and form of the fins, even to their minutest details, are exactly the same in both.

The species described by Agassiz are undoubtedly good, and well marked. I am not so well acquainted with the characteristics of *Cheirolepis Trailli,* as of the other two species, but in these latter, at all events, the scales are quite sufficient to distinguish them from one another.

In *Cheirolepis Cummingiæ* the scales are small, rhomboidal, and quite smooth, as in *Acanthodes Mitchelli* and *Ischnacanthus gracilis.*

In *Cheirolepis uragus* they are small and rhomboidal, with five or six delicate converging striæ on the anterior edge of the inner surface, somewhat like those of *Cheiracanthus microlepidotus* and *Diplacanthus longispinus,* but smaller than those of the latter.

In *Cheirolepis Trailli* they are small, rhomboidal, and have each a very prominent, sharp, oval, lengthened tubercle in the middle, parallel, with the oblique posterior border.

Reswallie, Forfar.

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## IV.—On *Didymaspis*, a new Genus of Cephalaspidian Fishes.

By E. Ray Lankester, Esq.

(PLATE VIII., Figs. 4–8).

THE specimen which I intend briefly to notice was obtained by Dr. Grindrod, of Malvern, about two years since, from the red, compact Sandstones, immediately resting on the grey 'Passage-beds' at Ledbury. Dr. Grindrod has kindly lent it to me for description.

The fossil is in two pieces, one showing the convex surface, the other the concave impression, of the cephalic shield of a fish, evidently closely allied to *Cephalaspis*. This shield is a little above an inch in length, and a little less in breadth. Anteriorly, it is transversely divided by a well marked line of junction into two portions; an anterior semi-circular piece, and a posterior, larger, and somewhat square piece. The anterior portion exhibits two distinct oval orbits, placed close together at its centre. Radiating channels mark the inner surface of this portion of the scute, recalling the similar 'channelling' in *Cephalaspis*. The line of junction between the two plates describes a double curve, the two produced angles of the semi-circular plate embracing the posterior plate, but not diverging from it; whilst in the median line, the anterior piece is produced into the posterior to a small extent. In this way the double curvature of the margins is effected. Posteriorly, the posterior plate becomes contracted, and its margins tend towards describing a dome-like outline when it is abruptly truncated, and the truncated margin thickened and inflected. A thickened ridge passes anteriorly along the median line. No radiating channels mark its inner surface.

Flake-like fragments from the inner substance of the scute, soaked in Canada-balsam, and examined beneath the microscope, show large "bone-lacunæ" very densely packed, arranged at right angles in the different lamellæ of the bony-material, so as t produce the appearance of cross-hatching. (See Plate VIII., Fig. 7

From these characters, it is sufficiently clear that this head-shield belongs to a member of the *Cephalaspidæ*, and of that section of the family in which the calcareous material presents true bone-lacunæ. It resembles most closely the *Auchenaspis* of Sir Philip Egerton, which has two species to represent it; it differs from this genus in the absence of diverging cornua from the anterior portion of the shield, in the relatively larger size of the orbits, and in the very different form, and far greater relative size, of the posterior or neck-plate. Hence I propose to call this form *Didymaspis* (δίδομος twin, ἀσπίς shield), alluding to the two nearly equivalent portions into which the shield is divided. This species I wish to call *D. Grindrodi*, after the indefatigable investigator to whose collection it belongs. There appears to be a distinct homology between the anterior portion of the shield in *Auchenaspis* aud *Didymaspis*, and the rostrum, orbital pieces, and cornua, of the genus *Pteraspis* (the most elaborate form of that section of Cephalaspids in which the shield presents a cancellous structure, with no bone-lacunæ), whilst the "neck" plate of *Auchenaspis*, and larger posterior plate of *Didymaspis*, correspond to the disc and spine of *Pteraspis*. In *Cephalaspis*, on the one hand, and *Scaphaspis*[1], on the other, these

[1] *Scaphaspis* is the genus allied to *Pteraspis*, which includes the species *Lloydi*, *truncatus*, etc., with a simple ovate shield.

pieces, or plates, are not differentiated—the shield in both is of a single piece; but it is obvious that in *Cephalaspis* the rostral, orbital, and cornual element predominate, whilst in *Scaphaspis* the discal region chiefly is represented.

EXPLANATION OF FIGURES.

Fig. 4. Relievo } of *Didymaspis Grindrodi*, sp., nov., from the Lower Old Red,
5. Intaglio } Ledbury.
6. Outline of the shield of *Didymaspis*.
7. Bone-lacunæ from the posterior portion of the shield of the same.
8. Outline of *Auchenaspis*.

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## V.—Notes on the Geology of South Bedfordshire.

By J. Saunders, Esq.

THE Geology of South Bedfordshire is now being exhibited more fully than hitherto, as the extension of the Midland Railway from Bedford to London is opening up a series of sections in the newer Secondary rocks which characterise this part of the county. The following notes were chiefly taken during a walk made last summer along the line, between the towns of Bedford and St. Alban's (Herts). For the first few miles the excavations are slight, and exhibit only the Drift sands and gravels of the rich valley of the Ouse, though these are well worthy of careful examination for flint implements and mammalian remains, which have been discovered on the north side of the river, at Biddenham, by J. Wyatt, Esq. About three miles from Bedford is an excavation in the Oxford clay; the upper portion is dark brown merging into dark blue beneath, and it abounds in fossil wood in various stages of carbonization, the colour of which ranges from brown to jet black; it is so abun-

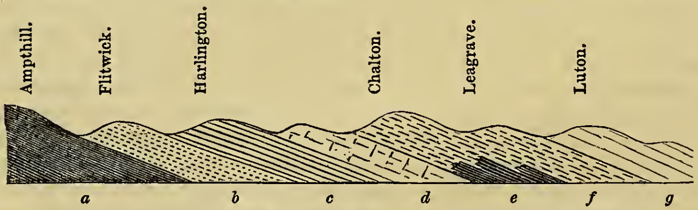



Diagram to Illustrate the Geology of South Bedfordshire.
*a*. Oxford clay. *b*. Greensand. *c*. Gault. *d*. Totternhoe stone. *e*. Supposed bed of clay under the Lower Chalk. *f*. Lower Chalk. *g*. Chalk with flints. The dip of the strata is a little greater than that of the surface of the country.

dant in places that some of the excavators fancied they were coming upon a coal-mine. Running through the mass of clay is a profuse abundance of roots and fibres in inextricable confusion. *Belemnites* are common in this bed, as is also *Ammonites Calloviensis* in the clearages, but the fossils are so hopelessly compressed and fragile as to defy all attempts at extrication, save in the smallest specimens. This formation extends to Ampthill, where it is more largely developed, and where a tunnel is carried through it immediately beneath the Park. The approaches to the tunnel exhibit a series of beds of clay, brown at top and merging into dark blue below, with intermediate bands of hard grey limestone, ranging from a foot to eighteen inches in thickness. The northern approach shows an anticlinal in these limestone bands. The upper beds of brown clay contain very many small crystals of selenite, which sometimes constitute one-third of the entire mass. In the lower beds the crystals are rare, but much more regular in form and beautiful in appearance, and also much larger, one specimen measuring about six inches in its major diameter. The fossils observed were bones of *Plesiosaurus*, one vertebra of which weighed ten pounds, spines of several species of *Echini*, *Ostrea carinata* and various other species, *Pentacrinites*, *Belemnites*, *Gryphea*, and *Ammonites Calloviensis*.

Near the village of Flitwick are two cuttings in the Lower Greensand, consisting of white and yellow sands, alternating with bands of ironstone. These beds extend beyond Sandy, in a north-easterly direction, and to Leighton south-westwards. At Silsoe, five miles east from Flitwick, are beds of a brown compact sandstone, which furnish good building material; these are also of Lower Greensand age.

A short distance south from Westoning, the coprolitic bed of the Lower Greensand is exposed,[1] over which is a bed of dark heavy clay (Gault?),[2] which in its turn is capped by a bed of drift sand and gravel. This coprolitic bed is worked in several places in the immediate vicinity for its phosphatic nodules, and furnishes the usual fossils characteristic of this stratum. At Harlington is a cutting in the drift, but not sufficiently deep to disclose the subjacent formation. Between Harlington and Chalton is a cutting in the Totternhoe stone, a local representative of the chalk marl.[3] This occurs in a hill, isolated from the general range of hills that form the north-west escarpment of the Chalk formation. At Chalton is an extensive excavation, upwards of a mile in length, through the range of hills that constitute the watershed of the district. The combes, that have been eroded by the action of the springs that rise at the base of these hills, have many of them great local celebrity on account of their picturesque scenery, and the lovely landscapes that may be seen from the summits of the surrounding hills. The Totternhoe stone is exposed at the north-west end of the cutting at Chalton, where it is hard, compact, rather sandy, and of a light brown colour. The deepest part of the excavation, where it is about seventy feet deep, exposes the Lower Chalk, which is lighter in colour and less compact than the chalk marl, beneath which is a bed of dark clay, containing many pyrites. It is somewhat doubtful whether this bed should be classed with the Gault or Chalk-marl, it has a very strong

[1] See Rev. P. B. Brodie's paper "On the Phosphatic Nodules in the Lower Greensand at Sandy, Bedfordshire."—Geol. Mag. Vol. III., 1866, p. 153.

· See also Mr. J. F. Walker's paper "On a Phosphatic Deposit in the Lower Greensand of Bedfordshire," in the Ann. and Mag. Nat. Hist. 3rd series, vol. 18, November, 1866.—Edit.

[2] Or Boulder-clay?—Edit.

[3] Totternhoe stone is *not* a local representative of the chalk-marl. It is the top bed of chalk-marl through Bucks. and Berkshire; there is eighty feet of chalk-marl below it. See Mr. Whitaker's paper thereon, Quart. Journ. Geol. Soc., vol. xxi. p. 398 (1865).—Edit.

resemblance to the Gault, but is most probably a member of the marl.[1] So far as observed there appears but little difference in the fossil remains of these strata, the chief distinction being the much greater abundance of *Ammonites varians* in the Lower Chalk than in the other beds.[2] One peculiarity respecting the Cephalopods is the total destruction of the shell itself, its place being occupied by a brown ochreous substance, and in most instances, when a specimen is fractured, the internal divisions of the chambers are most beautifully indicated by the same substance. Only one specimen has been discovered with any trace of the shell; this was in the fragment of the outer whorl of a large individual, which, when entire, must have measured sixteen inches in diameter, in this case the outer shell was absent, but the internal separations were preserved. The *Ammonites varians* varies in size from an inch to upwards of a foot in diameter, and the same remark will apply to a species of Nautilus occurring in the same locality. The shells of *Ostrea, Terebratula, Pecten,* etc., have not suffered the decay incident to the Ammonites and their congeners. Most of the Cephalopods are very much compressed and contorted, more particularly the *Ammonites varians,* which sometimes present such anomalous forms as to render it scarcely recognisable. The fossils obtained from this cutting are mentioned in the subjoined list.

At Leagrave is an excavation in the Drift formation, that exhibits a series of alternating sands, gravels with sub-angular flints, and clays, containing rolled fragments of fossils from the Secondary strata. At the south-eastern termination of the cutting a member of the Lower Chalk appears, that has been coloured a light yellow by the percolation of water through the superincumbent bed of clay.

About midway between Leagrave and Luton is another bed of the Lower Chalk. This is hard and compact, with almost a metallic ring when struck with the hammer, and so indurated, that blasting has been necessary in working it. The natural cleavages have a greenish tinge. This bed has, numerically, a great many fossils, but the species are few, the most prevalent forms being *Terebratulæ* and *Inocerami.* At Luton the Lower Chalk is softer than the preceding, and runs along the valley of the Lea as far south as Wheathamstead.

Between Luton and New Mill End is a series of cuttings in the Upper White Chalk. This contains an abundance of flints, in layers at irregular intervals, and also several thin seams of a grey clay, somewhat resembling fuller's earth. These clay bands may be seen at Harpenden, where the roads have been altered for the convenience of the new railway. The fossils from these cuttings are those characteristic of the Chalk-with-flints, of which a list is subjoined. From Harpenden to St. Alban's the Upper Chalk is exposed, capped with drift sands and gravels, and as we approach the latter town

[1] When the Lower Chalk is *full of water* it presents the appearance described here by the author, of a "bed of dark clay;" the Lower Chalk is always rich in iron pyrites.—Edit.

[2] *A. varians* is remarkably abundant in the Totternhoe stone of this part.—Edit.

these accumulations are seen to increase in depth, and contain an abundance of large flints only slightly rolled, as well as dark pebbles obtained from the disintegration of older conglomerates.

The following list of fossils of South Bedfordshire, though incomplete, may furnish a means of comparison with other localities :—

| | | Upper Chalk with flints. | Lower Chalk without flints. | Chalk Marl, & Totternhoe Stone |
|---|---|---|---|---|
| AMORPHOZOA. | | | | |
| | Ventriculites decurrens ... | * | | |
| | „ impressus ... | * | | |
| | Spongia ramosa ........... | * | | * |
| | Cephalites perforatus ...... | * | | |
| | „ capitatus......... | * | | |
| | „ constrictus ...... | * | | |
| | Brachiolites racemosus...... | * | | |
| | „ elegans ......... | * | | |
| ANTHOZOA. | | | | |
| | Monocarya centralis......... | * | | |
| | „ cultrata ......... | * | | * |
| | Spinopora Dixoni ......... | * | | |
| BRYOZOA. | | | | |
| | Petalopora pulchella ...... | * | | |
| | Pustulopora .................. | * | | |
| | Flustra inelegans............ | | | |
| ECHINODERMATA. | | | | |
| | Cidaris clavigera ............ | * | | |
| | „ sceptrifera ......... | * | | * |
| | „ sulcata ............... | * | | * |
| | Cyphosoma Milleri ......... | * | | |
| | „ variolaris ...... | * | | |
| | Echinopsis pusillus ......... | * | | |
| | Discoidea Dixoni............ | * | | |
| | Galerites .................... | * | * | |
| | Ananchytes .................. | * | | |
| | Holaster ..................... | * | | |
| | Micraster .................... | * | | |
| | Bourgueticrinus ............ | * | | |
| | Pentacrinus .................. | * | | |
| ANNULOSA. | | | | |
| | Serpula annulata............ | * | | |
| | „ plexa ............... | * | | * |
| CRUSTACEA. | | | | |
| | (Cast of caudal extremity) .. | | | |
| BRACHIOPODA. | | | | * |
| | Hippurites Mortoni ......... | * | | |
| | Crania striata ............... | * | | |
| | Terebratula bulla............ | * | * | |
| | „ sexradiata ...... | * | | * |
| | „ striatula......... | * | | |
| CONCHIFERA MONOMYARIA. | | | | * |
| | Inoceramus Lamarckii ...... | * | * | |
| | „ involutus ...... | * | * | * |
| | Lima spinosa ............... | * | | |
| | „ granosa ............... | * | | |
| | Pecten jugosus.............. | | | |
| | „ subinterstriatus ... | * | | * |
| | „ Dujardinii ......... | | | * |
| | „ æquicostatus ...... | * | | * |
| | „ quinquecostatus ... | * | | |
| | Spondylus spinosus ......... | * | | * |

| | Upper Chalk with flints. | Lower Chalk without flints. | Chalk Marl & Totternhoe Stone. |
|---|---|---|---|
| CONCHIFERA MONOMYARIA (*continued*). | | | |
| Gryphea globosa | * | | |
| Ostrea, various sp. | * | * | * |
| Dentalium difforme | * | | |
| Hipponyx | * | | |
| Scalaria compacta | | | * |
| Pleurotomaria perspectiva. | * | | * |
| Turbo | | * "Chalk-Rock."[1] | * |
| Aporrhais stenopteris | | | * |
| Belemnites | * | | * |
| Nautilus | | | * |
| Ammonites varians | | | * |
| Ammonites | * | | |
| Turrilites triplicatus | | | * |
| PISCES. | | | |
| Ptychodus mammillaris | * | | |
| " decurrens | * | | |
| " latissimus | * | * | * |
| " polygyrus | * | | |
| Corax falcatus | * | | |
| Saurodon | * | | |
| Enchodus | * | | |
| Otodus appendiculatus | * | | |
| Lamna acuminata | * | * | * |
| Notidanus microdon | | | * |
| Coprolites of Macropoma | | | * |
| EPTILIA. | | | |
| Ichthyosaurus | | | * |

## VI.—THE ANGLO-BELGIAN BASIN.

By the Rev. JOHN GUNN, M.A., F.G.S.

THE principal object of a paper which I read at the British Association was to point out the connection between an ancient river running on the Continent, in the direction of the Rhine, and the estuarine deposit of the Forest bed, on the eastern coast of this country. Many geologists have maintained that such a river ran from south to north, which would be in the direction of the Straits of Dover. In proof of the correctness of this supposition, I mentioned that numerous vertebræ of whales had been found in the estuary, which indicated an opening to the sea, and also arctic shells, which indicated a northerly direction; at the same time that the immigration of elephants and other animals proved the junction of this country with the Continent.

The way over, then, for such animals was on the south side, by the ridge of chalk hills, now severed, between Dover and Calais; and I mentioned that this ridge of hills formed a barrier to the influx of boulders and Boulder-clay in France and the South of England. Professor Ramsay (the President of the Geological Section), while admitting the absence of the Boulder-clay from France, expressed his opinion that it would be found to the south of the Thames. This, probably, is correct, as the chalk hills of the Downs may have served as a barrier to the south of the Thames; and ice-action and striated

[1] See Mr. Whitaker's Paper, Quart. Journn. Geol. Soc., vol. xvii. p. 166.

boulders are to be found to the extreme south-west of Devonshire and elsewhere. I had found a boulder myself near Bovey Tracey, and regarded it as a proof of the extension of northerly drift; but Prof. John Phillips informed me that it came from the neighbourhood of Hay-Tor, and he expressed his opinion that during the Glacial period such ice-action might have been propagated from the heights of Hay-Tor, to which the rounded eminence of that rock bears evidence.

I do not think, therefore, that the discovery of striated boulders and Boulder-clay to the south of the Dover chalk hills at all militates against my theory, namely, that such a ridge of chalk formed a barrier to the spread of Boulder-clay over France, and a way for the elephant, etc., to have migrated into this country.

Such was the main object of my paper. I propose in this, as a sequel, to assign the probable boundaries of land on the north side. Mr. Godwin-Austen, in his valuable article on the "Belgian Tertiaries" (Quart. Journ. Geol. Soc. August, 1866, p. 240), represents the opening between the Atlantic and Arctic Sea, and also Baffin's Bay, to have been closed, while he leaves open the Straits of Dover. I beg most respectfully to differ from him, both with respect to his arrangement and distribution of land and sea on the north and on the south: on the south for reasons already given; and on the north because it is scarcely possible, that with due regard to centrifugal tendency, and the accumulation of ice and sea near the North Pole, the waters could be so permanently and extensively hemmed in. The reflux of accumulated ice and snow seems a necessary consequence of the form and motion of the earth, and therefore I cannot admit the probability of the exclusion of the Arctic Sea from the Atlantic. But it appears to me that there was a considerable extension of land from the coast of Norway to the west, so as to mask this country on the north, and serve as a defence against the flowing of icebergs from the Polar regions; and this extension of land appears to account for the phenomena which present themselves to the geologist from the Triassic to the Glacial epoch.

I cannot resist the conclusion that icebergs charged with boulders would have been borne from arctic to southerly regions; and yet not one instance of a scratched boulder during that enormous period of time has, I believe, been found. This, I humbly submit, must be due to such masking of this country between the North and the Arctic Sea. No such boulders appear to have been imported into Great Britain, and none appear during the level and warm condition of this country, and of Europe generally, to have been propagated within such territories. As the elevation of mountain ranges is seen to be the cause of depression of temperature, so must the normal, or level, state of the earth's surface be of a warmer and more genial temperature; and before we invoke extraordinary causes for the rise of temperature, it would be well if attention were turned to what would be the result of the absence of mountains or of hills, at least above the permanent snow-line, and what would be the accumulating effect of warmth, just as of cold.

The great discovery by Professor Ramsay of signs of glaciation in the highly disturbed Permian epoch, the succession of a warmer period, and then the return to cold in the Glacial epoch, when we know that mountains were elevated to an extraordinary height and extent, appear to me to tell a very consistent story of this part of the history of our earth.

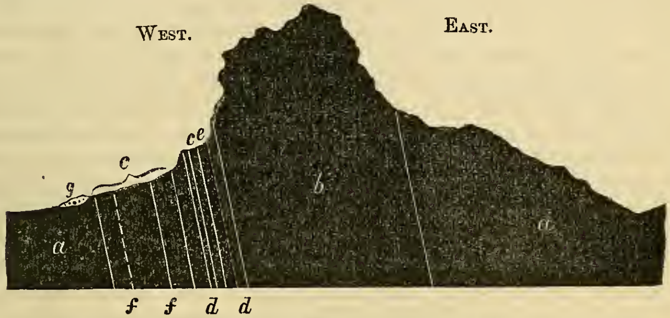
No sooner was the north of Europe, and the land which masked this country, depressed and submerged, than icebergs and field-ice were borne down, and covered parts of this country, of which we see such interesting evidences in the Eastern Counties.

In conclusion, I will add a few remarks on the distribution of Proboscideans, which bear upon the subject. It has been a question whether the *Elephas primigenius* has ever been obtained from the forest bed. Certainly its constant companion, the *Rhinoceros tichorhinus*, has not. The result of my own observation is that an elephant resembling the *Elephas primigenius*, in point of number of the laminæ of the teeth, is found not only in the forest bed, but in the Norwich crag. This has been regarded by Dr. Falconer as a type of *Elephas primigenius*, the true *Elephas primigenius* having been a Post-glacial importation, together with the *Rhinoceros tichorhinus* and the reindeer. They could pass into France and this country, and live there long after some of their race had been entombed in the ice of Siberia. That they migrated from the north of Europe, driven by the cold, which their hairy and woolly coats could not enable them to bear, is, I think, correct. That the *Mastodon Arvernensis*, *Elephas meridionalis*, *E. antiquus*, *E. priscus*, and others, migrated from the south-west with the *Rhinoceros Etruscus*, and that their remains were also carried into the estuarine deposit of the Forest bed by a river flowing in the direction of the Rhine from the south-west, are statements which are based upon long observation and experience.

## NOTICES OF MEMOIRS.

### I.—On Bituminous Strata of Gneiss and Mica Schist in the Province of Wermland (in the West of Sweden). By L. J. Igelström.

In the north-western district of Wermland, M. Igelström has discovered a hill consisting, in its central part, of hyperite, the rest chiefly of common reddish granitoid gneiss. Beneath the central hyperite and above the fundamental gneiss, there is a mass, twenty Swedish fathoms in thickness, consisting of bituminous strata of gneiss and mica schist. The bituminous matter is distributed everywhere throughout the whole mass of these strata, so as to be present even in the smallest fragment and thence giving them a black colour closely resembling gunpowder. When M. Igelström heated some fragments in a retort of iron, there were formed combustible hydro-carbons as gases, to the amount of nine per cent., and a combustible oil, as well as a non-combustible, colourless oil were collected in the receiver of the heating-apparatus. This interesting discovery of bituminous matter in rocks that, perhaps, are to be considered as Laurentian, strengthens the views put forth by so many able authors as to the "non-azoic" nature of these rocks, and it is especially worthy attention that, so far as we are aware, bituminous matter is nowhere else found in such old rocks and in such abundance as to throughly penetrate them and to become an integral part of them. What we did hitherto know was the presence of graphite in the Laurentian rocks.[1]




Section of "Nullaberg" in Wermland.

EXPLANATION OF SECTION.

*a.* Common reddish granitoid gneiss. *b.* Hyperite. *c.* A thick layer of bituminous gneiss and bituminous mica schist together. *d.* Thin strata of bituminous mica schist, from one to one and a half Swedish yard in thickness. *ce.* Fine grained gneiss or mica schist. *f.* Black, thin, bituminous strata with silvery scales of mica. *g.* Drift, gravel, etc.

G. L.

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II.—THE OTOLITES OF FISH. By E. T. HIGGINS, M.R.C.S. Journal of the Linnean Society. Vol. IX. No. 35, January 30, 1867.

THE object of this paper is to show that the otolites of fish have a certain distinctive value in determining the genera and species to which they belong, and that the close study of them in the recent forms will enable the ichthyologist to confirm or disprove the specific relationship of recent individuals, and to determine the affinity of the fossil species.

The author gives a description of the auditory apparatus in fish, comparing it with that of other members of the animal kingdom. The otolites of osseous fish may be said to be three in number on each side, as the exceptions to the rule are very rare; of these three, however, but one—the central or largest—is of scientific interest, the other two in the majority of fish being so small as to be with difficulty found, and, when found, to be of very little use for the purpose of identification. The author states that although he has examined many thousands of fossil otolites he has not yet met with a single specimen that could be referred to either of these smaller bones.

Mr. Higgins does not agree that the shape of the groove on the under surface of the central otolite is absolutely necessary for the

[1] See GEOL. MAG., Vol. I, page 202. Dr. J. Bigsby, On the Laurentian Formation.

identification of a species, as has been asserted; he admits that there is a very great difference in its shape amongst genera, but in closely allied species it is so similar as to be almost identical, and not to be depended upon. In his opinion, identity of outline is the only certain character; in by far the largest number of fossil otolites the convex under surface is more or less bouldered, and consequently the shape of the groove altered, so that, were this essential for identification, but few species could be recognised. The concavity of the upper surface being better preserved, the task is rendered comparatively easy, and but little skill is necessary in dividing them into species. The author remarks that in all fishes differing from one another to that degree as to entitle them to rank as distinct species, he has found the otolites in each case to be distinct and well marked. This, he adds, is perhaps more than can be said of either teeth or scales, and it is a generalization of the highest interest in connexion with palæontological researches, as otolites are often met with in Tertiary deposits, when no other vestige of the fish to which they belonged has been preserved.

## REVIEWS.

I.—On the Physical Geography and Geology of the County of Leicester. By D. T. Ansted, M.A., F.R.S., &c. (Nichols and Sons).

THOUGH a large part of the county of Leicester presents nothing very striking either in its geology or physical features, the north-western portion offers a fine field to all interested in geological studies. It is valuable as showing within a very small area a remarkable variety of rocks, while both in the pure and the applied branches of the science, there are some knotty problems yet unsolved.

The district has naturally had a fair amount of attention already paid to it. In the "Annals of Philosophy" for Jan. 1824, is a paper by Messrs. W. Phillips and S. L. Kent, on the mineralogy of the crystalline rocks of Charnwood Forest, and the rocks of Enderby and Croft are noticed by the Rev. T. Yates (vol. ii. 2nd series, Trans. Geol. Soc., p. 263). In 1836, Mr. Mammatt published his "Collection of Geological Facts intended to elucidate the formation of the Ashby Coal-field." This, as the title points out, was intended mainly as a record of observed facts; but the clear way in which these are stated, and the few generalizations attempted to be drawn from them, shew the author to have been no common man, and, considering the state of the science at the time of publication, are deserving of the highest praise. In 1842, Mr. Jukes published in Potter's History of Charnwood Forest, an account of the geology of that district and its immediate neighbourhood. This little tract has always seemed to us a model of clear geological description, and is unmistakeably the result of painstaking labour in the field, and not a mere compilation from books. The author of the work now before us has thought fit to make some disparaging remarks on its description of the crystalline rocks, and on this head no doubt Mr. Jukes would now modify the views he then held; but, in 1842, it is not unlikely that Professor Ansted would have agreed with him. In 1860, the Geological Survey of Great Britain issued a Memoir by Mr. Hull, on the Leicestershire Coal-Field, in which Charnwood Forest came in for rather a scanty notice; but it must be recollected that the memoir professed only to deal with the country included in sheets 71 S.W., and 63 N.W., of the Survey Map,[1] and that at least half the Forest lies outside the limits thus assigned, a fact that should certainly have been *noticed* by the author.

Lastly, in 1862, a short notice of the rocks of Charnwood Forest, by Professor Ramsay, was published in the third edition of the Descriptive Catalogue of the Rock Specimens in the Museum of Practical Geology in Jermyn-street. In the same year, the late Mr. Coleman, who had devoted some years as an amateur to the subject, drew up for White's Directory a short, but most lucid and comprehensive account of the geology of the county. Of this Professor Ansted has largely availed himself, not without, however, indulging in a somewhat severe, and, as we think, mistaken criticism on some passages in it.

Good service would then be rendered by any one, who, after a study of these materials, followed by careful work in the field, should draw up a monograph on the geology of the county, full enough to be a guide to the beginner, and pointing out to the experienced worker the difficulties still wanting solution. We cannot say that the book before us at all supplies this want. The author has certainly availed himself largely of the labour of his forerunners, and often with scant acknowledgement; but we find little trace of independent investigation in the field, nor can we see much that is new in the book, unless it be a statement that the author is the first who has asserted the metamorphic origin of the crystalline rocks of Charnwood Forest, which statement we believe to be perfectly new, and shall now shew to be unfounded.

After quoting some passages from the works of Mr. Jukes and Mr. Coleman, Professor Ansted proceeds thus :—"That the rocks of Charnwood Forest, *hitherto described as igneous*, are strictly metamorphic; that the syenitic and porphyritic rocks there exhibited really alternate with the slates, and are strictly contemporaneous; that the whole series therefore is nothing more than a series of altered stratified rocks, with few intrusive or trappean rocks, is a suggestion that may startle the geological reader, as it seems to contradict, in a matter hitherto regarded as beyond question, *all the opinions of those geologists who have hitherto described the country*"[2] (p. 11).

In this passage Prof. Ansted claims to be the first to have put forward the view that the rocks in question are metamorphic. We

[1] Whether such a restriction, attempting to tie down geological description by artificial limits be the best method or not, is not here the question; the regulation exists, and the author, as an officer of the Survey, must comply with it.

[2] The italics in this passage are our own.

have said before that there is little else in the book that can be looked upon as original, and therefore we are anxious to test the value of this claim. Now on p. 8 of Mr. Coleman's pamphlet, we find the following:—"The general character of the rock, in this quarter, is such as to convey, irresistibly, the impression that it is nothing else but the clay slate itself, heated to the melting point, and then crystallized by cooling. . . . It would seem that a series of beds of clay, more or less pure, resembling the binds and pot-clays of the Coal-measures, were first consolidated into slates, and then subjected, *in situ*, to intense heat under pressure." Again, in the catalogue of Rock Specimens, Prof. Ramsay says (p. 19 and 21), "Between Grace Dieu Wood and Charley Wood, there is a tract of country. . . . some part of which seems, in ordinary terms, to be igneous; . . . other parts show every degree of gradation, from a common, unaltered, slaty character, to rocks that seem to be, in hand specimens, igneous; but, on a large scale on the ground, shew traces of stratification, and other signs, proving them to be of sedimentary origin, but so much altered that they have been partly, and, in some cases, entirely fused, and thus pass into so-called igneous rocks of the deep-seated kind. . . . The following specimens are arranged so as to show something like a passage from greenstones, and porphyritic greenstones, into syenites. These are well crystallized, and are, in ordinary terms, intrusive igneous rocks; but from the foregoing remarks it may be surmised that they also are probably only stratified rocks, which have been so thoroughly melted that all traces of original structure has disappeared."

These extracts speak for themselves. Prof. Ansted may not have seen the latter, but he has made so large a use of Mr. Coleman's pamphlet, that we should have scarcely supposed him unacquainted with the former. Though this does not look well, we might, perhaps, be disposed to make excuses for the author, if he had made good use of his own materials, and those which seem to have come from previously published sources. But he cannot be said to have done even this much. In proof take his section No. 4. It looks like the faint general sketch, which a cautious observer offers, of a country hastily, and for the first time, crossed, and no one would for a moment imagine that it ran through a largely worked coal-field. We are indeed told that the "dips are not indicated with any approach to correctness," but this rather superfluous statement is not a sufficient excuse, in a country where the dip and lie of the beds are perfectly well-known. Had the author taken the trouble to consult Section No. 2, Sheet 52, of the Horizontal Sections of the Geological Survey of Great Britain, the dips might have been inserted with that amount of correctness which is derived from a study of actual workings; and he cannot plead ignorance of this section, for it is, we cannot quite say copied, but "conveyed," in an inferior style of drawing, in Section No. 3 of his work. We may also notice, that Nos. 8, 9, 10, of Prof. Ansted's sections, are closely *adapted*, without acknowledgment, from the woodcuts on pp. 35, 45, 54, of Mr. Hull's memoir.

We have now discharged a very disagreeable duty, in pointing out what seem to us grave errors in this work, and have left but little room for further remarks. We may notice, however, that the account of the Physical Geography of the county is fairly executed, and we are not without hope that the book may be useful to the beginner, by pointing out what he is to expect to meet with in the district described, and what spots are best worth a visit. More than this he must not look for, but must take the field, and touch, taste and handle for himseif if he wants thoroughly to be master of his subject.

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## II.—On the Geology of the Island of Bombay.

By A. B. Wynne, F.G.S., etc., Geological Survey of India.

THIS paper forms a part of the fifth volume of the Memoirs of the Geological Survey of India, a series of publications containing many valuable and interesting papers on those portions of India which have been investigated during the progress of the Geological Survey, under the able direction of Professor Oldham. The island of Bombay has been carefully surveyed by Mr. Wynne, who, after alluding to the researches of previous observers, to whom he does full justice, has now given a detailed description of the arrangement of the rocks of Bombay Island. He shows that the geological structure of the island is closely allied to that of the neighbouring coast, and other portions of Western India, although it presents local differences. The physical features of the island are intimately connected with its geology, as modified by denudation; the form of the ground, and elongate shape of the island, depend on two main ridges or chains of hills consisting of igneous (trappean) rocks, separated by alluvium and other superficial deposits, which form a central plain. The longer and more gentle slopes of the ridges are to the west, and the steeper sides to the east, coinciding in a general way with the planes of stratification, which have a more or less westerly dip. The whole island presents an ascending series of stratified trappean and aqueous rocks, commencing with the black basaltic rock of Seoree on the east, succeeded by the traps and shales of the eastern hills, which are overlain again by the shaly beds seen on both sides of the flats, and terminated by the basaltic beds of Malabar ridge and Warlee. The rocks present many varieties, some resembling Greenstone Melaphyre, Felstone, others different forms of trap, both silicious, compact, white, and amygdaloidal, volcanic breccia, and also various kinds of ferruginous and flaky ash, and the intertrappean shales, sandstones, and flags, derived apparently from the mechanical disintegration of trappean rocks.

The shale series contains remains of reptiles, amphibians, insects, mollusca, with leaves, stems, and seeds of plants, suggesting their freshwater origin, but these deposits have been traced only a short way beyond Bombay Island, from which Mr. Wynne infers that trappean flows approaching from opposite sides left shallow basins, which became repositories of mud and sand, the results of the disintegration of trap, washed down by rain during long intervals, between the eruptions of the trappean materials; intervals in which the muddy basins became the receptacles of many forms of organic existence, and then subsequent trappean flows overran and covered up these lacustrine deposits, long afterwards to be exposed again by denudation, nearly as we see them now. The author has paid special attention to the relations between the form of the ground, and its geological structure, and to the effects of denudation, elevation, and depression, in modifying the surface features, thus rendering the Memoir a practical and useful contribution to geology.

J. M.

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III.—A Sketch of the Geology of Fife and the Lothians. By Charles Maclaren, F.R.S.E., etc. Second Edition. Edinburgh, 1866. pp. 320.

IN 1839, when this work was originally published, the Science of Geology had, at least in the Scottish metropolis, a very different direction from what it has now. The value of fossils was unknown. Their importance had already dawned on students in England and France, but in Edinburgh the lithological aspect of the science engrossed the chief, almost the whole interest; and arguments in defence of the particular theories of the observer, were the great lessons that were learned in the field. Mr. Maclaren's work belongs to those happily bygone days. It abounds with accurate descriptions of the rocks of the district, accompanied with sections and diagrams of the more interesting phenomena, so careful and characteristic that it has been for many years an invaluable hand-book to the student of local geology. Mr. Maclaren knew only two kinds of fossils from the Silurians of the Pentlands; fragments of Trilobites and Orthoceratites; but he was the first to notice that they existed there at all. Since 1839 Edinburgh students have not been idle. Papers and volumes have been published by Fleming, Miller, Chambers, Bryson, Geikie, Howell, and others. The nature and relation of the rocks, and the character of the organisms contained in them, are now well known—even the very language of the science is changed. It is strange to take up this volume with the date of 1866 on its title page, and find oneself carried back a quarter of a century, and immersed in discussions long since exploded, without a ray of light from subsequent observers. Even Mr. Maclaren's own later views, published at intervals in the *Scotsman*, are overlooked. There are sufficient verbal changes throughout the volume to make it not a simple reprint of the first edition. But it does not express the views now entertained, regarding the structure of the district—nor, indeed, the views entertained, for many years before his death, by its venerable author. It is greatly to be regretted that Mr. Maclaren was advised to bring out his volume in this form. To those who know anything of the history of this volume, and who remember that its talented author was considerably over eighty years of age when he was induced to republish it, it will not affect the high position which Mr. Maclaren's contributions to science won for him; but the general reader, who only knows that in 1866 these views were published by the author as abreast with the science of the time, will of necessity do him a great injustice. The volume was out of print, and could not be had for love or money. A reprint was wanted—a verbatim reprint of the first edition would have been valued by every one, when it was impossible from age and health for the author to undertake a thoroughly revised edition. Our love and great respect for Charles Maclaren, who, though he had had a rough life, battling for political freedom, was the very impersonification of mildness and gentleness, and who, as we knew him within the last ten years, was to our mind, in appearance, in manners, and in conversation, a model philosopher; our love and respect for him have compelled us thus strongly to condemn the way in which this work has been reproduced, which, however well meant, will we fear do injury to the fame of its distinguished author.

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### IV.—The General Glaciation of Ireland.

By the Rev. Maxwell H. Close.

[Read before the Royal Geological Society of Ireland, March 14, 1866.]

THIS pamphlet contains a very elaborate explanation, partly founded on personal observation, of the primary glaciation of Ireland by means of a general ice-crust, or ice-flow, with occasional remarks on secondary glaciation by "district glaciers." The author may be said to have done for Ireland what Mr. Jamieson has done for Scotland. While referring the main form of the ground to marine denudation, he attributes to ice the smoothing, furrowing, and ridging of the sister Isle, both by denudation and accumulation. He clearly shows the distinction between what are locally called "drumlins" and "eskers," the former consisting of straight and parallel ridges of gravel, with blunted and scratched blocks, whereas the latter are irregular as regards direction, and are composed of water-sorted materials. The pamphlet is well worth a careful perusal.

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## REPORTS AND PROCEEDINGS.

Geological Society of London.—I. February 20, 1867.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair.—1. "On the British Fossil Oxen."—Part II. *Bos longifrons*, Owen. By W. Boyd Dawkins, Esq., M.A. (Oxon.), F.G.S.

The author analyzed the characteristics usually assigned to *Bos longifrons*, and concluded that there were none of specific value to separate it from the smaller varieties of *Bos Taurus*. The large series of skulls in the Dublin and Oxford Museums show that *Bos frontosus* of Nilsson is a mere variation from the more usual type. Professor Owen, on the faith of its occurrence on the Essex shore, along with the remains of extinct animals also washed up by the waves, ascribes to this species a Pleistocene age. This inference, on a rigid examination of the premises, turns out to be faulty, and there is no evidence anywhere in Europe that it co-existed with any of the extinct mammals, the Irish elk being excepted. It is very commonly associated with the remains of man, of a date anterior to the Saxon invasion. It was kept in great herds during the Roman occupation, and supplied the Legionaries with beef. On the Continent, as in Britain, it is found around the dwellings and in the tombs of the Bronze and Stone folk. Nowhere is there evidence of its having a higher antiquity than the Neolithic age of Sir John Lubbock. It disappeared along with its Keltic masters before the Saxon invaders from the more fertile portions of Britain, and took refuge in the Highlands of Scotland and Wales, where it still survives in the smaller domestic races. In no case has it been found in association with Saxon remains. The inferences to be drawn about it are, first, that it has not yet been *proved* to have existed before the Pre-historic age; and second, that it is the ancestor of the small Highland and Welsh breeds. It is essentially the animal with which the Archæologists have to deal, and its only claim for insertion in Geological catalogues is the fact of its occurrence in the most modern of all the stratified deposits.

2. "On the Geology of the Upper Part of the Valley of the Teign, Devonshire." By G. Wareing Ormerod, Esq., M.A., F.G.S.

The district noticed in this paper lies to the north of Bovey Tracey. The author describes the courses of the Teign and its feeders, and the strata traversed by those streams, namely, Granite and Carboniferous Limestone. Gravels are occasionally found, which the author regarded as having been deposited before the re-excavation of the valley, and he showed that these had been transported by a current from north-west to south-east. From the absence of these gravels in the gorge of the Carboniferous rocks between Hunts Tor, near Chagford, and Clifford Bridge, he considered that that valley had been opened since the time when the boulders and gravels were deposited, and then showed that the stream from the valley of the Teign, prior to the opening of that valley, would have passed by Moreton Hampstead to Bovey Tracey. The paper contained notices of the Minerals found in the district, and of the Granite veins in the Carboniferous rocks.

3. "Notes on the geological features of Mauritius." By George Clark, Esq., Communicated by the Assistant-Secretary.

Mr. Clark describes the occurrence of a calcareous formation of at least 30 feet in thickness, with a dip of about 30°, composing many of the islets, supported by the coral reefs of the Mauritius, which have been generally regarded as forming an integral part of the islets, but which the author considered to be of greater antiquity. A soft sandstone was stated to cover in many places the calcareous rock, and to contain imbedded remains of roots, and bases of trunks of trees.

The following specimens were exhibited by C. Carter Blake, Esq., F.G.S.:—Horn-cores of Oxen (*Bos trochoceros*, *B. primigenius*, and *B. frontosus*) from a Kjökenmödding at London Wall, found by Colonel Lane Fox, F.S.A.

Geological Society of London.—II. March 6, 1867.—Warington

W. Smyth, Esq., M.A., F.R.S., President, in the chair.—The following communications were read:—

1. "On ancient sea-marks on the coast of Sweden." By the Rt. Hon. the Earl of Selkirk, F.R.S., F.G.S.

This paper contained a detailed description of some observations made in the month of July, 1866, upon certain marks placed so as to show the level of the sea on the coast of Sweden, (seen by Sir Charles Lyell thirty-two years ago,) and which were supposed to indicate a gradual and equable rise of the land of about three feet in a century. Two of these marks were off the harbour of Gefle, and one on the Island of Gräsö, off Öregrund, on the east coast of Sweden; the rest were on the west coast, a little to the north of Göteberg.

The conclusion arrived at was that these marks do not afford any very certain proof of such rise of the land; the fluctuation of the level of the water being so great that any difference of the level of the land in thirty-two years is lost in comparison with the daily and weekly changes, owing to shifts of wind and other causes affecting the *water*, not the land. The marks off Gefle gave most indication of a change of level; but there were various elements of uncertainty connected with them.

2. "On a Post-Tertiary Lignite, or Peat-Bed, in the district of Kintyre, Argyllshire." By His Grace the Duke of Argyll, K.T., D.C.L., F.R.S., F.G.S.

A section of the bed appeared in a bank cut through by a small stream near the village of Southend. The bank appears to belong to the "Old Coast Line," which is so well-marked a feature around most parts of the west coast of Scotland. The Peat at the point described is 3 feet 9 inches thick; above it is a bed of fine clay, from 13 to 14 inches thick, containing hazel-nuts, followed by a bed of fine yellow sand 4 feet thick, which is succeeded by a bed of coarse gravel, with small boulders of the thickness of 14 feet.

About 400 yards further up the stream there is a bed of fine black-blue clay with Mussel-shells.

These beds appear to furnish evidence of some five or six different changes of level. (1) The Peat-bed has been depressed under shallow and very muddy water, depositing the bed of fine clay; (2) a further depression has subjected this mud to an inroad of the sea, bringing with it the sand which overlies the clay; (3) a further depression, or possibly a partial elevation, exposing the same surface to some strong current or littoral action, has brought down upon it the bed of coarse gravel; (4) all these beds have been consolidated and re-elevated above the sea; (5) another depression has enabled the sea to erode the valley of which the "Old Coast Line" forms the boundary, and in which this section is exposed. A long period seems to have followed, during which this Old Coast Line formed the Coast of Scotland, and during that period the upper Mussel-bed seems to have been deposited; (6) a final elevation of the land has determined the present coast-line, and left the old one as it now appears—subsequently modified by atmospheric action, and cut through by streams. All these changes have occurred during what, geologically, must be called the existing period, as the vegetable remains in the Peat, and in the Clay, seem to be all referable to existing species.

The following specimens were exhibited:

1. The Duke of Argyll exhibited a fossil in a rolled pebble, found near Inverary. It is the first trace of an organism which had yet been discovered in any part of the Mica-Slate series of the interior of Argyllshire. All the transported matter of the district appeared to belong to the surrounding hills. This pebble agreed in lithological character with some beds in the neighbourhood. The fossil, though a fragment, was beautifully distinct, and had been pronounced by palæontologists to belong to the Silurian Fauna. So far, therefore, the discovery of this fossil seemed to confirm Sir Roderick Murchison's determination of the geological horizon of the Argyllshire Mica-slates and Quartzites.

2. Bones of the Dodo, from Mauritius; exhibited by S. Flower, Esq.

Edinburgh Geological Society.—The second ordinary meeting of this Society for the winter session was held on Thursday evening, the 20th December, in 5, St. Andrew Square, Mr. David Page, F.R.S.E., F.G.S., President, in the chair. The following communications were then made to the Society:—

1. "On the Occurrence of a Submerged Forest at West Hartlepool, and its Relation to Similar Phenomena along the Eastern Shores of the British Islands," by the President, who exhibited specimens of the peat which he had found at Hartlepool, containing wing-cases of beetles, etc.

2. Mr. James Haswell, M.A., exhibited and described a very extensive and valuable collection of Carboniferous fossils, chiefly from the coal-fields of Lanarkshire, belonging to Mr. Hunter, which were generally admired.

3. "On the Occurrence of Fossils in the Old Red Sandstones of Westmoreland," by Mr. Henry A. Nicholson, B. Sc.—The author gave a brief description of the characters of the Old Red Sandstone of Cumberland and Westmoreland. The series here was shown to be composed of conglomerates, sandstones, and sandy shales, and Mr. Nicholson had recently discovered two beds containing well-preserved plant remains. The entire formation, as developed in the North of England, had until now been believed to be devoid of organic remains: and it was pointed out that the character of these fossils would lead to the conclusion that the Old Red of Westmoreland and Cumberland was of the age of the Upper Old Red Sandstone, a determination which previously rested on stratigraphical evidence alone. The plant remains consisted of fluted stems allied probably to *Knorria*, stems apparently referable to *Filicites linearis*, and ferns of the genera *Sphenopteris* and *Pecopteris*.

4. Notice of the genus *Slimonia*, recently discovered in the

Silurian beds of the Pentland Hills, by Mr. John Henderson, who also exhibited the well-preserved fragments which he had found of this interesting crustacean.

The third ordinary meeting of this Society was held in the Lecture Hall of the Museum of Science and Art. There was a numerous attendance. Mr. M. Lothian occupied the chair.

The Chairman introduced Mr. Archibald Geikie, F.R.S., F.G.S., who proceeded to deliver a lecture upon "Geological Time."

Mr. Geikie spoke of the geological evidence of the earth's antiquity under three heads:—1, Inorganic evidence; 2, Organic evidence; and 3, The bearing of astronomical and physical data upon the question. Under the first of these divisions he noticed the fact that the whole surface of the earth, from the mountain-top to the sea-shore, was slowly changing and undergoing a process of waste. The process of waste, however, was so slow as scarcely to be appreciable in a man's lifetime. Besides these changes, there was the action of icebergs and glaciers, which acted mechanically in grinding down the rocks to sand and mud. The lecturer illustrated this portion of his lecture by reference to well-drawn pictures of the glacier-fields of Norway, and remarked that in every Scottish glen they found that the rocks had been ground down in the same way as they were being planed away in Norway, and how vast must have been the time taken in the process. Representations of sandstone rocks standing upon the Laurentian gneiss in Sutherland and Ross-shires were pointed to as illustrating the gradual manner in which the former had been worn, and proving that there had not been any sudden convulsion or cataclysm in producing the geologic changes alluded to. Coming to the organic evidence of the changes, the lecturer referred to the occurrence of a Germanic Flora in this country as a proof that the temperature was much more moderate in this country now than it had been in former eras. Plants that formerly bloomed in our valleys had now become alpine in their character, and were only to be found on the tops of the hills. In regard to the Fauna, shells that had lived during the Glacial period were still to be found in our seas, and only a few species had become extinct. As the plants had become inhabitants of hill tops, so these shells of a former age had become denizens of the deeper parts of the sea. All these changes had been effected since the Glacial period, and when they knew, as they did, the length of time that had elapsed since then, how long must have been the time since the plants and animals of former periods were extintinguished! In regard to the bearing of astronomical and physical data upon the question, Mr. Geikie remarked that the geological record afforded no data for computing the length of its periods in years. If, however, it contained traces of any great cosmical event it might be possible to arrive at the date of such an event, for the astronomical periods were not like those of geology, but could be computed in years. It had long been the belief of many geologists that if any actual data of this kind were to be found, it must be by the labours of the astronomer rather than of the geologist. An attempt had recently been made by Mr. James Croll, of Glasgow, to connect in this way the two sciences, and his papers deserved careful study.

Taking the Glacial period as his starting point, Mr. Croll proposes to explain the recurrence of cold periods in the earth's history, by the combination of the precession of the equinoxes, with the slow secular variations in the eccentricity of the earth's orbit. Reasoning upon this, he demonstrated that the nearest period to which the glacial period could be assigned was about 800,000 years ago. Comparatively speaking, the change produced on the earth's crust in that time had been very small indeed, and as most of the shells living then were living still, how enormous must have been the time required to extinguish the numerous extinct races.

As geologists, we are apt to err, rather by underrating than by overrating the value of time in the past history of the globe. In all such questions as the history of life upon the globe, and the antiquity of living species, including, of course, man, the element of time plays so important a part that it must be made itself a subject of study if these questions are to be intelligently discussed.

In conclusion, Mr. Geikie remarked that, as to the charge or insinuation that we use our scientific researches as a cloak for undermining the religious faith of the country, he took too much notice of it when he repelled it with indignant scorn.

Geological Society of Glasgow.—The monthly meeting of this Society was held on Thursday evening, the 7th February, in Anderson's University,—the Rev. Henry W. Crosskey, Vice-President, in the chair.

The Chairman delivered an address on the scientific labours of the late President of the Society, James Smith, Esq., of Jordanhill.—(See Obituary Notice, Geol. Mag., March).

Professor Young, F.G.S., felt certain of the concurrence of the meeting in the suggestion that Mr. Crosskey's eloquent address should form part of the records of the Society. Critical biographies of men who had opened up, or led the way in, new fields of inquiry are always valuable as contributions to the history of science.

Mr. James Dairon exhibited some specimens of Graptolites, obtained from the Lower Silurian Shales at Dobb's Linn, near Moffat. The series embraced upwards of fifteen species belonging to the genera *Graptolithus, Diplograpsus, Didymograpsus,* and *Rastrites.*

Mr. John Young exhibited a number of specimens of fossil leaves from the Tertiary beds of Ardtun-head, in the Island of Mull, obtained last autumn by Mr. Loudon F. M'Lean, a student in Glasgow University. The leaves exhibited belonged chiefly to the Plane, Buckthorn, and Laurel, some of the species of which are either extinct or do not now exist in these latitudes.

Professor Young exhibited a fragment of a jaw (from the Airdrie black-band), containing several teeth with doubly trenchant margins, like those of *Rhizodus*; but the backward curvature and feeble plication at the base lent probability to the conjecture that they belonged to a Labyrinthodont, additional specimens of which might perhaps be found in the collections of members of the Society,

Mr. J. Wallace Young read a paper, entitled "Notes on the Ballagan Series of Rocks." This was a supplement to his previous paper (see Geol. Mag. March, p. 132). He described the lithological character of the beds; and after quoting several analyses of the limestones and shales, the author went on to say that we could not explain the formation of these dolomites upon the supposition that they were originally limestone, and subsequently changed. From their somewhat nodular structure and impure character, it rather appeared as if they had proceeded from the segregation of a dolomitic mud, so to speak. At all events, it is quite evident that the conversion, if such was required, must have taken place at, and not subsequent to, their deposition..—J. A.

North Staffordshire Naturalists' Field-club.—Stoke Athenæum, 11th of December, 1866, R. Garner, Esq., F.L.S., in the chair. Mr. W. Molyneux, F.G.S., of Burton, read a paper "On the Gravel Beds of Trentham Park."

The gravel beds of Trentham Park belong to the division of the New Red Sandstone formation, known as Bunter conglomerates, or pebble beds, which in this particular locality attain a thickness of about 300 feet. The entire division includes three distinct groups of strata, consisting, firstly, of red and variegated sandstones and marls; secondly, of the pebble-beds or conglomerates in question; and thirdly, of soft red mottled sandstones, with marly interstratifications. Upon these latter rests the Lower White Sandstone of the Keuper series.

The beds exposed in the section opened up on the west flank of the Trentham Park hill are about eighty feet in thickness, and maintain a uniform inclination due west, at an angle of four inches in twelve. The upper portion consists of gravel, which is followed by irregular beds of red and white sandstone, with intersections of gravel more or less coarse, and reposing upon a thick mass of yellow-white sandstone dotted with pebbles. On the east flank of the hill these pebble beds are shown to pass downwards into soft red variegated sandstones, which here, as at Normacott, overlie marls and sandstones of the Permian age. The total thickness of the conglomerates at this point is about 150 feet. The pebbles of which they are composed consist of a most astonishing variety of quartzites passing in colour from pure white down to black. With these are intermixed fragments of rocks derived from the Silurian, Mountain Limestone, Yoredale, and Millstone-grit formations, but in no instance have any of later age been detected.

The fossils of these beds are of a remarkably interesting class, and as stated, belong almost exclusively to the fauna characteristic of the Silurian and Lower Carboniferous Rocks. The former fossils are nearly all of the May Hill Sandstone group, which form the base of the Silurians, and consist of 14 genera and 20 species. Of these *Pentamerus oblongus* and *Pentamerus lens* are the rarest, and *Atrypa hemispherica* the most plentiful. The Mountain Limestone fossils are represented by 15 genera and 27 species: making a total from the two formations of 29 genera and 47 species.

I have, as the readiest means of giving the necessary information, prepared the following list of these fossils, as determined by Mr. Salter, F.G.S., who writes to me, "It is extraordinary that there should be only Corals, Crinoids, and Brachiopods—no Cephalopoda, no Gasteropoda, except *Dentalium.* Such collections show the variable character in particular localities, even of such a homogeneous deposit as the Carboniferous Limestone:"—

MAY HILL SANDSTONE.

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 præacutus.
Halysites catenulatus.
Petraia subduplicata.
——— var. crenulata.
Phacops Weaveri
Tentaculites Anglicus.

MOUNTAIN LIMESTONE.

Poteriocrinus 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.
Producta semireticulata.
Producta concinna.
——— mesoloba?
Streptorhyncus crenistria, 2 var.
Spirifer triangularis.
——— bisulcatus.
——— octoplicatus.
——— glaber?
Chonetes variolata.
——— Hardrensis.
Dentalium ingens.

In what direction from this point are the parent rocks situated which furnished these pebbles and fossils, and in what manner were they transported from thence to the position they now occupy? An examination of geological maps of the British Isles leads to the conclusion that the original source of these beds was north and west of the point in question, and probably in a large tract of country now forming part of the bed of the North Sea and Atlantic Ocean,

These bunter beds have themselves at various times been subjected to considerable denudation. They enter largely into the composition of the water-worn stones of the Keuper series, and also contribute more than any other formation to the gravels of the Trent Valley. Originally they must have covered an area of many thousand square miles, and even now, after enduring successive periods of submergence and abrasion, they contribute in no slight or uninteresting degree to the picturesque character of our inland scenery.—*Staffordshire Advertiser.*

BATH NATURAL HISTORY AND ANTIQUARIAN CLUBS.—At a meeting held in January, Mr. R. E. Crickitt read a paper on "The Hot

Springs of Bath and elsewhere." Referring particularly to the Bath waters, Mr. Crickitt adduced reasons from their solid contents to show that the supply must be looked for in strata not deeper than the Carboniferous Limestone; and came to the conclusion that these springs must be referred to the so-called "Golden valley," near Bitton, about five miles north-west of Bath. This valley trends about north-east, and contains an area of nearly eighteen square miles, which would therefore give an ample supply. In reference to their heat—after combating the theory of a general central heat accounting for all hot springs—he stated that the gaseous contents might be expected to furnish a clue to this point. To prove this, he stated, in the first place, that, contrary to the usually received explanation, the large quantity of nitrogen in the water was not the residue of the gas derived from the air in the meteoric water, but was the effect of a chemical decomposition of ammonia derived from decaying vegetable matter. He then endeavoured to show that these waters traversed the Coal-measures, and that coming in contact with coal a union was formed between carburetted hydrogen evolved by the coal and the oxygen free in the water, causing heat; that also there were evidences that the coal itself was undergoing a slow decomposition, also accompanied with heat; and that these causes combined would account for the moderate and steady warmth of the Bath springs; in fact, that the heat was a symptom of molecular motion occurring beneath the earth's surface.

Mr. Charles Moore, F.G.S., in refutation of this theory, considered that the area referred to by Mr. Crickitt was too limited to admit of such a constant and steady flow of hot water. Moreover, that the extensive north and south faults which existed between Bath and Bitton would prevent the supply of water reaching Bath from such a source. He was of opinion, therefore, that the source of the Bath hot waters was very much deeper than Mr. Crickitt supposed.

H. H. W.

Montreal Natural History Society.—At a meeting of this body held on Nov. 26th, 1866, the President, Dr. T. Sterry Hunt, F.R.S., F.G.S., made a communication *on the Mineralogy of crystalline limestones,* with special reference to those of Laurentian age in Canada. A sketch was given of the geographical range of this formation in Canada, and in parts of the United States, and it was stated that its equivalents had been recognised by foreign geologists in Scotland, Scandinavia and Bavaria. Among its most prevalent rocks in Canada are coarse-grained granite like gneiss, quartzites, dolomites, etc., and crystalline limestones. Some of these limestones are fine-grained and pure; others again are coarse, and contain foreign minerals, such as silicates of lime and magnesia, etc.

Two specimens were exhibited, one containing pyroxene and apatite, the other serpentine in a matrix of crystalline carbonate of lime. It was stated that these grains of foreign minerals were rounded, but still crystalline, and not amorphous. Even where they occur in cavities the crystals are rounded. By some geologists it was thought that this rounding of the crystals was caused by fusion, but the lecturer remarked that it was often the most infusible of minerals that had their angles rounded. These crystals of foreign minerals belong to veins. A portion of a vein was exhibited containing, first, a layer of apatite, then one of quartz, then a coating of white calcspar, and lastly, a layer of sulphate of barytes. Another showed a layer of orthoclase, then one of pyroxene, and lastly, one of graphite. Some geologists have thought that these crystalline limestones have an eruptive origin, analogous to trap; but the beds, the lecturer stated, are distinctly stratified. Crystalline limestones are either indigenous, that is, are formed in situ, or they are endogenous, *i.e.*, have been formed by crystallization in veins. A rounded crystal of apatite, from a cavity, was exhibited.

It was stated that springs containing mineral matter in solution sometimes are affected by great chemical changes, and that, perhaps, in this way the same waters which produce crystals, under altered chemical conditions, have, in some cases, the power of wholly or partly re-dissolving them, and rounding their angles. Crystals of apatite and quartz, supposed to have been thus rounded, were exhibited. The crystals of felspar were said to be indissoluble, and as further examples, crystals of spinel, oriental ruby, brown tourmaline and of pyroxene, from the crystalline limestones were shown, presenting sharp and unrounded angles.

In the indigenous rocks, also, that is in the main body of the limestones, many of the foreign crystals are rounded, but not as in the vein stones.

Attention was then called to the discovery of organic life in these ancient rocks, and a description was given of the *Eozoön.* It was shown that the chambers of the shell of this species became filled with serpentine or pyroxene, the crystals of which have thus acquired a rounded form. It was stated, also, that Dr. Gümbel, who has studied closely the Laurentian rocks of Bavaria, had determined that many other rounded crystals of foreign origin in crystalline limestones are due to organic agency.

Principal Dawson moved a vote of thanks to the lecturer, and in doing so took occasion to defend the genuineness of the discovery of organic life in Laurentian rocks, and stated the doubts entertained by some Irish naturalists, as to the organic nature of Eozoön, were entirely due to a misconception on their part, and that what they had taken for Eozoön was mineral matter.

## CORRESPONDENCE.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—In the February number of your Magazine, Mr. D. Forbes, in an article entitled "On the alleged hydrothermal origin of certain granites and metamorphic rocks," has made two recently published papers of mine the subject of some remarks. "The appearance of these memoirs," he says, "apparently representing in some measure the views entertained by the Geological Survey of Great Britain, decided the writer in at once protesting, etc." It is as well to assure Mr. D. Forbes and your readers that the Geological Survey is no way to be identified with opinions expressed in "extra-official" communications; for these the writers themselves are alone responsible.

If I do not misunderstand Mr. D. Forbes, his opinion seems to be that a profound knowledge of chemistry and mineralogy is necessary to the geologist who would attempt the investigation of metamorphic phenomena; that, in short, if he be neither a practised chemist nor mineralogist, his purely geological observations go for little or nothing. Every one, indeed, is aware that the subject of metamorphism has for many years occupied the attention of able chemists and mineralogists; and it is never denied that without their aid the geologist cannot hope to do much towards clearing away the many difficulties by which the subject is surrounded. It is not doubted that the question of metamorphism is one which can only be settled by the zealous co-operation of the various sciences involved. But if it be true that these sciences are all equally concerned in this matter, then it follows that there must be different kinds of evidence, viz., chemical, mineralogical, and geological evidence; and three classes of investigators,—chemists, mineralogists, and geologists. It is quite possible, indeed, that an individual observer may combine in himself a fair knowledge of the three sciences, but highly improbable that he shall be equally good as a chemist, mineralogist, and geologist. One of the three studies is sure to exert a preponderating influence upon his mind, so as in some measure to prevent absolute impartiality in his investigations. According as his bent is chemical, mineralogical, or geological, he will prefer a particular line of evidence. It is vain to hope for an "admirable Crichton," who shall be at once a profound chemist, mineralogist, and geologist, with a mind so equally balanced that he shall be able to accord to each kind of evidence its proper place and value. All that we can expect is, that each labourer, be he chemist or geologist, shall honestly state his convictions as deduced from data, for the study of which he has had a special training. Cases of metamorphism, which the unassisted geologist never could have discovered for himself, have been detected by chemists and mineralogists. On the other hand, it is no less true that the metamorphic origin of certain rocks is capable of being proved by evidence purely geological. Nor can it be denied that there are instances where both the work of the laboratory and the labours of the field observer are equally necessary before the metamorphic origin of some rocks can be decided upon. If eminent chemists and mineralogists, who are sometimes "not much at home" in geology, have, nevertheless, contributed largely to our knowledge of metamorphic phenomena, it can scarcely be presumption if a geologist believes that he, too, although confessedly not versed in chemistry, may yet be able to see something of the subject, by viewing it from his own peculiar stand-point. The geological evidence in favour of metamorphism is quite as deserving of study by the geologist, as the chemical evidence is by the chemist. Mr. D. Forbes admits, indeed, that the geologist has something to say in the matter; but subsequently observes, in reference to certain geological evidence bearing upon the origin of some granites, that chemical analyses "may not improbably entirely annihilate" it. If geological proofs and evidence are thus liable to be "entirely annihilated," it is difficult to see why, in such investigations, chemists and mineralogists should be bored with the company of their hammer-bearing brethren.[1]

I have looked over my paper on the Carrick metamorphic rocks, and must own that I have been careless and unguarded in the use of chemical phraseology. Thus I admit that I have frequently spoken of magnesia, of lime, and of alkaline matter, when I ought to have stated that what I referred to was the magnesia of highly magnesian minerals, and the lime of the carbonate of lime. I was quite aware that the green tinge so characteristic of many of the rocks within the area described was not due to the presence of the oxide of magnesium, but to that of certain minerals which contain a large percentage of magnesia. Notwithstanding Mr. D. Forbes' opinion, that "from the style of this memoir (but for its errors), it might have been written by a chemist," I believe an impartial reader will acknowledge that my arguments are based chiefly on geological data, which in their very nature cannot be "annihilated" by future chemical analysis. My references to the chemistry of the subject are very meagre, as I had to content myself with the usual tests employed by field-geologists, and certainly never dreamed that any one should think that I based "my entire conclusions on chemistry."

Mr. D. Forbes imputes to me the opinion that "granite, diorite, serpentine, porphyrite," etc., may be derived from one and the same bed of greywacké. There is nothing in the memoirs to warrant this; but I have distinctly stated my belief, and have brought forward evidence in support of it, that present differences of composition among metamorphic rocks point to original differences in the composition of the strata. Certainly I am not alone in this belief, nor can I agree with my critic that it is "a waste of time, thought, and energy," to place such a view "before a rational public."[2] The greywackés familiar to Scottish geologists do not "consist essentially of seventy-five per cent. of quartz," nor have they any definite composition whatever. The term "greywacké," as used by Scottish geologists, is applied exclusively to the hardened felspathic, and sometimes argillaceous sandstones of the Silurian regions, in which, although quartz is freqently present, it is yet by no means a necessarily preponderating ingredient. They vary in texture from fine-grained, almost compact, rocks, to pebbly conglomerates.

[1] Some interesting remarks on the value of chemical analyses of rocks will be found in Cotta's "Rocks classified and described" (1866) p. 79.

[2] Similar opinions, based upon long-continued study of the chemistry of the subject, have been placed "before a rational public," by, among others, Delesse, and Sterry Hunt.

It seems that "the petrologist may throw up his hands in despair when he finds Mr. James Geikie describing minette as a quartzless granite." As the pages of this Magazine are probably sometimes scanned by readers who may not be quite familiar with the term *minette,* but to whom the composition of granite must be well known, I could think of no shorter or more apt description of minette than that given, and cannot see how it is likely to mislead anyone. No one would dream of labelling a museum specimen of minette as quartzless granite, nor of ranging it under the granites in a system of classification.

My critic further finds fault with my use of the term *dioritic,* and then proceeds to teach how the petrologist defines diorite and greenstone. In my remark that "under the term *dioritic* are included all those rocks which consist essentially of silicates of lime and magnesia set in a felspathic base or matrix," I referred only to the rocks alluded to in my paper as characteristic of the district described, viz., the diorites, hyperites, etc.; nor can I imagine how I should have been understood to mean more. The closely allied nature of hornblende, hypersthene, and diallage seemed to warrant me in using *dioritic* as a convenient general term for the rocks in which those minerals make their appearance.[1]

From the tone of Mr. Forbes' remarks one might gather that the terminology of petrology was as fixed as that of the exact sciences. Scarcely two petrologists, however, can be found to agree in their definitions of many rocks. "The petrologist," we are told, "regards greenstone as that variety of diorite in which green or dark coloured hornblende either predominates, or, when the rock is fine-grained, renders more obscure the presence of the felspar." Now the term *greenstone* has long been employed by writers on Scottish geology as a generic and not a specific term. Hence we read of *hornblendic* as distinguished from *augitic greenstones*.[2] As it is sometimes impossible to tell in the field whether a rock is to be classed as a diorite or dolerite, the use of *greenstone* as a generic term has proved of some utility.[3]

It appears to be "difficult for a petrologist to understand what a

[1] Cotta includes hyperite, diorite, diallage-rock, and some other allied rocks in his Greenstone group.

[2] The term *augitic greenstone* is not, however, confined to the pages of writers on Scottish geology; Cotta has the same expression. [See "Rocks classified and described," p. 146.] He describes the "greenstones" as "compounds of some species of felspar with pyroxene, or hornblende, as essential ingredients, etc.:" among the species of greenstone *augite-porphyry* is mentioned. In Professor Phillips's "Manual" we find mention made of *augitic greenstone* (augite and felspar) as distinguished from *greenstone* (hornblende and felspar); and Sir C. Lyell, while he defines greenstone to be a compound of felspar and hornblende, yet takes care to state that "the name has usually been extended to all granular mixtures, whether of hornblende and felspar, or of augite and felspar." (Elements of Geol., p. 594).

[3] J'emploie le terme de grünstein pour les roches trappéenes cristallisées verdâtres, que je n'ai pas examinées, et qui ont été décrites sous ce nom, et pour celles que j'ai bien observées en place, mais dont je n'ai conservé aucun échantillon pour pouvoir constater à présent si ce sont des dólérites ou des diabases." Boué, *Essai Géologique sur l'Écosse,* 1820, p. 135.

*granitoid* diorite may be, especially since he is immediately informed that 'it is simply an admixture of hornblende with white and pink felspar.'" For the meaning of granitoid, reference may be made to the glossaries of geological terms. In Mr. Page's handbook it is said to be applied to "such rocks as have the granular-crystalline aspect of granite * * without being so in reality." The expression *granitoid hornblendic greenstone*, however ridiculous it might appear to "the petrologist," ought to be intelligible to anyone acquainted with the literature of geology.

Mr. Forbes observes that "trap is an extremely vague name to designate rocks by." I have never designated any particular rock by the name of trap, but have used the term in a general way as applied to that great series of igneous rocks which includes many dolerites, melaphyres, basalts, diorites, etc.

Again, my critic remarks that I have laid "great stress upon the circumstance that, as instead of being flattened and drawn out, the vesicles found occurring in the rocks are spherical, and are so over considerable areas, the rocks therefore cannot be trappean or igneous." This is an overstatement of what is said. I merely observe that "these appearances, along with other considerations, threw doubt upon the igneous character of the rocks under review." Had this been all the evidence to be gathered it is not likely that I should have regarded it in any other light than as a somewhat anomalous fact, as I had never seen nor heard of so wide an area of amygdaloid destitute of flattened cavities.[1]

It is absurd to say that the development from aqueous strata of certain crystalline rocks (as granite, syenite, hyperite, diallage-rock, and diorite) is a notion supported only by my own assertion. Even those geologists who hold most strenuously by the igneous and eruptive character of all granite must admit with Cotta that the proofs of such an origin are sometimes wanting, and that "there are many circumstances that point to a contrary assumption in certain districts."[2] Bischoff has brought forward a vast accummulation of chemical data to show that many of the rocks held by geologists to be of igneous origin may, nevertheless, be due to processes of metamorphism.[3] Prof. Keilhau,

[1] No one has of late years done more towards the explanation of metamorphic phenomena than the well-known chemist and mineralogist attached to the Geological Survey of Canada. Dr. Sterry Hunt is of opinion "that heated alkaline waters have produced the alteration of sediments," and "that, except in local and comparatively rare cases, the process has only taken place in sediments so deeply buried as to be directly affected by the internal heat of the earth." Whether we agree with him or not in his conclusions as to the causes of metamorphism, those among us who may still cling to the notion that all crystalline rocks which cannot be classed among the gneisses and schists must be of igneous origin, will do well to study the details furnished in the "Reports" of the Canadian Survey. We there find rocks described as metamorphic which at one time would certainly have been coloured upon a geological map as igneous; for they frequently present appearances (as, for instance, *an amygdaloidal structure*) which are commonly believed to be characteristic of igneous rocks only. See Geology of Canada (1863), pp. 603, 607.

[2] Rocks Classified and Described, p. 388.

[3] It is instructive to find this eminent chemist thus endeavouring to "prove" the formation in the wet way of certain crystalline rocks which geologists on the other hand are frequently (not always) well assured must be of igneous and eruptive origin.

so long ago as 1836, described[1] the crystalline rocks of the neighbourhood of Christiania; and after detailing the various appearances presented by the granite, syenite, porphyry without quartz, amygdaloid and basaltic rocks, eurite-porphyry, greenstones (diorites and aphanites), and rhombic porphyry, came to the conclusion that all these rocks were the result of metamorphic action. The metamorphic rocks of Canada, which have been so ably investigated by Sir W. Logan and his associates, abound in serpentines, diorites, hyperites, euphotides, and granites, which, as Dr. Sterry Hunt observes, "have by most geologists been regarded as rocks of igneous origin, whereas they appear to be for the greater part undoubtedly altered sedimentary layers or masses."[2] Professor Ramsay has likewise adduced[3] striking evidence of the metamorphic origin of the Cambrian quartz-porphyry of Llanllyfni, and the granite of Anglesey. Similar references might be multiplied, but I will only cite one more. Dr. Dana classes[4] under the metamorphic rocks granite, syenite, hyperite, diallage-rock, diorite, pyroxenite, etc., etc. His definition of metamorphic rocks is—"they are made from the sedimentary rocks by some crystallizing process." He adds "they are sometimes called *plutonic*, to distinguish them from the true igneous rocks." It is strange that Mr. D. Forbes, during his "careful examination of the literature of the subject," should have overlooked the expressed opinions of so noted a mineralogist and geologist as Professor Dana.

Mr. Forbes objects strongly[5] to my remark that "we must beware of assuming an igneous character merely from the appearance of veins ramifying from crystalline into granular non-igneous beds. This may in general be an excellent test of eruptive origin, but it certainly cannot always prove that the main mass, from which the veins appear to have come, has been forcibly thrust into its present position." If we are to take the sending-out of veins as an invariable test of igneous action, then we must believe that serpentine is an intrusive rock, all other evidence to the contrary notwithstanding.

[1] See his memoir in the first number of the "Nyt Magazin for Naturvidenskaberne," a translation of which (with notes by Professor Jameson) will be found in the "Edinburgh Philosophical Magazine," Vol. xxiv., p. 387.

[2] Geology of Canada, p. 586. The Canadian geologists also describe certain granites which they consider to be eruptive, designating them as *intrusive granites*, in contradistinction to those having a metamorphic origin, which are termed *indigenous granites*.

[3] Geology of North, Wales Mem. of Geol. Survey, vol. iii., pp. 140 et seq; 190 et seq. After describing certain phenomena exhibited in the neighbourhood of the quartz-porphyry, Professor Ramsay remarks that he can only account for these appearances by the supposition that the beds associated with the quartz-porphyry have, as it were, been partly *eaten into* by heat, and themselves converted into porphyry. He comes to similar conclusions in regard to the granite of Anglesey.

[4] Manual of Geology, p. 74, et seq.

[5] My critic represents me as refusing any longer to accept the definition of eruptive or intrusive rocks which geologists have been accustomed to give, viz., that they "are such rocks as are met with apparently breaking through, protruding into, or sending out ramifications, dykes, or veins, into the adjacent stratified deposits." Now all that can be inferred from what I have said is, that some of these appearances are simulated by metamorphic rocks, and in this I believe "most geologists will concur with" me.

Some gneiss will be equally well proved to be of igneous origin;[1] nay, even masses of crystalline limestone must frequently be classed as igneous rock.

It is needless, however, that I should follow Mr. Forbes into all the minute criticism which he has thought proper to bestow upon my papers. He remarks that "the crystallographer will be rather puzzled" with my somewhat careless expression, *porphyritic felspar crystals;* if so, it will not argue much for the crystallographer's penetration.

The writer concludes his remarks by disclaiming "any feeling of personality against a gentleman whom he has never even seen." Surely in a discussion of this kind, such a disclaimer ought to be quite unnecessary. Personalities are here utterly out of place, and I would, with deference, submit that personal details are equally so. Is it not beside the question altogether, that a gentleman so well known as Mr. Forbes should tell his readers that he "does not speak upon the strength of an acquaintance with this subject of a few months or years, but for more than twenty years has continuously occupied himself in a special and minute study of the crystalline and metamorphic rocks;" that he should assure us that he has examined these rocks "in the field over a great part of Europe, North and South America, Polynesia, part of Africa, etc., with all requisite appliances at his command, and without having neglected the study of chemistry and mineralogy;" that besides pressing upon us the fact of his being a qualified chemist, mineralogist, and petrologist, he should be at the trouble to point out that he knows how to handle the microscope, and that he has gathered together "above 900 sections of crystalline and metamorphic rocks from about 480 localities, in different parts of the world;" that, in addition to all this, we should be informed that he is well acquainted with "the English, French, German, Spanish, Italian, Swedish, and Danish languages?" Surely the many memoirs and articles contributed by Mr. D. Forbes to British and foreign scientific publications ought to testify enough to his rare opportunities for observation, and be sufficient guarantee of his accomplishments.

I am, Sir, faithfully yours,

JAS. GEIKIE.

EDINBURGH, *February* 20*th*, 1867.

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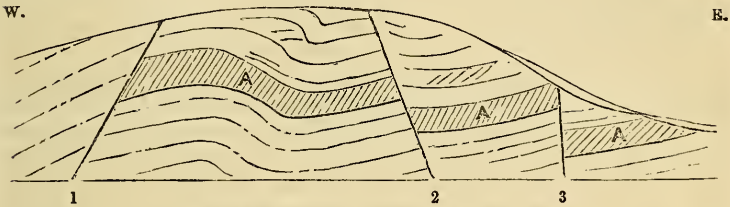
## FAULTS IN DRIFT.

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR.—As the subject of faults in the Drift has been before your readers for some time past, I venture to send you a sketch, taken a few months since at Rochdale, in Lancashire, during the progress of excavations for the new Town Hall. Though personally inclined to be incredulous regarding the occurrence of faults in these deposits, knowing how subject they are to sundry irregularities of

[1] I am well aware that some geologists are fully persuaded of the igneous and eruptive character of certain gneissic rocks.

stratification, yet, I confess, the clearness of the bedding, and the sharpness of the fissures convinced me that in this instance there had been several vertical displacements. The following is the section:—




FAULTS IN DRIFT SAND AT ROCHDALE.

The height of the section is about fifty-five feet; the length two hundred feet. The throw of No. 1 is down to the west; No. 2 down to the east ten feet; No. 3 down to the east twelve feet The beds between Nos. 1 and 2 are much contorted.

The whole section is composed of fine white or yellow sand, with occasional layers of gravel, and contains in the centre a well marked band of loamy sand (A. A. A.), which shows exactly the amount of displacement. Three faults are shown. The amount of throw in two of these is twelve feet and ten feet respectively; that of the third being uncertain. The sand is the middle member of the Drift series according to my classification, lying between the upper and lower tills, or Boulder-clays, neither of which are shown in this section.

As to the origin of these apparent faults I do not venture an opinion. It cannot be owing to mining operations, as the position is beyond the out-crop of the *Arley Mine*; besides this the amount of the slip is much greater than would be caused by the ground giving way in consequence of the extraction of a seam of coal less than five feet in thickness. On the other hand, it must not be forgotten that very considerable vertical elevations of the solid strata have occurred in the interior of the country since the Drift Period, amounting to at least 2,000 feet, and it is not improbable that old fissures may have been re-opened, or even new ones made in the older formations, which would pass upward into the overlying drift-beds.

I am, etc.,

EDWARD HULL.

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## ON THE PARALLELISM OF THE DRIFT DEPOSITS IN LANCASHIRE AND THE EASTERN COUNTIES.

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR.—I hope you will not think it highly objectionable if I address you twice in the same month; but while I have my pen freshly steeped in Drift, allow me to draw attention to the remarkable similarity of the Drift-series in the Eastern Counties as indicated by Mr. S. V. Wood jun., and that in Lancashire and Cheshire, described by myself in a paper "On the Drift Deposits in the neighbourhood of Manchester."[1] That this similarity may be made more apparent I here place the two series in juxta-position.

DRIFT DEPOSITS OF THE NORTH-WESTERN AND EASTERN COUNTIES.

| *N. W. Counties.* | *Eastern Counties.* |
|---|---|
| 3. Upper Boulder-clay, or Till. | 3. Upper Drift (Boulder-clay). |
| 2. Middle sand and gravel. | 2. Middle Drift (sand and gravel). |
| 1. Lower Boulder-clay, or Till. | 1. Lower Drift (Boulder-clay). |

I see that Mr. Maw, in the March number of the GEOLOGICAL MAGAZINE, endeavours to show that the above is not the true order in time of the Lower and Upper Boulder-clays in the Eastern Counties; but he allows that the evidence is not conclusive, as the true relations of the coast Boulder-clay (1) and the high-level Boulder-clay (3) have not been laid open to inspection; but from his own account I should conclude that the evidence is in favour of Mr. Wood's classification, as he says, "there are very many instances of the coast Boulder-clay being capped with gravel, and of the Boulder-clay of the high ground being super-imposed on a subjacent gravel bed; it must be admitted that these gravel beds correspond in height, and in many cases present the appearance of continuity, but proof of their identity seems to be wanting." I should say from the above, that if the *proof* is wanting, the *evidence* is very strong.

Any evidence which shows the sequence in the Drift deposits on the opposite sides of England to be similar is of such value, and is so great a stride towards simplifying our knowledge of the quaternary beds, that I, for one, sincerely hope Mr. Wood's classification will ultimately be established beyond the possibility of a doubt; and as regards the succession in Lancashire and Cheshire given above, more extended investigations made since my paper was written, have confirmed me in the belief that it is a real and widely-extended sequence of deposits of the Glacial period.

I am, etc.,

EDWARD HULL.

## THE ORIGIN OF ESCARPMENTS.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—May I beg the insertion of a few observations upon a letter by Mr. Mackintosh which appears in your MAGAZINE for March.

It will be remembered that Mr. Mackintosh, in the interesting articles which first invited discussion in your pages, repeatedly declared his belief in the marine origin of escarpments, and as frequently referred to "terraces," etc., thereon which were thought to support his views. Bearing this in mind, I was a little surprised to find the following admission in his letter of last month. "These longitudinal valleys and basins, which are *not open plains*, and which often occur in what *must once have been land-locked situations*, appear the more mysterious the more frequently they are contemplated." I think Mr. Mackintosh must admit that marine action would be wholly unable to erode continuous lines of cliffs in "land-locked

[1] Mem. Lit. and Phil. Soc. of Manchester, vol. ii. third series, 1863–4.

situations," or indeed along the borders of any submerged areas "not open plains."

I find no mention of ordinary marine action in this part of Mr. Mackintosh's letter, other than the supposition that "transverse gorges" may have been finished by "marine currents." Such transverse valleys it is admitted "may have been partly excavated by streams flowing down *once* continuous slopes." Rain and frost are rejected by Mr. Mackintosh as sufficient agents for the denudation of the valley systems referred to; but, he adds, "It must have been a *wholesale denudation*, and not a denudation by instalments. Large bodies of water in the shape of marine currents, or "waves of translation," caused by sudden elevations, ought not, I think, to be rejected as a cause, until their inadequacy has been clearly shown."

I think, Sir, your readers will have perused the foregoing assertion with no little surprise, remembering that Mr. Mackintosh originally commenced this discussion as an avowed advocate of Sir Charles Lyell's theory, that escarpments are old sea-cliffs, formed by *ordinary* coast action. Now, it should not be forgotten that both Sir Charles Lyell, in advocating marine action, and the "subaërialists," in advocating atmospheric-action to account for the origin of escarpments, alike appeal to *causes now in action*, the effects of which are known. This is the chief lesson which the works of Sir Charles Lyell have taught geologists, and subaërialists in urging "rain and rivers" as denuding agents are consistently following out his philosophy. But when ideas are introduced wholly unknown to modern science, such as "large bodies of water," "waves of translation," etc., the discussion is at once carried back to geological controversy, as it existed before the publication of the "Principles of Geology." I think the sentence quoted above should read thus, and I am sure Sir Charles Lyell would fully agree with my rendering—"Large bodies of water in the shape of marine currents, or 'waves of translation,' (however produced), ought not to be admitted as a cause, until their adequacy, (or, at least, their possibility,) has been clearly shown."

Upon Mr. Mackintosh's further suggestion that, in the event of such diluvial action being found untenable, "equally great bodies of moving ice" may prove satisfactory, I need say nothing. It apparently belongs to the same cataclysmic class of agencies as the former. The claims of *Ice*, in a moderate and reasonable form, have already been advocated in your pages by the Rev. O. Fisher (Nov. 1866); and if Mr. Fisher is prepared to show that Glacial action in comparatively modern (geological) times, has been universal over the globe, as we *know* escarpments to be, the idea might be worthy of consideration, as indicating a probably important agent in modifying, if not in originating, escarpments. But it is unwise to accept agencies of limited applicability to explain universally occurring phenomena, when we have agencies *everywhere* active, and which are believed, *given sufficient time*, to be equal to the work performed.

In a footnote at p. 137, Mr. Mackintosh refers to a paper by me on

East Yorkshire, which appeared in the GEOLOGICAL MAGAZINE for October, 1866. A comparison was there made between escarpments and modern sea cliffs, and I remarked "on the Yorkshire coast, we pass in the *same line of cliffs*, from Lias in the north, through all the Oolitic series in succession, to Chalk in the south. Such is never the case with an inland escarpment. This presents the same set of beds throughout the entire length." This I believe to be true of all the Secondary escarpments of England, as it is known to be true of all sea-cliffs whatever. But Mr. Mackintosh observes, "this theory is not applicable to many parts of the south-west of England and other districts, where the sea, in making cliffs, shows a tendency to follow the strike, and where many inland cliffs run obliquely to the strike. Numerous instances might be brought forward, did space permit." Now it is not enough to show that any line of cliffs has "a *tendency* to follow the strike," though this would be an interesting fact. Cliffs might even for a short distance *coincide* with the strike, as in some part of their course they probably would do; but can Mr. Mackintosh give a single instance of a *long line* of modern sea-cliffs following the strike, and being at all comparable to what we all know as escarpments? Does not a simple inspection of any geological map, show that *different* formations are intersected by the sea *along the same line of cliffs;* and that "the sea, where we now see it at work, pays no regard to dip and strike?"

Mr. Mackintosh's second objection, that, in the south-west of England, "many inland cliffs run obliquely to the strike," is more difficult to meet. We all understand what is meant by the term "a sea-cliff," but we are by no means agreed upon the definition of "an escarpment." The subaërialists, I presume, limit the term to such lines of hills as, more or less constantly, run along the strike, and whose steepest sides, the "scarp," faces the dip: in this sense I believe the term is generally used by geologists. The Chalk, Greensand, and various Oolitic "escarpments" of east and central England are of this character. If, therefore, any hills were proved to run obliquely to the strike, such would probably not be called escarpments. It is quite possible that of such hills some may be true inland sea-cliffs, in which case marine deposits will probably be found at their bases. It would be interesting to have examples of some of the numerous instances to which Mr. Mackintosh refers.

At present I think the point at issue may be simply stated thus—Can the advocates of the marine theory produce any undoubted traces of marine action, along the many hundred miles of inland cliffs we all call "escarpments," or any undoubted marine deposits, *not* Glacial drift, at their bases? Or, on the other hand, can they produce a single instance where the sea is now forming a long continuous line of cliffs having any analogy to such escarpments?

W. TOPLEY.

GEOLOGICAL SURVEY OFFICE, JERMYN ST.,
*March 9th*, 1867.

## GRAPTOLITES.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—In my short note in the February number of your Journal I recorded some observations I had made relative to the affinities of Graptolites with recent animals. Will you permit me to make one or two remarks on Mr. Nicholson's reply to some of those observations in your last number.

Your correspondent objects to my saying that he had only one specimen showing the mode of connection which he figures. I am yet unable to make his original statement mean anything else, and his subsequent explanation shows that this interpretation is correct, for he says he has in fact three specimens, "and in the two, which I did not figure, the position of the mucro could not be made out!" That is only one specimen which showed the relation as he figures it. But he has other evidence. He has found pustules or pits on his *Didymograpsus anceps*. Does he not see that if these have any connection with the capsules they entirely destroy his position, as they indicate a connection by a small point and not by a wide mouth? Even Mr. Nicholson then must allow that we yet want evidence of the connection between the 'capsules' and the graptolite.

I am sorry if I have hurt your correspondent's feelings in supposing that he could fall into an error so gross as not to recognize specimens of *Siphonotreta micula;* but he will find, if he will again turn to my note, that I never imagined this, but only stated that my powers of observation led me to think that his drawing was not at all unlike that minute brachiopod. And though I do not yet doubt his powers, I am afraid that, until I have further evidence than his drawing and description, I must believe in his possession of capsules so preserved simply on his *ipse dixit.*

I regret that I inserted in the proof from memory the name *Diplograpsus Whitfieldii* instead of *D. marcidus*, which is Hall's synonym for my *D. tricornis*. Your correspondent may, however, advantageously add to his knowledge of *D. Whitfieldii*, Hall, by examining Hall's figure (Palæontology of New York, iii. p. 516), where he will find that it has more than one mucronate radicle.

In regard to the spines of *D. pristis*, Mr. Nicholson may, perhaps, some day discover that his *D. quadri-mucronatus* is very different from Hall's species, and not very different from *D. pristis*, His.; but into this and other critical remarks, which his paper in your last number suggests, I will not now enter, as I hope to have a more fitting opportunity before long when I perform my long-entertained plan of describing the Dumfriesshire Graptolites.

WM. CARRUTHERS.

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## RECENT EARTHQUAKES.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—It may be interesting to some of your readers to notice the following shocks of earthquakes that have occurred during the last three months:—

1st. A shock at Valparaiso, noticed in the "Illustrated London News," for January 5th.

2nd. The great earthquake at Algeria, on the 2nd inst., through which the villages of Chiffa el Affran, El Ain Ben Rasmi, and Mouzaïaville were almost destroyed, and the town of Blidah greatly damaged. At Mouzaïaville 37 people were killed and 100 injured, and other mischief done.

3rd. A second shock in Algeria on the 4th January.

4th. A prolonged shock, experienced at San Salvador.

5th. An earthquake causing loss of life and property, and destroying Lixuri, at Cephalonia, on the 5th of February. This shock was also felt at Zante and Patras.

6th. Two shocks felt at Malta, during a calm, on the 4th February.

Yours, etc., L. C. Casartelli.

The Crescent, Salford,
*February* 18, 1867.

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## FISH IN THE DEVONIAN (NOT OLD RED) ROCKS.

Mr. Pengelly has the pleasure to inform Mr. Salter, in reply to the queries contained in his letter which appeared in the Geological Magazine for March last (p. 134), that the information he desires has already been published in the Reports of the British Association for 1862, Trans. Sec., p. 85; in the Geologist, vol. v. p. 456; and in the Trans. Roy. Geol. Soc. of Cornwall, vol. vii. p. 441. The specimen (which consists of a single scale of *Phyllolepis*) is in Mr. Pengelly's private collection.

It was seen and examined by the late Dr. S. P. Woodward, and by Professor Owen, and identified by Mr. W. Davies as the *Phillolepis concentricus*, of Agassiz, with the figure of which species it agrees well.

The fossil was found by Mr. Alfred Pengelly in the gritty slate, at the foot of the cliff, between Meaford beach and Hope's Nose, Torbay.

Mr. William Pengelly was present, and assisted his son in extracting it from the matrix.

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## LITHODOMOUS PERFORATIONS IN LIMESTONE CLIFFS.

With reference to Mr. D. Mackintosh's letter on Denudation,—which appeared in the Geological Magazine for March, 1867, pp. 136–139,—Mr. Pengelly calls attention to the fact of his having read a paper in Sept. 1864, "On Changes of Relative level of Land and Sea in South-Eastern Devonshire, in connexion with the antiquity of man" (which under the title of "Early Man in Devonshire," was printed, nearly in full, in the "Reader" of Nov. 19, 1864).

Mr. Mackintosh's earliest paper on Denudation appeared in the Geological Magazine, Vol. II. April, 1865, p. 154, and therefore subsequent to Mr. Pengelly's communication.

Mr. Pengelly has no doubt the perforations mentioned by him in his paper (quoted above), to which Mr. Mackintosh refers in his letter, were drilled by marine mollusks; but he has not ventured to refer them to any species of *Pholas*.

[The Editor has had the pleasure, on three occasions, to see and examine Mr. Pengelly's interesting rock-specimens, exhibiting Molluscan borings, and he has no hesitation in referring them to *Pholas*, as they agree perfectly with specimens in the late Dr. Woodward's cabinet, which still contain the valves of *Pholas* within the cavity.]

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[We are requested by Mr. Mackintosh to correct his letter in our last No. as follows:—Page 137, line 16, for "planes," read plains—line 30 for "These," read Those; page 138, line 1 (in notes) for "these," read those—line 4 (in notes) delete "which"—line 16 (in notes) for "dualogical" reasoning, read analogical reasoning.]

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## AGE AND POSITION OF THE DRIFT DEPOSITS OF THE EASTERN COUNTIES.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—You will, perhaps, allow me to explain, and correct, an opinion which Mr. Maw, in his paper in the last number of the Magazine, has attributed to me.

He quotes (page 99) my expression that the Chillesford beds are evidently part of the Middle Drift; but he seems to have overlooked a qualification of that opinion which I subsequently made. When the remarks which Mr. Maw quotes were written, I had traced the Till and Contorted Drifts of the Cromer coast (*a* and *b* of Mr. Maw's fig. 1), from the Weybourne extremity of the coast section into a marl, which passed inland under the Middle Drift (or bed D of the figure), until I found it thin out against the Chalk, before the Crag district was reached. Hence, as the Middle Drift was a capping bed common to these beds, the Crag, and the Chillesford clay, alike, I was induced from the appearance of the latter at Chillesford, Sudbourn, and Orford, to regard them as belonging to the lower part of the Middle Drift formation. Subsequently to this, however, I succeeded in tracing the beds of the Cromer coast from the other, or Hasboro', extremity of the coast section (which I had previously only traced under the Middle Drift sands as far as North Walsham) completely over the Chillesford clays, and the Fluvio-marine Crag of Norwich.

In doing so, I availed myself of the labours of Mr. Harmer, of Norwich, who systematically worked out and mapped a considerable area on the east and north of that city. This gentleman found that the Green Clay worked for bricks, into which the Cromer beds pass from Hasboro', by North Walsham, to the Bure Valley, had an extensive spread beneath the Middle Drift on the north of Norwich; and with it passed under the Upper Drift, at Trowse and Arminghall, on the south of the city. This green clay in the Bure Valley is underlaid by a sand containing pebble beds, which, at Coltishall and Wroxham, yields a small proportion of the shells of the Fluvio-marine and Red Crags, and of the Chillesford bed. Mr. Harmer and myself found this green clay to pass over the Crag, a pit of it occurring on the hill above the Thorpe pit, and close to it.

On examining the Crag pit of Thorpe more closely, I found the pebbly sands of the Bure valley to cap the pit section, resting upon the attenuated Chillesford clay. Mr. Harmer had detected a bed of blue clay, about twelve feet thick, interstratified with sand bands, over a considerable area on the south-east of Norwich, which was quite distinct from the before-mentioned green clay. This I at once recognized as the Chillesford clay, and found it to be present in the Crag pits of Brundall, Bramerton, and Thorpe, attenuating in the latter to half its usual thickness; the Chillesford *shell-bed* occurring in all three, in its usual place in the sands beneath the clay. The exposure of (so-called) Crag at Toftmonks, in the Waveney valley, made known by Mr. Rose, I recognized also as the Chillesford clay and shell-bed; and was thus enabled, by an almost continuous line of sections, to trace these clays from Norwich, where they pass under the Bure Valley beds and green clay, to Easton cliff, from which they are admitted to extend to Chillesford.

On analysing with my father the fauna (as far as known), we found the sequence of the four formations to be in the following ascending order, viz:—1, Fluvio marine Crag; 2. Chillesford bed; 3. Bure valley beds; 4. Weybourne sand (or so-called Norwich Crag of the coast); which precisely agreed with their position, deduced by me from the sections as above explained. I was then satisfied that I had been misled by the apparent transition from the Chillesford clay to the Middle Drift, which the sections around Orford, Sudbourn, and Chillesford seemed to indicate; and I took the opportunity of a note to the structural diagram of the beds from the Red Crag upwards, which I gave in my father's paper on the Red Crag (Quarterly Journal of the Geological Society, Vol. xxii., page 552), to correct this error; and I had hoped in a manner sufficiently intelligible.

The green clay, before mentioned, changes southwards from Norwich, first into a red loam—in which form it comes up beneath the Middle and Upper Drift, at the base of the Coast Section, between Yarmouth and Lowestoft, and at Pakefield Cliff; and then into red sand, in which form it is present over the pebbly Bure valley sands on the top of the Covehithe and Easton Cliffs, and comes up beneath the Middle Drift in the lower part of Dunwich Cliffs. About this part also the Bure Valley beds lose their pebbles; and thus all the beds between the Chillesford clay and the Upper Drift, becoming, as they approach Orford, Sudbourn, and Chillesford, simple sand, the illusory appearance of this part of the area is produced.

I take the opportunity of demurring to the altitude of any glacial, or post-glacial, bed, being regarded as a test of its age, except where two beds occur in close contiguity to form a terrace; and then no further than as a test *inter se.* I hardly think that Mr. Maw is aware that the clay, of which he speaks as occupying heights from 150ft. to 230ft. above the sea, descends from High Suffolk and Norfolk (underlaid by the Middle Drift) gradually to the sea level at Scratby Cliff; and to within 30ft. of it at Corton and Pakefield

Cliffs; while, in the opposite direction, after overlapping the Middle Drift, it reaches to the crests of the Downs over Royston and Baldock—heights, I imagine, exceeding those he gives for it in his paper. SEARLES V. WOOD, JUN.

BRENTWOOD, ESSEX.

## MISCELLANEOUS.

LECTURES ON MINING.—In a previous number of the Magazine, attention was directed to the course of lectures on practical mining being given by Professor Smyth, and reported in the *Mining Journal;* the following are the heads of the subjects treated of, in continuation of those previously alluded to, viz.:—On the driving of levels, and the direction which ought to be taken in seeking deposits which have been lost; on securing the ground by timbering, and the relative value of the different kinds of wood that are used in England and other countries, the nature of the ground to be timbered, and the necessary precautions to be adopted; on the employment of stone and other materials in walling; on the sinking, position, form, and size of shafts, in relation to the nature of the strata to be passed through, and the modes of securing and protecting their sides; on tubbing, and the methods used for sinking through difficult ground, in which the ingenious suggestion of M. Triger is fully described. Following the nature of exploratory and other works, called dead work, Professor Smyth treated of the difference in working metalliferous and stratified deposits, and on some deposits which were worked by methods common to both. These lectures successively appear in the *Mining Journal,* and are carefully and somewhat fully reported, and will be found useful records to the students who attend the lectures, and instructive to those who have not had the opportunity of hearing them.—J. M.

THE *RHYNCHOCETI* OF THE CRAG.—The group of Cetaceans called by Eschricht *Rhynchoceti,* from their remarkable beak-like muzzle, are represented in the present fauna by about six species, belonging to four or five genera, according to Professor Huxley (Quart. Journ. Geol. Soc. 1864, p. 395). The species described by M. Fischer, as noted in our February number, probably belongs to one of these genera. The fossil *Rhynchoceti* at present known are the *Ziphius cavirostris* of Cuvier, of doubtful age; *Choneziphius planirostris,* from the Lower Antwerp Crag; and nine species belonging to the genus *Belemnoziphius,* of which seven are known only from our English Red Crag; *Choneziphius* has never yet been recorded as occurring in our Suffolk strata, and is known almost solely from a fine specimen discovered at Antwerp,—a cast of which is in the British Museum. Mr. Ray Lankester informs us that two years since he identified a large specimen of a Rhynchocetan skull from the Red Crag, with the cast of *Choneziphius* in the British Museum, and that the identification was confirmed by Professor Huxley. The specimen was then in the possession of Mr. John Calvert, and was almost as perfect and satisfactory an example as the original Antwerp skull. Mr. Ray Lankester has also obtained flattened claw-like teeth from the Red Crag, which agree in external character with those of the *Micropteron Sowerbiensis* in the museum at Oxford; and are, in all probability, the denticles of the bident lower jaw of some of the crag *Belemnoziphii.* The Palæontographical Society have announced the publication of a monograph of the Crag Cetacea by Professor Owen, which cannot fail to be of the greatest interest at the present time, when the Cetacea are attracting so much the attention of osteologists.

Senarmontite, from Cornwall.—I have not been able to discover whether this mineral has hitherto been found in the British Isles. No mention is made of it in Greg and Lettsom's Mineralogy, nor am I aware of the existence of any other specimen than the one in the British Museum. The crystals are of the usual form, viz.: regular octahedrons, about two lines in thickness, opaque, and accompanied with minute crystals of carbonate of lead. They line the interior of a cavity in Jamesonite, which is associated with Bleinierite. This specimen is from near Endellion, in Cornwall.—T. Davies.

Geological Survey of Great Britain.—We understand that it is in contemplation to increase the staff of the Geological Survey, by a large addition to its ranks, with a view to the completion of the Survey within ten years. While we are glad to notice a development of further energy and interest in this important work, it remains to be seen whether sufficiently skilled assistance for this object can be obtained from practical geologists at the low rate of remuneration usually offered to scientific labourers.

New Classification of Meteorites.—In the "American Journal of Science" for January, 1867, Mr. C. U. Shepard gives a new classification of meteorites, with an enumeration of meteoric species. The author first arranges them under three classes—(1) *Litholites*, stony; (2) *Lithosiderites*, stone and iron mixed; (3) *Siderites*, chiefly iron. These are separated into sub-classes, and these again into orders; but we must refer our readers to the original paper for these details. The author gives a list of those species of minerals which are supposed to have existed in meteorites anterior to their arrival within our atmosphere; they are: Chamasite, Tænite, Oktibbehite, Schreibersite, Rhabdite, Chalypite, Ferrosilicite, Troilite, Graphitoid, Kabaite, Chromite, Quartz, Olivine, Augite or Eustatite, Piddingtonite, Shepardite, Anorthite, Labradorite.

## OBITUARY.

Alberto Cav. Parolini, Nobile de Bassano, was born in August, 1788. He was much attached to science, and was mainly instrumental in founding a Museum of Natural History at his native town, Bassano. So early as 1819 he had been elected a Foreign Member of the Geological Society of London. He was the author of several papers published in the Journal of the Royal Venetian Institute of Science, Literature, and Art. He died in January, 1867.

THE

# GEOLOGICAL MAGAZINE.

No. XXXV.—MAY, 1867.

## ORIGINAL ARTICLES.

### I.—On the Ages of the "Trail" and "Warp."

By the Rev. O. Fisher, M.A., F.G.S.

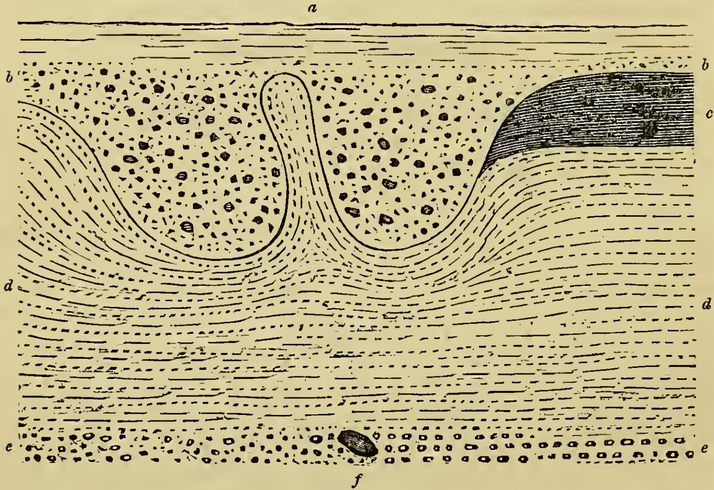
THERE are some points in Mr. Maw's[1] article on the relative ages of the Boulder-clays[1] which require notice from me, because they involve the consequence of assigning to the deposit which I have described under the name of "trail" an antiquity far higher than that which I believe to belong to it.

Mr. Dawkins, in his paper on the Brick-earths of the Thames valley,[2] noticed this deposit as being seen in all the sections he described; and he agreed with me in believing it to be a Glacial deposit, and, as I understood him, a subaërial one. In these views he corroborated my conclusions, as will be seen by reference to my papers on the subject in the Quarterly Journal, and this Magazine.[3]

Mr. Maw, however, endeavours to show a probability that the Glacial deposit of the Thames valley is co-ordinate with the Boulder-clay, or till, of the Norfolk coast; and gives reasons for supposing that the latter is more recent than the Boulder-clay capping the higher ground of the Eastern Counties. With regard to this second question, I have nothing to say at present, but I demur entirely to the position that the Glacial deposit overlying the Brick-earth is of the age of the Norfolk till. Mr. Dawkins, if I recollect rightly, put forward the idea that we might have in the Thames valley a remnant of a subaërial deposit of the age of the true Boulder-clay. This was, as Mr. Maw says, objected to during the discussion on the ground that the Thames valley was newer than, or at any rate deepened after, the period of the Boulder-clay. But I went further, and said that I recognized in the apparently Glacial deposit capping the Brick-earths at Ilford and Grays Thurrock the same deposit which I have noticed and described as filling troughs in the general surface of the country, and consisting of materials transported from higher grounds in rear by some agent, which I believe to have been land ice. This deposit, which I call "trail," whatever its origin may be, is evidently connected with the last denudation of the surface.

[1] See Geological Magazine for March last, p. 97.
[2] Read at the Geological Society, 9th January, 1867.
[3] Journal, vol. xxii. p. 554, and Geological Magazine, vol. iii. p. 483.

I have no hesitation in saying that the deposit in question at Ilford and Grays is this trail. At Ilford it consists chiefly of gravel and London clay confusedly mixed. The accompanying sketch, copied from one made on the spot, gives a rough idea of the manner of its occurrence. Now we have both these materials in the neighbourhood of Ilford, in the gravel of the Thames valley, and in the London clay of the higher grounds.




Section of about eight feet of the upper part of Uphall Brick-field at Ilford, Essex.

*a.* Warp.
*b. c.* Trail. *b* is clayey gravel; *c*, London Clay, with a few gravel pebbles.
*d.* Yellowish light-coloured stratified sand, belonging to the Brick-earth series, but disturbed by the deposition of the trail.
*e.* A pebbly band, in which a tooth of *Elephas antiquus* (in my possession) was found at *f*.
(The head of *Elephas primigenius*, in the British Museum, was found in a lower band.)

At Grays, on the other hand, the trail is thinner, and altogether a less important member of the section. The cause of this appears to be that the locality is on sloping ground. The materials of the trail are there chiefly of Thanet sand derived from the hill side above. It contains gravel also, but in subordinate quantities.

I do not believe that any argument as to the age of the Brick-earth can be founded upon this deposit, except—what would be self-evident without it—that it is older than the latest denudation of the surface.

Mr. Wood, jun., in his paper on the Thames valley, looks upon this trail in the Uphall pit at Ilford as a layer of the Thames valley gravel, *in situ*, overlying the Brick-earth, and has thence concluded that the Ilford Brick-earth is older than that of Grays. Mr. Dawkins, however, appeared to consider the two Brick-earths of the same age. Their age relative to each other, or to the Thames gravel, is not affected by the gravelly capping of the Uphall pit on the supposition of its being trail.

*Age of the trail.*—If this deposit be of Glacial origin, but do not date back to the Glacial epoch as Mr. Dawkins suggested, nor yet to the later Glacial era, which Mr. Maw supposes to be evidenced by the till of the Norfolk cliffs (though the general opinion has been that the Norfolk till belongs to the earlier part of the Glacial epoch), it may be fairly asked, To what Glacial period is it attributable? Is it conceivable that arctic conditions can have obtained at so modern a date as the trail evidently belongs to? To this question I endeavoured to give some reply in the concluding portions of my paper on the warp, as originally communicated to the Geological Society. But it was decided to abridge the paper before publication. The subsequent appearance of the first volume of Sir Charles Lyell's new edition of "The Principles," containing a full discussion of the present state of the theories upon Climatal Changes, now enables me to offer my views on this difficult question with somewhat greater confidence. It also relieves me from the necessity of describing the theories of M. Adhémar and Mr. Croll, which are clearly epitomised by our great geologist. Suffice it to say that the chief point in which the published views of Mr. Croll differ from those of M. Adhémar is, that M. Adhémar considers the present value of the eccentricity of the earth's orbit sufficiently great to produce a marked difference of climate in places having the same latitude in the two hemispheres. Mr. Croll, on the other hand, has stated (though I have reason to believe his opinions are modified) that the present value of the eccentricity is not sufficient for that effect.[1] If I understand Sir C. Lyell rightly, he does not deny that the present state of the eccentricity affects the climates of the two hemispheres, so as to render the northern warmer than it would be if our winter occurred in aphelion.[2] He only states that the mean temperature of the whole globe is warmer in our summer than in the summer of the antipodes, owing to the greater extent of land exposed to the sun's rays in the northern than in the southern hemisphere. But it seems to follow from the same cause, that since excess of land favors extreme climates, our winters would be colder than at present were the conditions reversed; though the shorter summers would be hotter as far as regarded the absolute power of the sun.

But, no doubt, with our present contour of land, the chief point for consideration is the course of the Gulf Stream. Mr. Croll has well suggested that if the southern summer occurred in perihelion during a state of high eccentricity, the Gulf Stream would be deflected into the Pacific instead of into the Atlantic.[3] Part of the equatorial current even now takes that course. It is conceivable that a moderate increase in the mean temperature of the southern hemisphere would so far weaken the force of the S.E. trade winds as to cause the equatorial current to impinge wholly on the southern side of Cape S. Roque, and to be deflected to the south instead of to the north.

If M. Adhémar is correct in his view, that the present extension

[1] Reader, 2nd December, 1865. [2] Elements, vol. i. p. 275, ed. 1867.
[3] Phil. Mag., Aug. 1864, and Feb. 1867.

of the S. Polar ice is due to the phase of precession in which we now are, then it may be readily admitted that the present position of the equator of warmth to the north of the "line," and the extension of the S.E. Trades in the same direction, is due to that cause; and, consequently, the change of seasons involved in the transference of our winter to aphelion (and of the southern winter to perihelion) would so far warm the southern hemisphere, as to weaken the S.E. trades, and cause what is now the Gulf Stream to flow southward instead of northward.

In all these questions, and many similar ones, the real difficulty is not to see in what direction the effect would be produced, but to what extent. And this difficulty is enhanced in the present case because we do not know with certainty what the absolute heating power of the sun may be, the temperature—239° F., attributed to space being by no means certainly correct.

If, however, Mr. Dawkins and myself are right in attributing this recent deposit to a Glacial origin, it is a proof that *some* refrigerating cause has been in operation during comparatively recent geological times, when this country had, or rather, as I believe, finally received, its present contour. Now, since one cause that we know of has been in operation within such a recent period, viz., that of precession, it seems extremely reasonable to attribute the observed effect to it.

In considering the effect of precession, we must not forget that its efficiency for producing climatal effects depends upon the eccentricity of the earth's orbit. Let us, then, observe what values this element had at those periods nearly preceding our own era, at which the seasons were reversed.

The northern winter solstice occurred in perihelion A.D. 1248. It therefore occurred in aphelion 10468 years previously to that epoch, that is, 11020 years before the year 1800; and at intervals of 20937 years each, preceding that period. Hence we have the following table :—

| | Number of years before 1800, when the Northern winter occurred in Aphelion. | Eccentricity of the earth's orbit nearly, + if it was greater, — if it was less than the value given. | Winter temperature of Snowdon without the Gulf Stream on Hopkins' first hypothesis.[1] | Ditto of Scotland, the Gulf Stream being diminished in proportion to the eccentricity (Mr. Croll).[2] | Excess of winter over summer in days. |
|---|---|---|---|---|---|
| | 11020 | ·0187 + | 5°.05 | Not given. | 8·6 |
| | 31957 | ·0151— | | | |
| | 52894 | ·0131 + | | | |
| | 73831 | ·0316 + | —1°.01 | 5°1 | 14·8 |
| A | 94768 | ·0452 + | —7°.17 | —3°2 | 21·0 |
| | 115705 | ·0460— | —7°.52 | —3° | 21·3 |

The fifth and sixth columns of Sir Charles Lyell's table, which give the mean hottest and coldest months in the latitude of London when winter is in aphelion, are calculated from the present means. It seems to me, however, that, for cold epochs, it will be safer to calculate from the mean as it would have been had the Gulf Stream not existed,

[1] Geol. Jour., Vol. viii. p. 68. [2] Phil. Mag. for Feb., 1867, p. 3.

and accordingly I have adopted Mr. Hopkins' value of 23° F. for Snowdon. The equation then becomes $\frac{239° + t°}{239° + 23°} = \left(\frac{0.9832}{1+e}\right)^2$.

I have also added Mr. Croll's values, on the supposition of the Gulf Stream being only partially deflected.[1]

My fifth column is calculated from the equation—

$$\text{Excess of winter over summer} = \frac{4e}{3 \cdot 1416} \times \textit{year}.$$

This is slightly more accurate than the rule I gave in the "Reader," 4th November, 1865.

Referring to the table it will be seen that in the year 1800 the eccentricity was ·0168. Hence, on the first preceding occasion of winter occurring in aphelion, the eccentricity was greater than at present by a small amount. On the two next occasions it was less. On the fourth it was considerably greater, and winter fifteen days longer than the summer. On the fifth this difference had increased; and on the sixth occasion it was larger still; but it was diminishing rapidly.

Now it is remarkable that though Sir Charles Lyell notices the high eccentricity occurring about the time of these last two epochs, between which falls his period A; yet he has not attributed any known Glacial phenomenon to it. Both he and Mr. Croll consider it too recent for the so-called Glacial epoch, and Sir Charles thinks it not recent enough for the Reindeer period. I would suggest that it is extremely probable that this was the epoch of the formation of the trail, and of the last general denudation of our country.

Then the period 11020 years before 1800 may be supposed to have been that of the reindeer. For the eccentricity was at that time appreciably larger than it is at present, and the winter nine days longer than the summer. This, with the winter in aphelion, might well have produced the change of climate necessary for the southward migration of the reindeer, though not sufficient to envelope these latitudes in a sheet of ice. The objection, that the summers would then have been too hot for the reindeer, may perhaps be met by observing, that the Southern range of that animal in Northern Asia at present reaches almost to latitude 50°, which is within the limit of the summer isotherm of 63°; while, on the other hand, the localities, in which its remains have been found in Southern Europe, must have been within the influence of the Atlantic, whose waters were at that time cooler than at present. Hence we may suppose that those countries would not have been heated, even by a nearer summer's sun, more intensely than the plains of Asia, which the reindeer inhabits, are heated at the present time. Still further, we must not forget Mr. Croll's arguments for cold and cheerless summers under a high condition of eccentricity. I am inclined to think that this was also the period of the formation of the warp, when, as I have shown, the winter frosts were more severe than they are at present.[2] The submergence of our lower valleys, beneath the *Scrobicularia* mud,

[1] Phil. Mag. Feb. 1867, p. 3. [2] Geol. Journal, vol. xxii. p. 564.

was one of its later phenomena, and the retirement of the sea, which deposited it, formed the commencement of the recent period.[1]

It is very satisfactory to observe that the periods thus assigned to the two Glacial phenomena, which I have been discussing, cause them to fall into the positions which they ought to occupy on purely geological grounds, and agree with awards of Sir Charles Lyell and Mr. Prestwich. From reasons, solely grounded upon the order of superposition, I concluded my paper on the warp with the following summary:—

"Upon reviewing the changes which have been indicated by the phenomena discussed in the present paper, we have disclosed, in the first instance, a condition of the surface when the general features of the landscape were the same as at present, during which the great mammalian fauna flourished contemporaneously with the fabricators of the chipped flints" (the Palæolithic period).

"We have, subsequently, though perhaps not in immediate sequence, a period of extensive denudation, indicated by the furrows filled with materials from the higher grounds, which have travelled in a plastic state, and which I have called 'trail.' This denudation brought the surface almost exactly to its present form. The period of the formation of the warp succeeded, in which the winter frosts seem to have been more severe than at the present time.

"It was either during this period or shortly afterwards, that the submarine forests flourished. A submergence of moderate amount, measured by a few tens of feet, next followed, and the *Scrobicularia* mud was deposited over the lowest forest-grounds. The sea was then depressed again, and the recent period commenced.

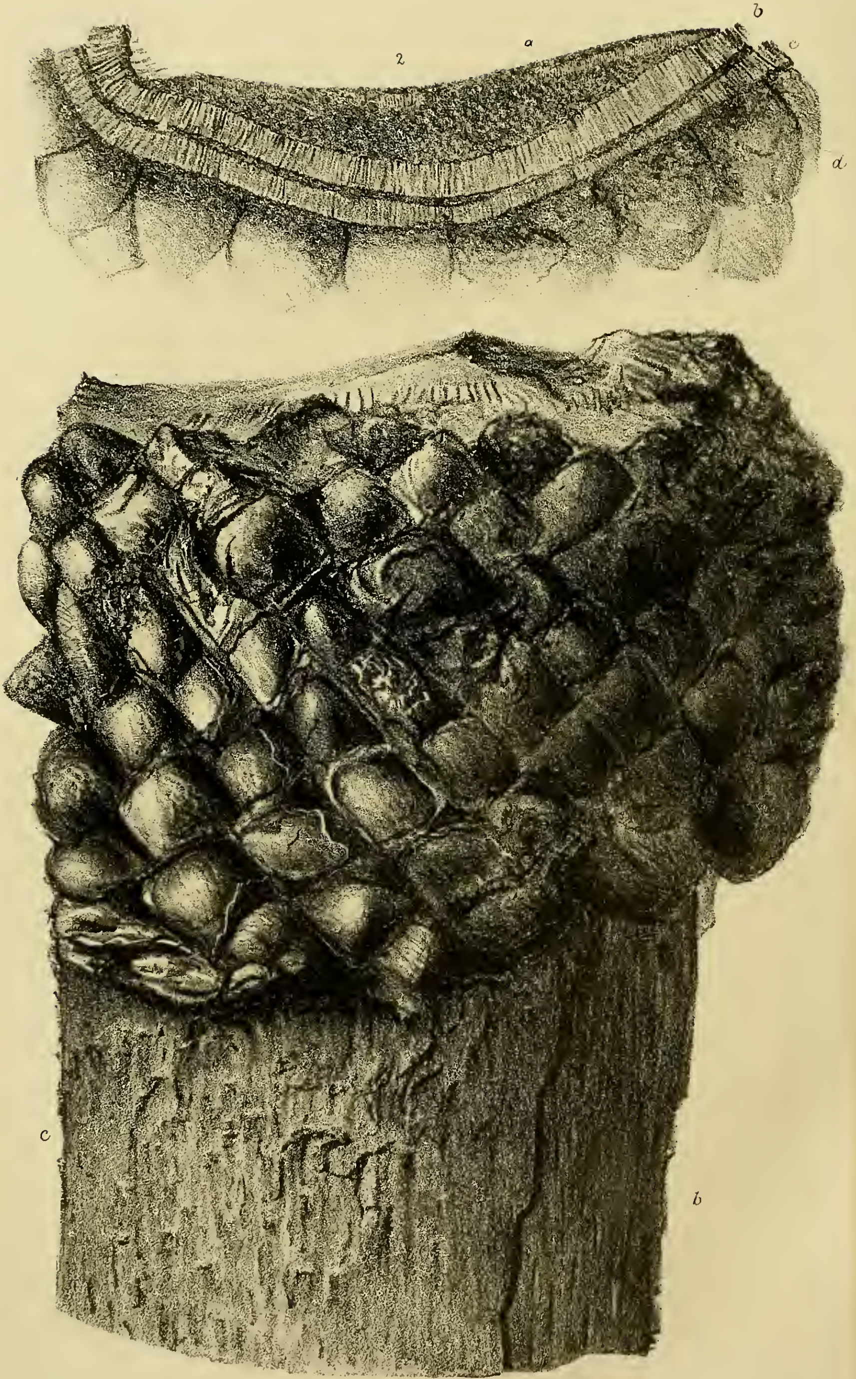
"The changes of form in the present surface which have taken place since that time may, I believe, be easily recognised, since they usually interrupt the more general contour of the surface."[2]

Upon correlating these geological conclusions, with what may be called our astronomical ones, we find that the Palæolithic period, shown to be older than the "trail," is thrown into the times antecedent to Sir Charles Lyell's period A; where, also, he himself places it. Nevertheless, if I should venture to differ from so great an authority, I would suggest that the period B, to which he inclines to assign it, might be somewhat too early, the eccentricity being likely to have rendered it too cold for the phenomena observed, and that the climate of some part of the interval between 100,000 and 200,000 before A.D. 1800, would have been more in accordance with what was requisite, and probably of sufficient duration.

There followed after the Glacial era of the "trail," a lengthened period of equable seasons of about 80,000 years, which would have been that of the submarine forests and their occupants. *Elephas primigenius* was still living in this Island,—witness his remains found at Holyhead harbour, preserved in the British Museum.

A short period of severe winter cold succeeded, which was the period of the warp, and of the *Scrobicularia* clays; and the date of it agrees remarkably with the result arrived at by Mr. Prestwich, on

[1] Geol. Journal, vol. xxii. p. 564. [2] *Ibid.*




G Massee delt et lith M & N Hanhart imp

CYCADEAN STEM FROM LEIGHTON BUZZARD.

summing up the evidence in regard to the Quaternary gravels. He is of opinion that the large pachyderms lived down to the commencement of the alluvial period, and on that supposition says, "I do not see any geological reasons why the great extinct mammalia should not have lived down to comparatively recent times, possibly not farther back than 8,000 or 10,000 years ago." In other words, he puts that period as having elapsed since, as I understand him, the last submergence of our lower valleys took place.

According to my views this submergence would have passed away in about a quarter of the term of 10468 years, subsequent to the epoch 11020—that is, about 8,000 years ago. This is, to say the least of it, a remarkable coincidence.

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## II.—On *Cycadoidea Yatesii*, a Fossil Cycadean Stem from the Potton Sands, Bedfordshire.

(PLATE IX.)

By Wm. Carruthers, F.L.S., of the British Museum.

When examining the collections of the Geological Society at the time of preparing the notes I published some months ago, on the Fossil Cones of the Secondary Strata, I found a small fragment of a curious vegetable organism, the nature of which I was then unable to determine, but which I was allowed by the kindness of the Secretary to take with me for the purpose of further examination. Some months ago I obtained from James Yates, Esq., a more perfect specimen, which clearly showed that it was the portion of the stem of a cycadean plant, as Mr. Yates had already determined. Professor Church subsequently brought me a yet finer specimen from the Museum of the Royal Agricultural College at Cirencester, and I have a fourth fragment from the collection of Professor Morris.

All the specimens were found in the iron and green sands of Potton, which rest on the Kimmeridge and Oxford clays, and are covered by the Gault. Mr. Seeley, who has paid some attention to these beds, kindly informs me that he considers them to "represent in their *upper part* the *Lower Greensand*, which part is generally unfossiliferous; the *middle part* is very rich in fossils, including many vegetable remains, such as fir and other cones, wood, etc. These beds are regarded as a marine representative of the *Purbeck and Wealden* period; and at the bottom are the representatives of the Farringdon gravels, and unfossiliferous sands." The Cycadean stems are found in the middle part of the sands. They are converted into a rich brown hematite, containing a larger proportion of iron than bog iron ore.

Mr. Pettit drew the attention of the Geological Society to these stems at its meeting on December 2nd, 1857, when he laid some fine specimens on the table. He referred them to *Clathraria*; but no description of them was published, nor further notice taken of them.

Professor Morris had had his attention directed to this fossil some years ago, and having seen the fine specimen at Cirencester, he came to the same conclusion as Mr. Yates regarding its affinities.

It must be referred to Buckland's genus *Cycadoidea* = *Mantellia*, Brongn. Besides the two species described by Buckland, from the isle of Portland, the genus contains a third species from the Lias of Lyme Regis, also having, like the original species, a bulbiform trunk, and three species with cylindrical stems from Secondary strata in France. All the species are characterised by having their trunks covered with the persistent bases of the petioles. With Professor Morris's concurrence I have named the species *Cycadoidea Yatesii*, after a gentleman whose name is well known, among other things, as a successful cultivator and diligent student of the interesting Order of plants to which the fossil belongs. I do not hesitate to give it a specific name, as the materials are more than sufficient to show its affinities; and though other vegetable fossils are known from the bed, none have been described to which this could belong.

The species may be thus distinguished:—

Trunk cylindrical, covered with the persistent bases of the petioles, which are rhomboidal in form, and terminate in a tumid boss, the apex of which is directed upwards.

The fossil belonged to an arborescent Cycad resembling in aspect the tall cylindrical stems of *Cycas* or *Macrozamia*, and differed in this respect from the spherical or ovoid trunks belonging to the genus, which were described by Buckland and Lindley. The cellular axis was relatively very large. The pith has disappeared, except in one of the specimens, where there are still some indications of it, and of the vascular bundles which abounded in it. The woody cylinder surrounding the pith consists of two rings, everywhere pierced by medullary rays, which are often so large as to separate the rings into numerous series of woody wedges, as in recent *Cycadeæ*. The presence of discs on the woody vessels has been detected both by Professor Morris and myself. The inner surface of the woody cylinder is marked by numerous narrow grooves and perforations, formed by the vascular bundles, as they passed from the pith into the wood. The outer surface has similar scars, produced by the vascular bundles, which passed from the wood to the leaves; but they are here larger and more regularly disposed than on the inner surface. Between the wood and the bases of the petioles there interposed a very thin layer of cellular tissue, through which the vascular bundles passed in an upward direction towards the petioles. In recent *Cycadeæ*, as well as in the other fossil British species of this genus, this layer is very much thicker than in our species. The bases of the petioles rise from this cellular layer. The leaves of *Cycadeæ* perish at first like the fronds of ferns and the leaves of monocotyledonous plants, which not being articulated to the stem of the supporting plant, wither and decay upon it. But a true articulation exists in Cycads, not as in deciduous leaves at the point where the base of the petiole rests on the surface of the stem, but at some distance from that point. When the decayed leaf at length falls off, the cicatrix is covered by an epidermal layer, giving to the persistent bases of the petioles an appearance not easily distinguished from the scales, which are interspersed among them. Some species of the South African genus *Encephalartos* afford fine specimens of this structure, the outer surface of the trunk having sometimes, as in *E. Altensteinii*, a quarter of its diameter composed of the persistent bases of the petioles. This also is a character as we have seen of the genus *Cycadoidea*, and our species may be distinguished from the others by the regular arrangement and symmetrical form of the bases of the petioles. They are rhomboids, the horizontal diameter of which is but little more than the perpendicular, and differing in this respect not only from all the other described recent species, but also from all the living Cycads with which I am acquainted.

EXPLANATION OF PLATE IX.

*Cycadoidea Yatesii*, Mor. and Car. From the specimen belonging to the Museum of the Royal Agricultural College at Cirencester. Two thirds the natural size.

Fig. 1. *a*. The persistent bases of the petioles. *b* and *c*. The lower portion of the stem, deprived of its outer covering, and showing at *c* the thin external layer of cellular tissue, and at *b* the outer surface of the woody cylinder.

Fig. 2. The upper surface of the same stem. *a*. The internal cavity occupied by the pith, but in the specimen figured containing amorphous iron-ore. *b*. The inner woody ring. *c*. The outer woody ring. *d*. The bases of the petioles.

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## III.—On the May Hill Sandstone.

By J. W. Salter, A.L.S., F.G.S.

It is at all times difficult to fix the parentage of a new geological idea. So many circumstances and so many hints and observations converge to its establishment, when the due time comes for its appreciation, that, looking back, it seems hardly possible to disentangle the ideas of one workman in science from the suggestions of another. Hence it is always difficult to establish an exact priority of claim in questions which have remained long unsettled.

In the elaborate, but too short volume by Prof. Ramsay and myself, on the Geology of North Wales (Mem. Geol. Surv. vol. iii. 1866), an attempt is made by the former to give a succinct history of the order of discovery of the various members of the British Silurian (and Cambrian) groups. With respect to the May Hill Sandstone—a group most important, as all will now recognize, as the key to the structure of Wales and the bordering Silurian counties,—I will add a few facts which suggest themselves to me on reading Prof. Ramsay's brief and important chapter on the nomenclature (chap. i.).

Even before the publication of Prof. Phillips' memoir on the Malvern Hills, 1848, it was observed by the Professor, then palæontologist to the Survey, that the Caradoc and May Hill Sandstone of the Silurian System included an upper group, distinguished by the prevalence of Upper Silurian fossils; and this upper rock of the Malverns was distinguished by the term, "Upper Caradoc,"—a bad name, since Sir R. I. Murchison had already called it May Hill Sandstone. It was known in 1848, by the Survey, that this Upper Caradoc ranged unconformably round the great Cambrian and Lower Silurian Island (so to speak) of the Longmynd, resting at one place on Llandeilo rocks, at another on the still older slates of the Longmynd itself. And in Prof. Ramsay's short account of the Geology of North Wales (vol. iv. Geol. Journ.)—to which, by-the-by, he makes but little allusion in the volume lately published—the relations of this Upper Caradoc were discussed by himself and Mr. Aveline; its unconformity recognized; and its relative age (by the fossils) given by Prof. Forbes and myself. But, by an accident, one or two typical Lower Caradoc fossils were again wrongly quoted from it, as had previously been done by Prof. Phillips.

It was, moreover, known that these "Pentamerus beds, or Pentamerus and Hollies Limestone" of the Silurian system (1839), were equivalent in age to the "Clinton group" of America, which Prof. Hall, in his Geology of New York (1843), had distinctly stated appeared to lie on the eroded surfaces of the underlying rocks, and yet to contain a few, and only a few (*Bellerophon bilobatus* being the chief) of their fossils.

We ought not, therefore, to have been surprised to learn (when in 1853 Prof. Sedgwick and Prof. M'Coy read a paper before the Geological Society on the distinctness of the two rocks, "May Hill" and "Caradoc"), that there must be a total difference in their age—only to be expressed by the use of separate terms—the one being of the age of the Bala rocks (Upper Cambrian of Sedgwick); the other a Wenlock grit or sandstone. These are the Professors' own words.

But this view of their total distinctness was not reconcileable with the fact, that the author of the "Silurian System" had obtained a mixed series from the typical locality where both were seen, viz., the *Hollies Limestone*, near Acton Scott. It was resolved by the then Director of the Survey, Sir H. de la Beche, that a survey should be again made along the Wenlock valley (Apedale), and the veteran geologist, Mr. Talbot Aveline, and myself, then assistant to Prof. Edward Forbes, were appointed to this duty. I wrote to Prof. Sedgwick, telling him our object; and his reply was, we should find them distinct and unconformable; he had the previous year tried to ascertain it. It was a cold spring in April, 1853, and not very pleasant weather for tracing muddy brook sections in clay land; but we had thick boots and light hearts, and the primroses and early violets were in full bloom. We found the unconformity first in the most difficult of all the sections, viz., the Onny river at Cheney Longville. And the slight discordancy (only a few degrees of angle) was only discoverable by wading knee-deep along the shelves, and one at a time hammering, while the other observed the line of contact from the opposite bank. Prof. Ramsay joined us here, and confirmed the unconformity by the same amphibious process. We need hardly have given ourselves so much trouble; for by proceeding northward we found the Pentamerus beds and purple (Tarannon) shale, thickening and thinning out, and forming "Jacob-stones." Every cottage doorsill and well step was Pentamerus limestone, when we hit upon the right line, which was no little trouble to do.

Moreover, Mr. Aveline, being an old stager, had bethought him that we must first gain a true section of the under rocks. This he did readily by going from Horderly turnpike to Cheney Longville and

Stretford Bridge; then by tracing the Caradoc divisions northward —some five or six very distinct ones—we found that they were *successively* each and all overlapped and covered up by the Pentamerus limestone and grit, all the way up to the Wrekin, where, indeed, they lie on the very lowest beds, or Shineton shales and slates, which I take leave to call the top of the *Llandeilo Flags* proper, and believe this to be their true position.

However, the unconformity was fully proved; and a pleasant bit of geology it proved when the snow was gone from all but the Longmynd top. I shall not easily forget the hot day we finished at the Wrekin. Professor Ramsay and Mr. Aveline had been up before; but nothing would do but I should drink at the Raven's Cup; and I shall remember that, for it had been artificially filled that day, and *not* with pure water.

On going to the Hollies Farm, in a pelting snow shower, I found the source of all the error. The house is built on true Caradoc flags, so calcareous and so full of Caradoc or Bala fossils, that they might be burnt for lime; and a little further down the brook, the Pentamerus limestone crosses, thick enough to tempt them to use it for the kiln. But the walls of the now deserted kiln were built of the Caradoc flags from the house quarry, while the May Hill or Pentamerus limestone had been burnt. The fire had calcined both, and fragments of each, found in the kiln, had been most innocently and unsuspectingly gathered by the Silurian chief, and figured together by accurate James Sowerby! Who was to blame? Not Sowerby, for he rightly named the fossils from the "Hollies." Scarcely Murchison, for who could dream that two limestones of such different age were calcined in the same kiln by accident? Not the farmer, who was wise enough to build his kiln of the firmer and less valuable stone. It was a chapter of accidents, such as has often happened before and will again. But there was no longer any doubt as to the supposed admixture, and the *experimentum crucis* had been made in an old lime kiln.

Henceforward all was plain sailing. The Upper Caradoc was abolished, for the May Hill Sandstone had acquired its right meaning; and as fossils were abundant in it, we easily rearranged the drawers of the Museum in accordance with the new facts. But this was not all. Professor Sedgwick and myself had shewn in 1845 (Quart. Geol. Journ.), as the result of our summer's work in North Wales in 1843, that the fossils of the uppermost portion of the Bala (or Caradoc) rocks in Montgomeryshire were full of these same *Pentameri* and of other fossils, *Petraiæ*, *Atrypa reticularis*, etc. These in many places were found (and more have been found since) to range along the border of the Upper Silurian rocks. In South Wales Sir Roderick had described them from near Llandovery, from Haverfordwest, from Marloes Bay; and they were included in what was then, indeed, a heterogeneous assemblage, under the term of Llandeilo Flag. I examined the country, from Builth to Carmarthen, in 1846, made easy then by the accurate map; and recognised, of course, the Upper Caradoc, as we then had begun to call it. It was evident enough, after 1853, that these localities must be revisited; and the last official act that I remember of Sir H. de la Beche was a kindly "God-speed" to Mr. Aveline and myself. We set out in 1857 for a fresh boundary line from Builth to Marloes Bay. But this journey (the results of which Sir Henry did not live to see) gave us a much more difficult task. Instead of soft shale, limestone, and sandstone, we had to draw a boundary between hard cleaved slate, and hard cleaved gritty slate; and the solemn pipe often assisted our deliberations. We traced the whole boundary together; found there were two Pentamerus series—one upper, with Wenlock fossils and *Pentameri*, lying *unconformably* upon a lower, full of Caradoc fossils and *Pentameri*—just such a mixture as had been at first supposed in Shropshire, but had turned out untrue. Here it was true enough; and many a long day was spent in deciding which was the upper and which the lower. For when two slates, one only a little more gritty than the other—tilted together, and bent and broken together, and cleaved in the same direction—have to be distinguished in a cultivated country, all I can say is that, if any one thinks geology is easy work, let him try that sort of thing.

However, in course of time it came all right. There was a May Hill rock, which began at Builth and swept on, in thick or thin patches, as far as Llandeilo, lost there, and again coming out to sea in the fullest force at Marloes Bay and Wooltack Park. Cleaved and tilted as they were, there could be no doubt of them. Professor Ramsay joined us at Marloes Bay, and accompanied us back to Haverfordwest.

And under these Lower Pentamerus beds at Haverfordwest, and on the rolling hill tops north of the Towy, and thence to Llandovery, we sought to find the boundary between these *Lower Llandovery* rocks (as Sir R. Murchison calls them) and the true Caradoc beneath. To me they seemed conformable; but Mr. Aveline afterwards by himself did find, in tracing them painfully in detail, and following them northward and westward, that the lower beds were sometimes a little discordant on the Caradoc. I believe no one but himself could have proved it. But it must be true, or there is little faith in fossil evidence, for the change in the fauna is sudden and considerable.

This account, rather briefly and imperfectly given, is all that I remember of the history of the May Hill and Llandovery rocks; but it may, perhaps, be enough to show how the observations of many men and many minds must concur, before the hypothesis is reached—which, as our old chief, Sir Henry, used to say, is the "peg to hang the facts upon." Sir R. Murchison had traced the course of the "Pentamerus beds" around the Longmynd and Shelve country without dreaming they were other than part of the true Caradoc. The Survey, misled by the supposed admixture of types, could get no further than an Upper and Lower Caradoc. Hall had noticed, but failed to see the full significance of the unconformity in New York. Pouring rain had beaten Sedgwick and M'Coy in their gallant attempt to take the Wenlock Valley by storm in 1852. And neither Swedish nor Russian geologists appear to have observed the discordancy of their great Pentamerus zone. The fruitful idea in this case was conceived by a good palæontologist, before he had even seen the rocks in question! And it was followed up by a man of genius, who had learned the importance of the fossil data to be second, and not first, in geological study. Coming fresh from Wales, where the Silurian rocks are altogether unconformable on what he termed Upper Cambrian or Bala rocks, he was ready to make the most of the suggestion of his friend, and was the cause of proof being made by his pupils in the science.

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## IV.—Valley Terraces.

By Colonel George Greenwood.

(PLATE X.)

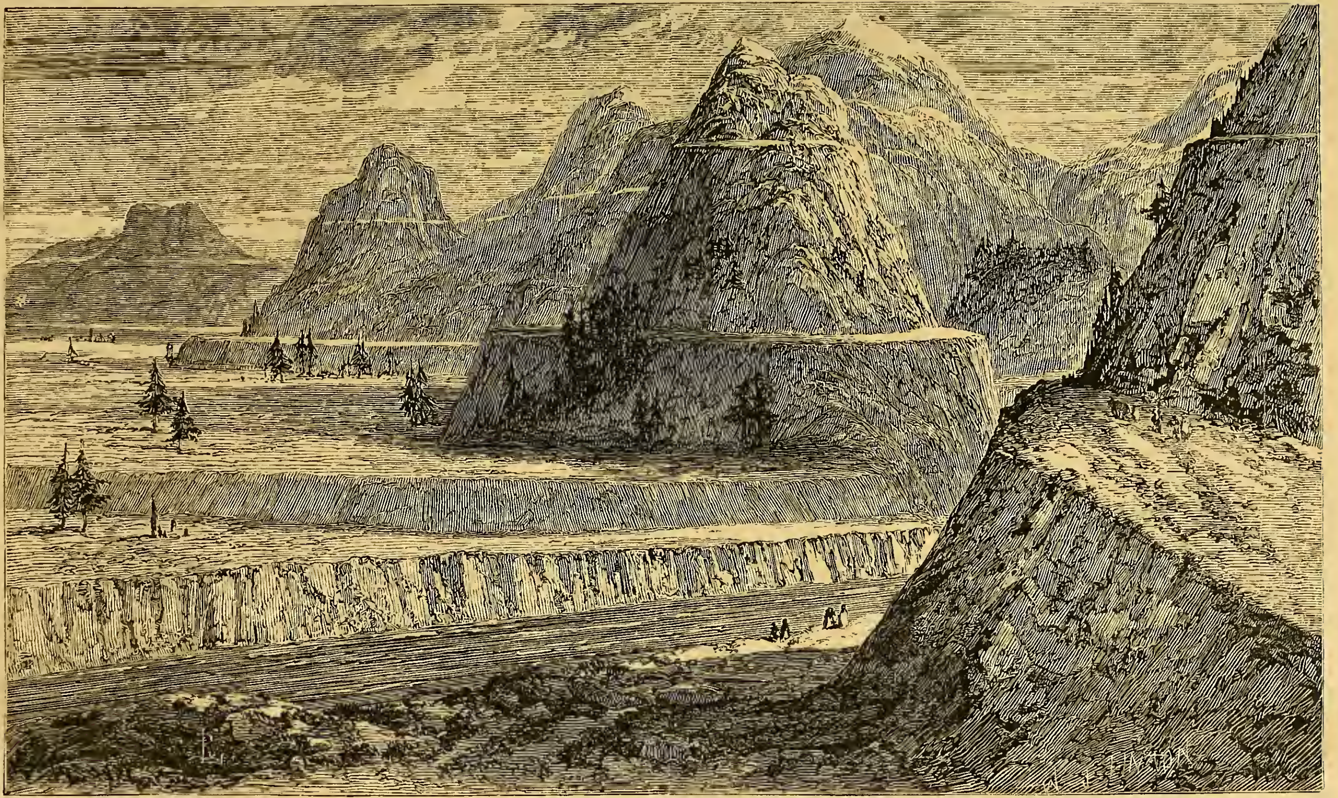
In the Journal of the Geological Society for November, 1866, page 463, Mr. Tylor gives a paper on "The interval of time which has passed between the formation of the upper and lower valley gravels." He says, "Mr. Prestwich argues that, although the upper valley gravels are at a higher relative level than the lower, yet the higher series are always the older, and the lower the more modern; and we have thus the ordinary superposition of new over old strata supposed to be reversed. This *difficulty* is considered by most geologists to have been *surmounted* by Mr. Prestwich's arguments, and his classification of the gravels has been generally accepted. My own opinion is that the evidence on which Mr. Prestwich's theory is based is insufficient." If the gravel terraces were *on* one another as well as *above* one another, there would not only be a *difficulty*, but an *impossibility* to *surmount*. But the terraces are not *on* one another —that is, although they are *in level* above one another, they are not *vertically* above one another. If in making a railroad cutting the sides were terraced, the upper terraces would be the first formed, and would consequently be "the older." The lower terraces would be the last formed, and would consequently be "the more modern." Mr. Tylor himself will allow that the upper part of a railroad cutting must be excavated before the lower part of it; and that if deposits were made during the excavation, the upper deposits would be the first made or "the older;" the lower deposits would be the last made or "the more modern." The case is the same if, instead of the formation of a railroad cutting by navvies, we suppose the formation of a valley, and the excavators to be rain and rivers. Mr. Tylor feels himself aggrieved that the valley of the Somme has "a transverse section of five hundred times the area of the present water-channel." It might have the same area without any "water-channel"—that is, without any river at all, simply from the erosion of rain. Indeed, it is only when rivers are flooded by rain that they erode the non-alluvial parts of their channels and deposit on the alluvial parts. So in chalk and other porous districts where the downward soakage of rain is not stopped, and consequently, where no springs are forced out to make streams, enormous valleys are formed by the erosion of rain only. Such may be seen in Salisbury plain. I have said, in "Rain and

Rivers" (page 152), of the valley of the Ganges: "In the *rainy* season there is, perhaps, a body of surface water which flows down the vale to the sea in volume fifteen times as great as the spring water; and were every spring of the Ganges permanently dried up, the vale would still be flooded every year by a stream in volume only less by one fifteenth part than that which flows every rainy season now, and fourteen times greater than that which flows in the three dry months." And what makes the river flood in the *rainy* season except the *rain?* "*Quum fera dilivies quietos irritat amnes.*"

And what is even the spring water of rivers but rain reappearing and returning to the sea? Also (*op. cit.*, page 155), "The source of the valley (that is the rain source of the valley) is always much higher up than the source of the river (*i.e.*, than the spring source of the river). The river has no power of making a valley above it, but a torrent of rain water has the power of scooping a valley below it. Terraces of gravel on the sides of chalk valleys are in general remains of beds of rivers. The rivers having eroded the softer chalk sides of their beds, deepen their valleys, and leave their beds as terraces on the hill sides. So that any number of long lines of gravel terraces, which were the beds of rivers or even the beds of rain valleys, may be deposited on the sides of valleys,—first on one side of the valley, then on the opposite side. Such terraces are, usually, on one side of the valley only. Parallel terraces, one on each side of the valley, may be ancient shores. But the vast majority of them are the remains of alluviums where no lakes have ever been. The alluviums are formed by the stoppage of the lowering of the valley. The valley above the stoppage is then worn horizontal. The rain flood waters from the sides and inclined parts of the valley, checked at the flat plains, overflow and deposit alluviums on these flats. The sea stops the lowering of every valley, therefore the bed of every valley is flat and alluvial at the end next the sea. But besides this marine or main alluvial plain, a valley may have any number of what I have called *patches* of alluvial plain at any distance from the sea. These patches, as I have had the honour to say in the Geological Magazine,[1] occur above every hard stratum which crosses the course of the valley or river, and which stops for a time the lowering of the valley or river bed. Rain and the river then form a horizontal flat on the comparatively soft strata above the gorge, and an alluvium on the flat. When the gorge is deepened and widened, the alluvium above is cut through, and disappears, leaving only two parallel terraces, and a new flat and a new alluvium are begun at a lower level. Lord Milton gives a drawing of the parallel terraces on the Fraser river which illustrates this theory (see Plate X.).[2] The terrace next the river is now in actual formation from the annual overflow of the river and the run of the sides of the valley and the old terraces.

[1] Geol. Mag., Vol. III. p. 519.

[2] The accompanying engraving has been most obligingly lent for the illustration of Colonel Greenwood's paper by Viscount Milton and Dr. W. B. Cheadle. It is one of the numerous illustrations to their interesting work, entitled, "The North-West Passage by Land. Being a narrative of an Expedition from the Atlantic to the Pacific." 8vo. London, 1865. Published by Messrs. Cassell, Petter, and Galpin.



THE TERRACES ON THE FRASER RIVER.

(*See page* 206).

The terrace next above is the last formed, and the topmost terrace is the first formed. The conical mountains, on which the remains of the terraces rest, exist only because they are harder than the beds which *have* formerly surrounded them; and, as I have said of the Weald Hill and the North and South Downs—those all-powerful excavators, air and moisture, rain and rivers, have as much *formed* these cones as the sculptor has formed the statue out of the Parian or Carrara block. And the human and the natural operators have worked on the same principle—that is, by the abstraction of external parts. And these cones stand out a magnificent monument of the enormous masses which have vanished by the disintegration of the atmosphere and the erosion of rain and rivers. These cones, however, though the *monuments* are by no means the *measure* of this denudation, since they have themselves been melting away for "an eternity of time," and are day by day vanishing *tenues in auras* at this instant. All this is going on now all over the world, and all day long. These simple yet sublime truths are beneath the contempt of poor marvel-seeking human nature. We must have a cataclysm, or a glacial epoch, or a "gravel period," to account for every heap of rain-wash. In his description of the parallel terraces of the Himalaya, Dr. Hooker's *facts* exactly correspond with my theory, that from the alternation of hard and soft strata across valleys, an alternation of gorge and alluvial flat results: as each gorge sinks and widens, the alluvium above is cut into two parallel terraces. While on the Tambur river (page 199, vol. i.[1]), Dr. Hooker says: "I was almost startled with the sudden change from a gloomy gorge to an open flat." Page 191, he says: "Above these gorges are enormous accumulations of rocks, especially at the confluence of *lateral valleys*, where they rest upon little flats like the river terraces of the Mywa." Now these "lateral valleys" (longitudinal as regards the stretch of the strata) are simply the consequence of the erosion of rain and rivers in the soft strata above or behind the hard gorges, as I first said of the lateral valleys in the Weald clay above or behind the gorges of the North and South Downs. In his description of the terraces of the Yangma valley (page 219, vol. i. *ibid.*), Dr. Hooker begins with a gorge: "The scenery was wild and very grand, our route lying through a narrow gorge choked with pine trees, down which the river roared in a furious torrent." "The path was very bad; often up ladders and along planks lashed to the faces of precipices, and overhanging the torrent which it crossed several times by plank bridges." Above this gorge, and above other "contracted parts of the valley," come his *supposed* ancient lake beds and the parallel terraces which he depicts, and of which he says (page 233): "On the opposite flank of the valley were several terraces, of which the highest appeared to tally with the level I occupied, and *the lowest was raised very little above the river*; none were continuous for any distance, but the upper one in particular could be

[1] Himalayan Journals. Notes of a Naturalist in Bengal. The Sikkim and Nepal Himalayas. By Joseph Dalton Hooker, M.D.R.N., F.R.S., London, 1855. Published by John Murray.

most conspicuously traced up and down the main valley, whilst on looking across the eastern valley a much higher but less distinctly marked one appeared on it." (See woodcut, copied from Dr. Hooker's work). In fact, the terraces have nothing to do with lakes. They are all the remains of ancient alluvial plains as we should call them, or of "river haughs," as the Scotch would call them; and "the lowest very little above the river" is a river haugh now in actual formation from the yearly floods of the river, and from the waste and erosion of the terraces above it. And all these terraces are at this moment on their way to the alluviums below, to the delta of the Ganges, to the bay of Bengal, and to the

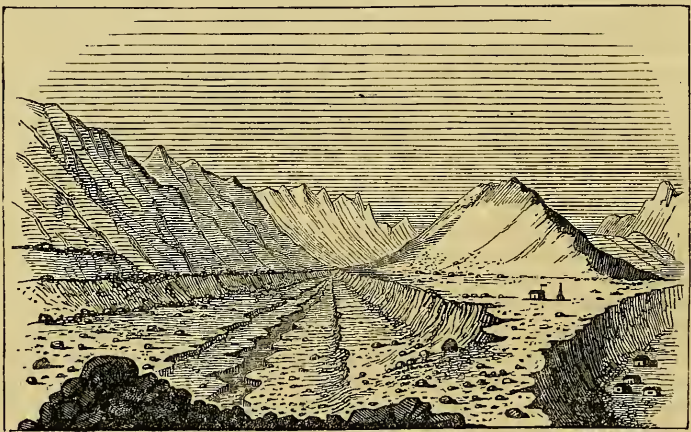


Diagram of the Glacial Terraces at the Fork of the Yangma Valley (copied, slightly reduced in size, from Dr. Hooker's Himalayan Journals, vol. i. p. 219).

Indian Ocean, under convoy of rain and rivers, as much as the run of every other hill-side is on its way to the valley below, and from the valley below to the sea at the end of the valley. The terraces are for a time arrested by the hard gorges; but as the hard gorges go, the terraces go. So far Dr. Hooker's facts and *my* theories agree. At page 222, *ibid.*, Dr. Hooker tells us that, "being familiar with *sea* ice and berg transport during my voyages in the south polar regions," *his* theory is that semitropical Indian *land* must have been formed under a polar sea; and that once upon a time "a glacial ocean stood high on the Himalaya, made fiords of the valleys, and floated bergs laden with blocks from the lateral gulleys, which the winds and currents would deposit along certain lines."

Yet if I wished for *facts* in favour of the *present* erosive powers of subaërial agents, against that of *ancient* glacial sea, Dr. Hooker is the witness that I should call. I might quote from almost every page of his journey to the Donkia Pass. Thus in vol. ii. page 41, he talks of "the prevalence of land-slips which descend sometimes 300 feet carrying devastation along their course. They are caused by the melting of the snow-beds or by the action of the rains on the rocks. This phenomenon is as frequent and destructive as in Switzerland." Again at page 76, "Huge masses were ever and anon precipitated into the torrent with a roar that repeatedly spread consternation amongst us. During rains especially, and at night when the chilled atmospheric currents of air descended, and the sound was not dissipated as in the day time, the noise of these falls was sufficiently alarming. My tent was pitched near the base of the cliff and so high above the river that I had thought it beyond the reach of danger. But one morning I found a large fragment of granite had been hurled during the night to my very door; my dog having had a most narrow escape. I have seen few finer sights than the fall of these stupendous blocks into the furious torrent along which they were carried amid feathery foam for many yards before settling." Page 78, "The rivers were much swollen, the size and number of the stones they rolled along producing a deafening turmoil." Page 97, "We were suddenly startled from our repast by a noise like loud thunder, crash following crash and echoing through the valley. The Phipun got up and coolly said, 'the rocks are falling, it is time we were off, it will rain soon.' The moist vapours had by this time so accumulated as to be condensed in rain on the cliffs of Chomiomo and Kinchinjhow which loosened and precipitated avalanches of rocks and snow. We proceeded amidst dense fog, soon succeeded by rain, the roar of falling rocks on either hand increasing as these invisible giants spoke to one another in voices of thunder through the clouds. The effect was indescribably grand." Page 112, "Terrific land-slips had taken place along the valley carrying down acres of rock, soil, and pine-forest into the stream, and I saw one which swept over 100 yards in breadth of forest. The bridge at the Tuktoong being carried away, we had to ascend 1000 feet to a place where the river could be crossed. In many places we had great difficulty in proceeding, the track being obliterated by the rains and landslips. Along the flats, now covered with a dense vegetation, we waded often knee deep in mud." Page 125, "Broad flats clothed with rhododendron, alternated with others covered with mud, boulders and débris which had flowed down the gorges on the west and which still contained trees inclined in all directions and buried up to their branches. Some of these débâcles were 400 yards across and sloped at an angle of 2° to 3°, bearing on their surfaces blocks fifteen feet in diameter. They seem to subside materially, as I perceived they had left marks many feet higher on the tree trunks. Such débâcles must often bury standing forests in a very favourable material, climate, and position for becoming fossilised." Page 126, "Enormous masses of rocks were continually precipitated from the west side close to the shed in which I had taken up my quarters, keeping my people in constant alarm and causing a great commotion among the yaks, dogs, and ponies." Page 127, "Shoots of stones had descended from the ravines." Page 128, "Beyond this the path crossed the river and ascended rapidly over a mile of steeply sloping landslip, composed of angular fragments of granite, which were constantly falling from above and were extremely dangerous." Page 153, "The whole valley was buried under a torrent or débâcle of mud and boulders, and half a mile of its course was damned up into a deep lake." Page 154, "I met my friend on the other side of the mud torrent." Page 184, "I descended obliquely down a very steep slope over upwards of a thousand feet of débris, the blocks on which were so loosely poised on one another that it was necessary to proceed with the utmost circumspection, for I was alone, and a false step would almost certainly have been followed by breaking a leg. The alternate freezing and thawing of rain amongst these masses must produce a constant downward motion on the whole pile of débris (which was upwards of 2000 feet high) and may account for the otherwise unexplained phenomenon of continuous shoots of angular rocks reposing on very gentle slopes in other places."

So far for the *present erosion* of rain and rivers. For the *present deposit* from them take Dr. Hooker's description of the Cosi (of which the Yangma is a tributary) where it runs out of the Himalaya and into the Ganges, page 86, vol. i., "Even at this season (April, the end of the dry season) the enormous expanses of sand, the numerous shifting islets, and the long spits of mud, indicate the proximity of some very restless and resistless power. During the rains the scene must, indeed, be extraordinary when the Cosi lays many miles of land under water and pours so vast a quantity of detritus into the bed of the Ganges, that long islets are heaped up and swept away *in a few hours;* and the latter river becomes all but unnavigable. Boats are caught in whirlpools formed without a moment's warning, and sunk ere they have spun round thrice in the eddies."

As I have said in "Rain and Rivers," what is everlastingly *ascending* through the air as vapour from the sea is everlastingly *descending* through the air as rain on the land. This continuous circle of causes is always washing the land into the sea. And it is fire only which keeps our heads above water. Fire is the quarryman that is ever raising the block, the entire land, above the sea. Rain (with atmospheric erosion) is the chisel, which in the hand of the Almighty artificer, is for ever sculpturing the block,—that is, shaping the entire surface of the land, even to the topmost pinnacle of the highest snowcapped mountain, for snow is frozen rain.

Brookwood Park, Alresford,
*9th March,* 1867.

## NOTICES OF MEMOIRS.

### I.—A Brief Account of the "Thesaurus Siluricus," with a few Facts and Inferences. By J. J. Bigsby, M.D., F.G.S., etc.

[Proc. Royal Society, February 21, 1867.]

The "Thesaurus Siluricus" is a general view of Silurian life, as far as now known, in the form of a table. After mentioning the genus (taken alphabetically), its author, and the date of its establishment, the species are successively named, and treated of under four or more heads, along one and the same ruled line. First comes the part of the stage in which it occurs, then, in a given order, its author and locality, or localities, in the column indicative of its proper stage. The "Thesaurus" contains 7553 species, and therefore gives abundant scope for profitable study; but probably it does not give the tithe of the whole Silurian life yet lying buried in the wilds of the Arctic Circle, of Hudson's Bay, Labrador, the two Americas, Scandinavia, Australia, India, etc.

The author acknowledges many valuable corrections and suggestions made by Messrs. J. W. Salter and Robert Etheridge, who have carefully gone over the manuscript: he has also received several unpublished contributions relating to the Silurian Fauna and Flora from foreign Palæontologists. In this brief account of the Thesaurus, the author gives numerous tables of the general results arrived at. One table shows the number of species common to regions very remote from each other, some of them being antipodal—a fact which tells the more forcibly from the tenacity with which a large part of Silurian life clings to locality as well as to horizon. Thus, 179 species are common to Europe and America; 5 species to Europe and Australia; 6 species to America and Australia, etc.

Another table gives a synoptical view of Silurian life, with special reference to vertical range or recurrence. The orders vary greatly in respect to recurrency. There is none among fossil fish. In *Cystidea* it is only 3 per cent., in *Gomophoceras*, 5 per cent., and is greatest in *Strophomena*, being 31 per cent. The author has prepared a number of inferences in regard to recurrence. Among which are the following: *Species do not often change their horizon, not even when placed in countries far apart; the same species may be typical of a single horizon in one country and recurrent in another; the number of recurrent species measures the amount of change in conditions.*

Respecting Extra-Epochal Recurrence, the author states that 133 Silurian species may be regarded as recurring above the Silurian beds; with the exception of *Chonetes sarcinulata*, they all stop within the Devonian period. The greater part of these recurrents are of low rank: 20 are Brachiopoda, 11 Zoophytes, 1 Amorphozoon, 7 Gasteropoda, 3 Caphalopoda; 1 Trilobite.

These species are very migratory—few being found in two epochs in the same country, but in different countries.

[The Royal Society having voted £200 in the aid of the printing of Dr. Bigsby's Thesaurus, we understand the veteran author intends to incur the further expense (probably £300 additional) himself.]

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II.—Oligocene Deposit in Hungary.—At a meeting of the Imp. Geol. Institute of Vienna, held on February 5th, 1867, M. de Hantken read a paper on some Oligocene strata, exposed in a shaft recently sunk at Sarisap, near Gran, in Hungary. The strata, which are of brackish and marine origin, attain a thickness of 156 feet. The brackish beds, consist of sandy plastic clay, characterised by the presence of *Cerithium margaritaceum*, *Melanopsis ancillarioides*, *Cyrena semi-striata*, Desh., *Rosalina Viennensis*, d'Orb., and seeds of *Chara*.

The marine strata overlie those of brackish water origin; they are, however, separated by a well-marked bed of clay; one foot in thickness, containing, in great abundance, specimens of *Cingula*, closely allied to *C. sutura*, Franeuf. A sandstone, 60 feet in thickness, of marine origin, covers this bed of clay; it contains no Molluscan remains, but portions of *Echinidæ* are met with.—H.B.W.

## REVIEWS.

I.—CATALOGUES OF THE SILURIAN FOSSILS OF THE ISLAND OF ANTICOSTI, WITH DESCRIPTIONS OF NEW GENERA AND SPECIES. By E. BILLINGS, F.G.S., Palæontologist to the Geological Survey of Canada. 8vo., 93 pages. Montreal, Nov, 1866.

THIS brochure is the continuation of the "Palæozoic Fossils," of 426 pages, by the same author; of which the last sheets appeared in 1865. It contains descriptions of two new genera and 104 new species of mollusca, crustacea, etc., from the Hudson River, Anticosti, Clinton, and Niagara groups of Canada, in connection with general remarks of a novel character upon the synonymy of the American and English older Palæozoic rocks. Mr. Billings, though very modest and rarely appearing in public, has within the past ten years been greatly instrumental in advancing our knowledge of American Palæozoic geology. It was almost universally believed that the enormous thickness of strata called locally the "Quebec Group," and extending from the Gulf of St. Lawrence to Alabama, was of Middle Silurian age; but Mr. Billing's descriptions of fossils, fortified by the opinion of M. Barrande, have convinced the whole world that the series is not Middle Silurian, nor even the equivalent of the Lingula flags (Potsdam), but that it forms a new group not before recognized, of about the epoch of the Lower Llandeilo. An idea of Mr. Billing's ability and industry may be gathered from the fact that he has described not less than 43 new genera and 870 species of new Paleozoic fossils; and there are many others in his hands awaiting description. It is very creditable to the executive capacity of Sir W. E. Logan that the Survey under his charge has collected so many rare fossils, and arranged them in their proper stratigraphical horizons, or rather intercalated new epochs in the Silurian almanac. We trust these preliminary notices will be speedily followed by such accurate engravings and elaborate descriptions of the new forms as their importance demands, and such as will reflect honor upon the liberality of the Canadian Government.

We will now present a table of the revised nomenclature of the North American older strata, and their synonymy with the English formations, as enunciated in this pamphlet.

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| 1. Clinton, or divisions three and four of the Anticosti groups ... | U. Llandovery |
| 2. Anticosti, divisions one and two ... ... ... ... | L. Llandovery |
| 3. Oneida conglomerate, and Medina S. | |
| 4. Hudson River and Utica slates ... ... ... ... | Caradoc |
| 5. Trenton limestone | |
| 6. Birds-eye and Black River | |

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| 7. Chazy limestone | ... ... ... ... ... ... | U. Llandeilo |
| 8. Sillery } Quebec | | |
| 9. Lauzon } Quebec | | |
| 10. Lévis } Quebec | ... ... ... ... ... ... ... | L. Llandeilo |
| 11. U. Calciferous | | |
| 12. L. Calciferous ... | ... ... ... ... ... ... | U. Tremadoc |
| 13. U. Potsdam ... | ... ... ... ... ... ... | L. Tremadoc |
| 14. L. Potsdam ... | ... ... ... ... ... ... | U. Lingula |
| 15. St. John's group | ... ... ... ... ... ... | L. Lingula |

The whole aspect of No. 1 is very much like that of the U. Llandovery, especially in certain *Strophomena, Leptæna, Pentamerus, Stricklandinia, Spirifera, Cyrtia,* and *Leptocœlia.* The L. Llandovery is like No. 2, because it contains a curious admixture of both Upper and Lower Silurian types. No. 10 is connected with the L. Llandeilo or Skiddaw by a great development of Graptolites. No. 10 carries a fauna very distinct from Nos. 7 and 12, with which it has been heretofore confounded, containing 220 species (51 graptolites). No. 12 is the original Calciferous Sandstone of N.Y., and finds its nearest analogue in the Durness limestone of Scotland. No. 15 is identical with the Lower Lingula flags, as determined by the *Paradoxides.* These are considered to be quite satisfactorily paralleled; the other groups upon the same lines are supposed to have been nearly equivalent, because they come between others that are identical.

The Trenton limestone has been paralleled heretofore with the Llandeilo, with which it has scarcely any palæontological character in common. It abounds in *Cystideæ* and *Asteridæ, Rhynchonellæ, Strophomenæ,* and *Zoophyta* of the group *Zoantharia rugosa,* and thus is more nearly allied to the Caradoc. The Sillery and Lauzon divisions are very sparingly fossiliferous. The stratigraphical relations of the Lévis formation are best shown in Newfoundland, where the same fauna as that near Quebec appears in slightly inclined strata, but above the true calciferous as well as an intermediate group unlike anything elsewhere known. The Lévis in Newfoundland is 1400 feet thick; the Upper Calciferous 1300, and the Lower Calciferous 1800. The middle group contains the European genera *Acrotretra, Nileus, Holometopus,* and *Ampyx,* which extend into the following formations also. No. 13 is what has hitherto been known as the Potsdam sandstone of N. Y. Can. W., Minnesota, etc.: Gasteropods and Cephalopods make their first appearance here. No. 14 is known only in the sandstones and limestones of Belle Isle, and the "Georgia slates" and "Red sand-rock" of the Vermont Survey. They are characterised by the presence of *Olenellus, Bathynotus,* and certain species of *Bathyurus, Conocoryphe, Obolella,* and *Camerella.* The lowest group (No. 15) only contains *Paradoxides.* It has been found near the Atlantic coast in Newfoundland, New Brunswick, and Massachusetts. In New Brunswick it is 3000 feet thick and covers other sedimentary deposits, and probably in Massachusetts. It is certainly newer than the syenite of Massachusetts.

It is suggested as worthy of consideration, whether a break in one country may not be synonymous with a group in another;

especially as the breaks in England are more numerous, and the formations less abundant than in America. Until the discovery of Nos. 8 to 11, no one suspected that the palæontological break between 7 and 12 was of any consequence. Now, it appears that this break in New York represents three or four large groups of strata 600 to 800 miles away. Much more, therefore, may a break in England represent a formation in America, and *vice versa*.

Singularly enough the establishment of a zone of life below the Potsdam of America is, in agreement with the views of Professor Emmons, who as long ago as 1842 maintained the existence of a system which he called *Taconic*, and correlated it with the Cambrian of England. A part of the strata included in Mr. Billings' Lower Potsdam were labelled Taconic by Emmons twenty years ago. Although many of the so-called Taconic strata are unequivocally Lower Silurian, the question seriously presses upon us whether Nos. 14 and 15, with perhaps other formations connected with them, ought not to be called Taconic at the expense of both Silurian and Cambrian.

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II.—An Elementary Treatise on Quartz and Opal, including their varieties, etc. By George William Traill, G.S.E. Edinburgh: Maclachlan and Stewart. London: Simpkin, Marshall and Co.

WHY this little book has been published we are at a loss to conceive, as it is not written in a popular manner, nor does it fill any gap in mineralogical literature. Students of mineralogy will find in the several manuals on this subject, already published, all that is to be found in this work; and, indeed, in some of them, much more. In his Preface, the author says that quartz and opal hold a prominent place in most collections, and are well suited to form an independent treatise. We agree with him, provided always that the treatise includes a complete epitome of all the investigations that have been made upon the subject up to the time of its publication. But in this book no mention is made of the results of the very complete studies of M. Des Cloiseaux upon the crystallography and other physical properties of this mineral, which is to be found in his "Manuel de Mineralogie," the first part of which was published in 1862: and more in detail in Vol. xlv. of the "Annales de Chimie et de Physique," and in various memoirs presented to the Academy of Sciences of Paris; nor to the researches of Dr. E. Weiss on the crystallisation of quartz—all of which would have afforded materials for some very instructive chapters. The former eminent mineralogist has arrived at the conclusion that a simple crystal of quartz is of very rare occurrence. He shows that the apparently simple crystals from Buxton in Derbyshire, Dauphiné, Traversella, and other localities, are really macles. The important phenomena of circular polarisation, so peculiar to quartz, and the curious structure of amethyst, the author dismisses in a few sentences, while the interesting varieties called right and left handed quartz are not even mentioned. The various minerals enclosed by quartz during the process of crystallisation are simply enumerated, no attempt being made to explain the probable mode in which such hair-like crystals as those of rutile, asbestos, etc., are enclosed, those of the former often crossing each other at various angles. In the British Museum is exhibited a very instructive series of crystals and masses of quartz with enclosed minerals, conspicuous among which is a large crystal, said to be from Brazil, enclosing a large cavity containing a fluid, in which are some small loose crystals of iron pyrites. The same crystal also encloses several distinct doubly terminated crystals of quartz, and the impressions of some large tabular crystals which were probably mica. Another interesting example of an Enhydros in the same collection is a small nodule of translucent chalcedony about two and a half inches long by one and a half wide, which is three parts filled with a fluid, no doubt water. This was found near Salto, in Uruguay, by W. G. Lettsom, Esq., and probably represents one stage in the formation of agates.

Small but perfect rhombohedrons of a red colour have been found in the calcareous geodes, "potatoe-stones," of Somersetshire, and enclosing peroxide of iron, at Wolf's Island, Lake Onega, Government of Olonetz, Russia. The author places silicious sinter with quartz, whilst all reliable analyses show it to be hydrous; and its nearly complete solubility in caustic potash. together with its low density, point to the species opal as its correct place. He also states that aventurine is often imitated in glass. Is he not aware that the glass is the true aventurine, the name being adopted for a variety of quartz which was somewhat similar in appearance? A Frenchman dropped some copper filings accidentally, *par aventure*, into a fused vitreous mixture, and gave the name aventurine to the glittering mass which resulted from this accident.

As we have shown, this book is of no value to the mineralogist, though the author might have produced a really useful work by giving a little more time and labour to his subject, so as to include the results of the labours of those who have, during the last ten or fifteen years, made these minerals their special study.

## REPORTS AND PROCEEDINGS.

Geological Society of London.—March 20, 1867.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The following communications were read:—

1. "Report on recent discoveries of gold in New Brunswick." By W. S. Shea, Esq. Communicated by the Right Hon. the Earl of Carnarvon.

Mr. Shea gave in his report a detailed account of his explorations into the gold-bearing gravels of certain river valleys in the counties Victoria, Northumberland, Carleton, and York, in Central New Brunswick. He had been enabled therefrom to draw the following inferences:—(1) That the gold in these alluvial deposits is derived from the quartz-veins penetrating the rock of the district; (2) that the gravel, which contains pebbles of all sizes, was derived from the disintegration of the rocks of the district; and (3) that, judging from the richness in gold of paying drift in California, it is probable that these auriferous gravels will pay also.

2. "On the discovery of Coal on the Eastern Slope of the Andes." By W. Wheelwright, Esq. Communicated by Sir R. I. Murchison, Bart., K.C.B., F.R.S., etc.

In this paper the author reported the occurrence of beds of Coal on the eastern slope of the Andes, between the cities of Cordova and San Juan, about twenty-five leagues east of the latter city.

3. "On the presence of Purbeck Beds at Brill, Buckinghamshire.' By the Rev. P. B. Brodie, M.A., F.G.S.

The existence of the Purbeck-beds at Brill not having been yet accurately determined, the author recorded their occurrence in that locality, which he had been able to ascertain by finding blocks containing several species of Purbeck freshwater shells, especially *Paludina subangulata* and *Cyrena media*.

4. "On the Lower Lias, or Lias-conglomerate of Glamorganshire." By H. W. Bristow, Esq., F.R.S., F.G.S., of the Geological Survey of Great Britain.

The object of this communication was to show that the more or less conglomeratic strata immediately underlying the ordinary Lias limestone on the coast of Glamôrganshire, between the River Ogmore and Dunraven Point, do not belong to the Rhætic series, as has been supposed, but to the Lias.

The Sutton-stone of Sutton and the so-called Southerndown series (seen in the cliffs under the hamlet of that name) constitute, in reality, but one series, the stratigraphical position of which is proved by reference to the sections at Cwrt, near Langan, at St. Mary Hill Common, west of Trymynydd, and at the Stormy Cement Works, where it immediately overlies the Rhætic series, while its palæontological affinity with the Lias is proved by the occurrence throughout its entire thickness of the most characteristic shells of that formation, viz., *Gryphæa incurva*, *Ostrea Liassica*, *Lima gigantea* and *Ammonites*.

These conglomeratic strata extend over a large area from Sutton to beyond Cowbridge; and wherever the Lias rests upon Carboniferous Limestone or Magnesian Conglomerate, it assumes an abnormal lithological character, and becomes more or less conglomeratic. The replacement, in this district, of the ordinary calcareous and argillaceous sediments, of which the Rhætic and Liassic series are usually composed, in the former case by sandstones, and in the latter by conglomerates, indicates that they are the near-shore and shallow-water deposits of an area that now forms part of South Wales, and which was partially undergoing slow depression during the deposition of the Lias.

After noticing the occurrence of lead-ore (Galena) in these beds, the term Lias Conglomerate, originally applied to them by Sir Henry De la Beche, was proposed as being sufficiently precise and distinctive, the name Infra-lias, by which they are sometimes denoted, being objected to, as being both vague and misleading.

5. "On Abnormal conditions of Secondary Deposits when connected with the Somersetshire and South Wales Coal-basins; and on the age of the Sutton and Southerndown series." By Charles Moore, Esq., F.G.S.

The author first describes the geological constitution of the Mendip Hills, which, in his opinion, were upheaved by the intrusion of a basaltic dyke (now noticed for the first time) during the period of the Upper Trias. The Mendip chain proved an island-barrier to the incursion of the deeper sea-deposits of the south, on which lived the *Microlestes* and other terrestrial animals. Along the south side of this barrier shore-deposits were formed, the "Carboniferous Limestone" constituting the floor of the ocean at that time.

He then instituted a comparison between the Rhætic and Liassic formations within and those without the Somersetshire coal-basin. The thickness of the beds, from the Trias to the Inferior Oolite, was stated to be, outside the coal-field, 3320 feet, whilst inside it was only 169 feet. These results were obtained from an examination of numerous sections, which were described in detail by the author.

After considering the horizontal deposits beyond the Mendips, and the unconformable conditions within its coal-basin, the author discussed the abnormal conditions which are presented by deposits of the same age, when they are intimately connected with the "Carboniferous Limestone." In the Charterhouse lead-mine a deposit of clay, twelve feet in thickness, and containing Liassic shells, was stated to occur at a depth of 260 feet in the Carboniferous Limestone.

Among the organic remains, three species of terrestrial shells, referable to the genera *Helix*, *Vertigo*, and *Proserpina*, and a Chara-seed, were discovered.[1]

The author concluded by pointing out the peculiarities presented by the Liassic strata in Glamorganshire, with special reference to the stratigraphical position of the Sutton Stone and the Conglomerates of Brocastle, etc.

II.—April 3, 1866.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair. The following communications were read:

1. "Remarks on the Drift in a part of Warwickshire, and on the evidence of glacial action which it affords." By the Rev. P. B. Brodie, M.A., F.G.S.

The later Drift-deposits in the district treated of occur along the valley of the Avon, and consist of the usual sands and gravels, with Mammalian remains; but as yet no Flint Implements have been discovered in them. The author enumerated the different kinds of rock represented by pebbles or fossils in the gravel, and referred to the abundance of flints, and the occasional occurrence of pieces of chalk in the gravel as proof that their mode of conveyance was by icebergs, unless it be conceded that the Cretaceous formation at one time had a much further extension northwards. The abundant

[1] Since the reading of this paper, Mr. Moore writes me (April 7th), "Additional evidence in confirmation of a Mendip land-area has turned up, namely, shells of *Planorbis*, *Valvata*, and *Hydrobia*; also from the Charterhouse mine."—Edit.

quartzose pebbles occurring in the drift of Warwickshire have recently yielded fossils identical with those occurring in the pebbles at Budleigh Salterton; and the author suggests that they had a similar origin to those in Devonshire.

2. "On the dentition of *Rhinoceros leptorhinus.*" (Owen). By W. Boyd Dawkins, Esq., M.A. (Oxon.), F.G.S.

The Pleistocene species of Rhinoceros in Britain are four in number: *R. tichorhinus*, Cuv.; *R. megarhinus*, Christol; *R. Etruscus*, Falc.; and *R. leptorhinus*, Owen [=*R. hemitœchus* of Falconer]. The latter of these is characterized by the possession of a *partially ossified* septum between the nares, and by the slenderness of its bones. In common with the other three it was bicorn. Its upper molar series, as compared with the megarhine, is characterised by the following points:—by the rugosity of the enamel surface; by the development of a *third costa* on the *posterior area* of Pm. 3, 4; by the concavity of the base of the *external lamina;* and by the more vertical direction of the inner side of the *colles.* The absence of the *anterior combing plate* and the stoutness of the guard are among the points that separate it from the tichorhine molars. The species does not seem to have existed in Britain before the great Glacial epoch, the remains from the Forest-bed, attributed to it by Professor Owen, viewed by the light of other specimens, turning out to belong to *R. Etruscus.* It is associated with the tichorhine species in Wookey Hole Hyæna-den, with that and the Megarhine in the Lower Brick-earths of Crayford, in Kent. In a word, there is ample evidence to prove that it was coeval with the Mammoth and tichorhine Rhinoceros, that it ranged from Yorkshire through the eastern counties into South Wales and the south-west of England, and that it was very inferior to those animals in point of number. Its nearest living analogue is the bicorn Rhinoceros of Sumatra. The dentition both of the tichorhine and leptorhine species agrees remarkably in one point, that it is more specialized or, in other words, more closely allied to living forms than that of the megarhine, a fact that seems to the author to imply that both came into being *after* the less specialized *R. megarhinus* had ceased to exist.

3. "On the strata which form the base of the Lincolnshire Wolds." By John W. Judd, Esq., F.G.S.

After giving a sketch of the previous very scanty literature of the subject, the author proceeded to describe the outcrop and the various outliers and inliers of the "Hunstanton Red Limestone," which in this district serves as a well-marked datum line in the series of strata. It was shown that this bed, while maintaining much uniformity of lithological and palæontological characters, undergoes a regular attenuation southwards, being 30 feet thick at Speeton, 14 feet and upwards in Lincolnshire, and 4 feet at Hunstanton, thinning out entirely about 12 miles south of the last-mentioned place.

In the second part of the paper a general sketch of the Chalk formation in Lincolnshire was followed by detailed descriptions of a number of red beds, previously confounded with the Hunstanton Limestone, but now shown to be intercalated in the series of the

Lower Chalk. A typical section made at Louth was then compared with the grand natural section at Speeton Cliffs, as described by the Rev. T. Wiltshire, F.G.S.

The extensive deposits underlying the Hunstanton Limestone were described as follows :—1st, Ferruginous sands (unfossiliferous). 2nd, a series of limestones, sandstones, and clays, containing a large and interesting suite of fossils, with an undoubted Neocomian facies, but presenting greater affinities with the faunas of certain continental deposits than with that of the English Lower Greensand. For this formation the provisional name of "The Tealby Series" was proposed. 3rd, another and thicker series of sands. In its northward development, the Tealby series was described as furnishing beds of ironstone (often of Oolitic structure and of considerable economic value), and finally as graduating into the upper part of the Speeton clay; while, in tracing it southwards, it is found to become almost wholly arenaceous,

The author gave lists of the fossils of the different beds, and described the numerous faults, etc., of the district, which he illustrated by a map and numerous sections. He concluded with some remarks on the age of the various beds, and on the causes of the remarkable red colour of some of them.

An appendix, containing remarks on some of the fossils, showed that the following well-known species of Sowerby, *Ammonites plicomphalus*, *Pecten cinctus*, and *Lucina crassa*, are Neocomian, and not Jurassic forms, as has hitherto been supposed.

The fourth ordinary meeting of the Edinburgh Geological Society was held on February 7th, in their rooms, 5, St. Andrew Square,—Mr. David Page, President, in the chair. Dr. Henry Campbell read a paper on "The *Rhizopoda*, and their importance in geological formations." The skeletons of one order of those animals, the *Polythazamia*, were abundantly procured on almost every sandy shore, and the fragile shells formed the principal constituents of several very important geological formations. Mr. Andrew Taylor read a paper on "The past, present, and future of the Scotch and Welsh mineral oil supplies."

The fifth ordinary meeting of this society for the session was held on February 21st, in their rooms, No. 5, St. Andrew Square—Mr. Thomas Wallace, in the absence of the President, in the chair.

Mr. George Lyon, the treasurer, read a paper "On the Shell Mound which was lately excavated by the society in Dalmeny Park." He showed that the mound in question was of very modern origin, and contained nothing of any interest either in a geological or an archæological point of view.

Mr. John Henderson read a notice, which was illustrated with specimens and drawings, of "Three Species of Trilobites from the Silurian Beds of the Pentland Hills." They consisted of *Phacops Stokesii*, *Calymene Blumenbachii*, and a species, not yet well determined, belonging to the genus *Encrinurus*.

Mr. D. J. Brown then gave a short notice of the discovery of specimens of *Strophomena Walmstedii* in the Pentlands. This species is new to Britain. It has been found, however, in Sweden.

The concluding paper was on "The Silurian Beds of the Pentland Hills," by Messrs. D. J. Brown and John Henderson. A description was given of the section of the North Esk Reservoir, and more than a hundred species of fossils from these beds were exhibited to the members of the society. The authors of the paper gave their opinion as to the age of the beds, stating that they considered them to be both of Wenlock and Ludlow age. They combated Mr. Geikie's opinion as to the red beds being the lower portion of the Old Red Sandstone, and as they had both obtained Ludlow fossils from them, they had arrived at the conclusion that there are a series of red beds included in the Ludlow portion of the Silurian formation in the Pentlands. They also pointed out an error in the Government geological map of the district. The red beds in the maps are marked as if cut off in the form of a triangle, but Messrs. Brown and Henderson had traced them by cutting through the soil on the hill sides, until they considered themselves justified in concluding that those beds stretched across the whole area, in the same manner as the other beds.

Geological Society of Glasgow.—This society met in Anderson's University, on the evening of 7th March.—Mr. Edward A. Wunsch, Vice-President, in the chair.

On the motion of the chairman, seconded by the Rev. Henry W. Crosskey, Vice-President, Dr. John Young, Professor of Natural History in the University of Glasgow, was elected President of the society, in room of the late James Smith, Esq., of Jordan-hill, F.R.S.

Dr. Young said he accepted with pride the honour which the society had conferred on him. He had, though but recently a stranger in Glasgow, received what under other circumstances he might have hoped for as the reward of services rendered. The society had, as it were, taken him on trust, and he would earnestly endeavour to justify their generous confidence. After alluding to the former school of geology in Scotland, and its influence on the present tendencies of the science, he said it was small gratification to our national pride that Scotsmen were so prominent in England, while in Scotland there exists as yet neither school nor teacher. In the honest work of such a society as that of Glasgow the means exist for restoring to Scotland somewhat of its former prestige, and he (Dr. Young) was much gratified at the opportunity now offered him of furthering this desirable object. In taking the chair, Dr. Young returned sincere thanks for the high personal compliment bestowed on himself, and for the tacit appreciation thus shown of the duties upon which he was about to enter elsewhere—duties which the society had indicated its willingness to aid him in discharging, while it had added one more to the ties which drew the University and the city closer together, to the mutual benefit of both.

Mr. James Bennie exhibited a number of small pebbles and nodules, chiefly of limestone, which he had obtained from a bed of black bituminous shale, exposed at various quarries in the district of East Kilbride; many of them were perforated with holes, resembling in size, shape and depth, those formed by certain of the mollusca.

Mr. Bennie also exhibited, from the shales of the same district, what he considered to be specimens of very minute Crinoids.

Professor Young and Mr. John Young read a joint paper on "Local Unconformity, as illustrated in the Carboniferous Rocks near Bishopbriggs." In Coltpark Quarry Mr. Young had discovered a series of vertical beds beneath the nearly horizontal main post of the Bishopbriggs sandstone; and in this paper the authors described and illustrated by diagrams the detailed survey they had made of the neighbourhood. They considered that the vertical beds are a part of those lying beneath the Cowglen limestone; that about twenty-five feet of strata have been removed by denudation; and that the extremely local nature of the disturbance is such as might be due to an intrusion of greenstone, of which two examples are seen not far off. They concluded with some general remarks on local unconformity without disturbance, as abundantly illustrated in the same district, and on the uses of the terms unconformity and overlap.—J.A.

II. March 28th.—Dr. Young, President, in the chair.

T. Rupert Jones, Professor of Geology, Royal Military College, Sandhurst; James W. Kirkby, Sunderland; Henry Woodward, F.G.S., of the British Museum; and J. H. M'Chesney, Professor of Geology, University of Chicago, were elected honorary members; and Messrs Andrew Mackie, M.D., Abbotsford Place, C. B. Aikman, writer, St. Vincent Street, Alex. Smith, Little Hamilton Street, and John Anderson, painter, St. Enoch Square, were elected resident members of the Society.

Dr. Young exhibited specimens of a variety of *Megalichthys*, which in Scotland occurs only at Quarter, near Hamilton, and has, he believes, a similarly restricted range in North Staffordshire, which contrasts with the wide distribution of *M. Hibberti*. The scale is not enamelled, and is thickly covered with alternating larger and smaller tubercles, giving a very characteristic and elegant ornamentation. He exhibited the scales of genera allied to *Megalichthys*, and pointed out the difficulty of determining genera from single scales, the intermediate varieties between distinct types being numerous. Only a few scales of the Quarter fossil have been found, but further discoveries may justify its erection into a separate genus; meanwhile it is best to retain it as a species.

Mr. J. Wallace Young read a paper "On some Local Sandstones." The results may be shortly summed up as follows:—1st, That in the greater number of sandstones examined, the cementing material consisted of carbonates; 2nd, That very considerable quantities of the carbonates of iron and magnesia frequently accompanied the carbonate of lime, although no definite ratio seemed to exist between them; 3rd, That these sandstones were harder the greater the proportion of carbonates they contain; 4th, Mica was found to be present in nearly all those examined, and, with one exception, was of the white variety; 5th, Soluble silicates were only found in three varieties, in any quantity, all three belonging to the Old Red Sandstone; 6th, That the different shades of colour seen in those sandstones belonging to the last-mentioned rocks appeared to be due solely to the peroxide of iron, and that the white rings and spots so often observed have resulted from the reduction and subsequent removal of the greater part of this iron.

Dr. Young concluded his remarks on the Osteology of Fishes on which he had previously lectured (14th March.) In that lecture he pointed out the arrangement of the facial bones in the osseous and Ganoid orders among living fishes, and indicated their homologues, so far as they had been established, in the higher vertebrates. He then described the structure of the head of *Megalichthys*, and, comparing it with that of *Polypterus* and *Amia* (two living ganoids found in Egypt and the Southern States of America), he explained the close connection which had been established between the former living genus and the extinct family in which *Megalichthys* is included. On the present occasion he briefly summed up the grounds on which *Palæoniscus* and the majority of Mesozoic fishes are included in the same family with *Lepidosteus*, the North American ganoid, and referred to the new genus *Calamoichthys*, of J. A. Smith, as representing, in the absence of the ventral fin, *Platysomus* and its allies. He then showed that the progression which had been asserted as observable among fish from Palæozoic to modern times was not supported by the facts, since there was reason to believe that osseous fishes existed in the Old Red Sandstone, and, in the structures just described, presented as high a stage of development in ancient as in recent times. He then discussed the forms of the caudal fin, and, illustrating this subject from the researches of Kölliker, Huxley, and others, showed that "homocercal" was a term liable to create confusion, since the majority of osseoüs fishes are as "heterocercal" as the sharks. The unequal division of the tail presents several degrees both in extinct and living ganoids, which might be described as "heterocercal equilobate, or inequilobate." "Diphycercal," M'Coy's term, should be restricted to truly homocercal tails, as of *Cœlacanthus* and *Diplopterus*. The difficulties of classifying fishes were spoken of in reference to the arrangement according to scales, as proposed by Agassiz; and the true principle, that of grouping according to the sum of characters explained.—J.A.

Montreal Natural History Society.—The first lecture of the Somerville course for the present season was delivered on Thursday evening, January 17th, by Dr. P. P. Carpenter, who chose for his subject, "The works and ways of shell-fish."

II.—On January 26th, the President (Dr. Hunt) in the chair.

Principal Dawson then read a paper "On certain discoveries in regard to *Eozoön Canadense*."

The paper was preceded by one from Mr. H. G. Vennor (of the

Canadian Geological Survey), relating the exact circumstances under which the specimen to be described was found, and giving a detailed description of a section of the rocks from which the fossil in question was procured.

Principal Dawson exhibited a photograph of a remarkable specimen of *Eozoön Canadense*, found during the past summer in the Laurentian limestone of Tudor, Canada West, by Mr. Vennor. The rocks at Tudor and its vicinity, which, according to the observations of Mr. Vennor, are Lower Laurentian, have experienced less metamorphism than is usual in formations of that age. And this peculiarity gives especial interest to the present specimen, which is contained in a rock scarcely altered, and in a condition not essentially different, from that of ordinary Silurian fossils.

The matrix is a coarse laminated limestone of a dark colour, and containing much sand and finely comminuted carbonaceous matter. The fossil itself is of a flattened clavate form, about six and a half inches in length, and with the septa of its chambers perfectly preserved, exhibiting on one side a well-defined marginal wall, produced by coalescence of the septa, and apparently traversed by small orifices. Under the microscope the minute structures of *Eozoön Canadense* can be detected, though less distinctly perceived than in some of the specimens mineralized by serpentine. In some of the chambers there are small amorphous bodies containing pointed silicious spicules, which seem to be the remains of sponges that have established themselves in the cells after the animal matter of *Eozoön* had disappeared.

The importance of this specimen was pointed out as establishing the conclusions previously arrived at from the study of the remains of *Eozoön* included in the serpentinous limestones, and as overthrowing the objections raised in some quarters to the organic origin of *Eozoön*. The specimen will be taken to England by Sir W. E. Logan, and full details of its characters will be communicated to the Geological Society, along with some other recent discoveries, tending to the establishment of a second species of *Eozoön*.

Dr. Hunt, in some remarks made at the conclusion of the paper, gave Mr. Vennor due credit for establishing the occurrence of Laurentian limestones at Tudor, and stated that the degree of metamorphism of rocks was not necessarily dependent upon the age of the formation.

III.—One of the course of six free lectures annually given by the Natural History Society, was delivered on February 9th, by Dr. T. Sterry Hunt, F.R.S., President of the Society, to a full and attentive house.

The subject announced was "The Origin of Continents." The lecturer proceeded to describe briefly the great facts with regard to the outlines of continents and oceans. The mean depth of the waters, which cover eight-elevenths of the globe, was about 10,000 feet, and the mean height of the land about 1,000 feet. If we suppose a globe eighty feet in diameter, the deepest parts of the sea would be represented on it by depressions of half an inch, and the highest mountains only about five-eighths, while the Alleghanies would not rise much over one-eighth of an inch above the mean level. Going back to the origin of the present continents, built up of sedimentary rocks,—sand, clay and limestone,—often more or less altered and crystallized; the lecturer described the condition of the primitive globe, a mass intensely heated, but solid to the centre, surrounded with an irregular surface partially covered by water. This, wearing down the crust, would form sedimentary rocks, which softened in their lower parts by the central heat, would permit irregular movements of depression and elevation of the superficial crust, consequent upon greater weight in one place, and less weight in another. To this was conjoined the contraction of the whole outer sedimentary envelope of the globe. The action of atmospheric and other agencies in slowly wearing away the earth's crust was dwelt upon, and it was explained that the matter thus carried down into the sea is distributed by great ocean currents. These are due to the different temperatures of the Equator and Poles, but are modified in their course by the rotation of the earth, giving the northern hemisphere hot and cold north-east and south-west currents, and in the southern hot and cold south-east and north-west currents. Besides, there is a great equatorial current from east to west. To these directions all the great mountain chains conform, with some variations from local causes. The lecturer then explained that the history of mountains was the history of continents, since mountains are but portions of continents which have escaped the eroding action that sooner or later breaks down the solid lands. He illustrated this part of the subject by reference to the geology of eastern North America, and showed how in early times the great ocean currents had spread, in a north-east and south-west direction, a vast mass of sediment along the eastern part of the continent, which now forms the great Appalachian belt, partly cut away, but still leaving ridges of mountains.

In conclusion, the lecturer observed that the field opened by his theme was far too vast for a single lecture, and that he had been obliged to omit many important points which were required for the full elucidation of this subject.

IV.—The annual Conversazione of this society took place on February 18th. Geology, Palæontology, Zoology, Botany, Chemistry, Physical Science, and the Fine Arts, were duly represented.

The President of the society, Dr. T. Sterry Hunt, F.R.S., welcomed, in the name of the society, the assembled guests, and alluded briefly to the general object of these annual conversaziones. He alluded to the services of their scientific curator, Mr. J. F. Whiteaves, to whose industry and extensive scientific knowledge the society were deeply indebted; and then proceeded to make some remarks on meteors, preliminary to an explanation of the periodic nature of the November meteors; he defined two classes, the stony or metallic äerolite, or fire balls, and the shooting stars; the first comparatively rare, and the last very common, and of daily occurrence.

From good data, Professor H. A. Newton, of Yale College, has calculated that they proceed from an elliptical ring, which has a period of revolution of 281 days, and through which the earth passes about this time, occupying three or four days, showing that this belt must be several millions of miles thick, and must contain, at a moderate calculation, more than three hundred millions of small meteoric bodies.

Now the earth at this time is advancing through space at the rate of about two millions of miles a day, and the bodies of this ring, having a retrogade motion, enter our atmosphere with immense velocity. The ordinary height of these luminous meteors is from fifty to seventy miles, and the rare atmosphere at that height opposes sufficient resistance to these rapidly moving bodies to heat them to whiteness, and even convert them into vapour. The latent heat of a given bulk of this rare atmosphere is as great as that of the same bulk of more dense air near the earth, and calculations show that a meteor, moving at a rate of only ten miles a second, or less than one-half the ordinary velocity of these bodies, at a height of thirty-four miles, would in one second's time evolve heat enough to make its mass white hot. The real luminous appearance comes, however, from the atmosphere condensed before the moving body, and from the matter of this converted into gas by the intense heat. If not already dispelled in vapour, these bodies,on reaching the lower region of the air, cease to be luminous from the very density of the atmosphere.—*Montreal Daily News and Gazette.*

## CORRESPONDENCE.

### ON THE ALLEGED HYDROTHERMAL ORIGIN OF CERTAIN GRANITES AND METAMORPHIC ROCKS.

*To the Editor of the* Geological Magazine.

Dear Sir.—The letter of Mr. James Geikie which appeared in your last number obliges me to send a few lines in reply.

I may premise by stating that my communication, "On the alleged hydrothermal origin of certain granites and metamorphic rocks," owed its appearance in print, solely to the fact of the Memoirs therein referred to, having emanated from the pen of a member of the Geological Survey of Great Britain, and it was the official position of the writer which alone caused his productions to be submitted to the severe, but just, criticism which therein appeared.

Mr. James Geikie, in his reply, takes me to task for so confounding him with the Survey; independent of his being actually an officer of the Survey, it will be seen, upon reference to his own memoir,[1] that after stating that the Geological Survey (represented by himself and his colleagues, Dr. Young, and Mr. A. Geikie) was in 1865 extended to the district in question; Mr. James Geikie announces the object of his memoir in the following words :—

"With Sir Roderick Murchison's permission, some of the more

[1] Quart. Journ. Geol. Soc., vol. xxii. p. 514.

interesting results obtained during the progress of the Survey are here described."

In my communication, I based my remarks upon principles which the entire geological world will unanimously concede to me, viz:—That in an investigation of admittedly one of the most intricate and abstruse problems which form the subject of geological research, it is absolutely, nay, vitally, essential that each step forward in the inquiry should be tested with the utmost care and suspicion; that each argument, derived from the collateral sciences, should be thoroughly examined into, as to soundness; and that no misunderstanding should be allowed to arise from the use of a bad or indefinite terminology.

From the tenor of Mr. James Geikie's remarks, may it not fairly be asked:—To whom does he address himself? or, for whom is he writing? whether to beginners in the science, or to the Geological Society of London? If to the former, may it not be inquired, whether the subject is not, in itself, too abstruse for beginners, and should not the most scrupulous care be taken, that nought but admittedly sound arguments, nomenclature, or similes, be made use of; for all know how exceedingly difficult it is to eradicate incorrect notions, when once they get into the head of a beginner in science. If to the latter, to whom his first memoir is especially addressed, are not geologists, when an author ventures to bring novel and sweeping views in the most abstruse departments of the science before a tribunal supposed to represent the highest geological talent of the empire, fairly entitled to demand that, at least, his premises are not indefinite or unsound, and that his phraseology is not, as admitted, "careless and unguarded."

After a careful perusal of Mr. James Geikie's reply, I cannot find anything therein which in any way disproves, or even shakes, the weight of my arguments; but, from that gentleman's defence, I can clearly understand, that the time has come when it will not do to mince matters in this discussion; for, as the reader will perceive, it is not against Mr. James Geikie that I am fighting, but against the system which he now attempts to defend.

Glad should I be if I could (as Mr. James Geikie would charge me with) believe "that the terminology of petrology is as fixed as that of the exact sciences;" what I do, however, believe is, that *it ought so to be,* and further, that it is a disgrace to the present state of geological science that it is not so.

No person is more fully aware that "looseness" in petrological nomenclature is unfortunately the rule, not the exception; and that geologists may continually be found mapping and writing of totally different rocks, under one and the same name; what I, however, would infer therefrom is, simply, that it is high time to reform.

In what, now, does Mr. James Geikie's defence consist? Upon perusal of his reply, it will at once be perceived that it is, in major part, a simple "tu quoque" to other (often eminent) writers upon the subject; an argument which may be very effective against these gentlemen, but one which the rest of the geological world will not accept, as either exculpating an officer of the Geological Survey, or acquitting him of following an example patently bad.

In such instances one mis-statement becomes a precedent for another, and although such precedents may fairly be brought forward in extenuation, still they do not, as Mr. J. Geikie would have us believe, entirely exonerate himself.

For this purpose, he quotes names of the highest authority in other branches of geology, as Lyell, Phillips, and Dana. I would, however, not do Sir Charles, our great expounder of geological principles, the injustice to suppose that he would attempt to enforce strictly the rock definitions contained in chapters xxviii. and xxxiii. of his Elements as a standard for exact petrological comparison; nor, do I imagine, would the cautious Professor Phillips think it fair-play if the chapter v. of his Manual was to be dissected for similar purposes; and still less would the celebrated mineralogist Dana commit himself, without reserve, to the rock definitions given in p. 246, vol. ii., of his Mineralogy, where he does happen to allude to mica-slate as a gneiss with a distinctly foliated structure.

In questions of petrology, instead of quotations from works on general or elementary geology, I had expected to have been referred to works specially devoted to that subject; but, with the exception of the recent translation of Cotta, on the classification of rocks, a work acknowledged not to fulfil the requirements of the present state of science,[1] Mr. James Geikie does not even allude to them.[2]

Mr. James Geikie deprecatingly expatiates on the profound knowledge of chemistry, mineralogy, etc., which he declares I would require of the geologist, evidently not wishing to acknowledge that the pith of my argument was but intended as a warning to those geologists who really possessed no knowledge of these sciences not to expose themselves to just criticism by filling their pages with unwarranted or unsound chemical or other data or hypotheses.

The geologist who enters into the details of any one department of his science, will regard "Admirable Crichtons" as fossils from a very early period of science, for nobody knows better the absurdity of any man, however talented, pretending to be an authority on all branches of any one science; for in this century every science presents far too wide a field for any single labourer to cultivate all parts of it properly, or in other words, to be at the same time "well up" in every department.

From time to time, in geology, as in every other science, the appearance of a generalising mind like Lyell is required to take up the accumulating chaos of facts, and mould them into shape: the true steady advance of geological science depends, however, in greater part upon the labours of the working bees who provide these data, by (without attempting to grasp too much) devoting their energies to the minute and careful investigation of some special branch, how-

[1] Vide Reviews in GEOLOGICAL MAGAZINE and *Atheneum*

[2] There is no want of special works on this subject; to witness the publications of Blum, Brongniart, Coquand, D'Halloy, Erdman, Leonhardt, Mayer, Macculloch, Pinkerton, Roth, Senft, Serres, Zirkel, etc.

ever small, of the science, bringing in to their assistance a sound knowledge (acquired by patience and labour) of so much of the collateral sciences, as specially applies to the chosen department of inquiry: without, however, attempting or pretending to the impossibility of being at the same time profound in such science.

Mr. James Geikie does me injustice in making me appear to say, that the development of crystalline rocks from aqueous strata "is a notion supported only by his assertion." How could I give that gentleman credit for an idea far older than either of us, and cases of which I have myself years ago examined and described.[1] Upon reference to my communication, p. 57, it will be seen that I simply record a decided protest against the statement made by Mr. James Geikie, when he writes—

"It is *certain*, however, that rocks, such as diallogite, hypersthenite, diorite, syenite, or even granite itself, can be developed directly from aqueous rocks," etc.

If instead of "certain," the word possible or even probable had been used, I should not have objected, and now repeat that a very careful inquiry into the literature of the subject, does, I consider, fully warrant me in protesting against any such dogmatic and sweeping assertion being made or accepted in the present state of our knowledge of the subject.

Opinions must not be represented as facts before they have received general acceptance. In a question in which the geological world is undoubtedly divided in opinion, no such sweeping assertions can be admitted as evidence in investigations of such intricate nature as those which are the subject of the present inquiry.

Mr. James Geikie cites, in support of his views, the labours of the late Professor Keilhau in his so-called "Transition-formation of Christiania,"[2] but surely, in so doing, he must be quite unaware that these had long ago been most thoroughly disproved, and set aside by the results of the subsequent explorations of Sir Roderick Murchison,[3] and the still later researches of Professor Kjerulf,[4] in his work upon that formation, which I would here recommend to all geologists as a model for the investigation of similar metamorphic phenomena as are here referred to.

Notwithstanding my distinct statement to the contrary, Mr. James Geikie seems determined to make the object of my communication appear as a declaration against hydrothermal action, and will not remember that it really was to examine his evidence, not to dispute his conclusions; and I now maintain, whatever truth may or may not

[1] Amongst others, I can refer to the highly crystalline Hornblende rocks so extensively occurring on the whole of the south coast of Norway, examined by me in 1853 and following year, and which it will be seen in my "Geologiske Undersogelse over det metamorphiske Territorium, ved Norges Sydkyst." Nyt Magazin for Naturvidenskaberne, Vol. iv. p. 164 et seq., I have declared to be, in my opinion, all formed *in sitû* from tuffs of aqueous deposition.

[2] Nyt Magazin for Naturvidenskaberne, Vol. i., 1838, and more fully in the Gaea Norwegica, Vol. i., of same author.

[3] Quart. Journ. Geol. Soc., Vol. i. p. 467.

[4] Das Christiania Silurbecken chemisch geognostish untersucht, 1855.

be in those conclusions, that they were not warranted by the evidence which he has laid before the geological public, who will, I think, agree with me in returning the Scotch verdict of "not proven," and advise him to try again if he wishes to convince the geological world of their correctness.[1]

To avoid extending these remarks to too great a length, I will, in conclusion, only refer to one more point in Mr. James Geikie's reply.

That gentleman differs from me as to the meaning of the term "greywacké" in petrology,[2] and in page 178 informs the readers of your Magazine that "the greywackés familiar to Scottish geologists do not 'consist essentially of seventy-five per cent of quartz,' nor have they any definite composition whatever. The term 'greywacké,' as used by Scottish geologists, is applied exclusively to the hardened felspathic, and sometimes argillaceous sandstones of the Silurian regions, in which, although quartz is frequently present, it is by no means a necessarily preponderating ingredient."

Always regarding science and its nomenclature as cosmopolitan, I am of opinion that such style of argument should be protested against; as no doubt Mr. James Geikie would do, if informed that he must be quite wrong, because "Manx"[3] geologists entertained a totally different opinion of the rock species "greywacké."

[1] Since my former communication, the arrival of Dr. Sterry Hunt in this country has procured me the pleasure of his personal acquaintance. The opportunity thus afforded us, of comparing notes on chemical geology, showed how many similar conclusions we had respectively come to, from the study of widely different parts of the globe, and assured us that any difference in opinion could not arise as to the agencies employed in Nature's operations, although we might be somewhat at variance as to the precise extent to which each agent had been engaged.

[2] A study of the rock in the field in localities specially characteristic, combined with an examination of the descriptions given by the numerous writers on the subject, has resulted in my defining this rock species as follows:—

Greywacké.—A sedimentary rock usually of a greyish colour (whence its name) found extensively developed in the earlier geological formations; but not specially characteristic of any one of same. Petrologically, "greywacké" is an impure sandstone, more or less argillaceous, formed from the débris of previously existing rocks, re-arranged by aqueous action, and subsequently, more or less consolidated. Usually compact, it may vary in texture from fine-grained to coarsely conglomeritic; the stratification of the beds is frequently indistinct, unless viewed upon the large scale; when coarse it may contain fragments of fossils, and of other rocks, as clay-slate, mica schist, granite, porphyry, limestone, etc. Mineralogically, it is essentially quartz, with more or less clay, and frequently contains grains or scales of mica, chlorite, talc, lithomorge felspar, calcite, iron pyrites, etc. Chemically, it is composed of some seventy to eighty-five per cent. silica, along with alumina and a little oxide of iron, with but traces of the alkali and alkaline earths. Chemical and microscopical examination show comparatively little combined silica, the major part being in the free state as quartz.

This definition I maintain is in accordance with the views of all the writers on the subject whom I have consulted, and in corroboration thereof, I would cite the following references: Bischoff, iii. p. 132; Blum, p. 284; Brongniart, pp. 123, 126; Coquand, p. 238; Cotta, p. 301; D'Halloy, p. 15; Erdman, p. 173; Grimm, p. 215; Jameson, p. 226; Kjerulf, p. 72; Leonhardt, p. 171; Mayer, iii. p. 1; Macculloch, p. 358; Page, p. 309; Pinkerton, i. p. 291; Phillips, p. 654; Roth, p. 59; Senft, p. 332; Zirkel, ii. p. 594.

[3] And our little Island is probably one of the best localities in Europe for the study of this rock.

I had, however, far too great a respect for the many eminent geologists of Scotland, and too little confidence in either Mr. James Geikie's petrology, or his assertions, to accept the above statement without examining into its correctness, and I think the result of the inquiry will satisfy the public that the name of the Scottish geologists has been taken in vain, and that

1. The term "greywacké," when "familiar to," and "used by" Scottish geologists, corresponds satisfactorily with the definition I have accorded to it—one endorsed by geologists of all nations.
2. That this rock possesses not only a distinct mineral character, but, within certain limits, also a definite chemical composition.
3. That quartz is "a necessarily preponderating ingredient," and is generally present in fully seventy-five per cent.
4. That the term is not, by Scottish geologists, "exclusively applied to felspathic," etc., nor that the word "felspathic" should be at all used when referring to normal "greywacké."

Mr. James Geikie, who in his reply expresses his doubt as to my "careful examination of the literature of the subject," will think it still more strange and presumptuous in my thus attacking him at home, and undertaking the defence of the Scottish geologists; but I would ask him whether he is aware that it was a Scottish geologist, Professor Jameson of Edinburgh, the pupil and friend of Werner, who first introduced the term "greywacké" into the English scientific language; and if he will refer to that author's work upon the mineralogy of the Scottish Isles, published in 1800, he will there find (vol. i. p. 226) my definition perfectly confirmed. If, then, he turns to the (for its period, excellent) work on petrology, "Macculloch's Classification of Rocks," published in 1821, also by a Scottish geologist, it will be seen, at page 358, that the different varieties of greywacké are there respectively defined as rocks composed of—

1. "Quartz sand, intermixed with lamina or massive schist."
2. "Quartz gravel, of various sizes, similarly intermixed."
3. "Argillaceous schist, with very fine grains or powder of quartz. Not fissile; fracture sometimes rough and splintery, and often resembling the fine and grey varieties of primary sandstone."
4. Ditto, "with visible grains of quartz of various sizes, and resembling the coarser varieties of the same rock."

And if, to carry the literature of the subject down to the present day, he refers to a recent work, also Scottish, and which he already has quoted in his reply, viz., Page's Advanced Text-book of Geology, he will there find (p. 309) the previous descriptions confirmed—nor in any case will he find the felspathic element of greywacké, which is so convenient for his metamorphic hypothesis, even alluded to by these Scottish geologists. David Forbes.

London, *3rd April*, 1867.

## THE DRIFT OF THE WESTERN AND EASTERN COUNTIES.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—I see that Mr. Hull has favoured you with a simple classification of the drift deposits of Lancashire and Cheshire, which he asserts to consist of (3) Upper Boulder-clay or Till, (2) Middle Sand and Gravel, (1) Lower Boulder-clay or Till. Now some twenty-five years since, in a paper printed by the Manchester Geological Society, I gave the following general classification:—

1.—Beds of stratified and unstratified gravel and sand, containing well rounded pebbles of primitive Primary and later Secondary rocks.

2.—Till, a thick deposit of marl or brown clay, mixed with angular or rounded pebbles of various sizes without any order of deposition.

3.—Beds of stratified fine rolled gravel and forest sand, often containing beds of clay or loam.

4.—Deposits of gravel and sand, both stratified and unstratified, found in the beds of valleys and low lands adjoining rivers and brook courses.

In addition to the above a bed of rich loam is frequently found in the valleys, covering the last-named deposit.

The Till or Boulder-clay of Lancashire and Cheshire, as seen at Blackpool and New Brighton on the coast, is one thick bed intercalated with beds of silt, sand, and gravel; but when we approach the sides of the Pennine Chain, a very different series of beds occurs. At Broadstairs Colliery, near Hyde, the following section in the descending order was met with, viz.:—

| | | FT. | IN. | | | FT. | IN. |
|---|---|---|---|---|---|---|---|
| 1 | Clay | 11 | 0 | 8 | Quicksand and Loam | 6 | 0 |
| 2 | Quicksand | 2 | 6 | 9 | Gravel | 3 | 0 |
| 3 | Strong Marl | 22 | 6 | 10 | Loam | 7 | 6 |
| 4 | Quicksand | 2 | 6 | 11 | Gravel and Sand | 3 | 0 |
| 5 | Loam with Pebbles | 12 | 6 | 12 | Clay and Loam | 15 | 6 |
| 6 | Buck-leaf Marl | 19 | 0 | 13 | Gravel and Soft Marl containing Pebbles | 10 | 0 |
| 7 | Dry Sand | 9 | 0 | | | | |

I give this section as an instance to show the difficulty of classifying the drift deposits, either by my old arrangement or Mr. Hull's new one. At present, probably both must be considered as provisional, to be perfected when the deposits have been more thoroughly investigated and better known.

The eastern part of England, I imagine, is in about the same condition; for, after some years examination of the Drift deposits in Notts., Lincoln, York, Durham, and Northumberland, I have not been able to make the sequence of the beds, as Mr. S. V. Wood, jun., appears to have found, more to the south.

I remain, Sir, yours truly,
E. W. BINNEY.

MANCHESTER, *April* 8, 1867.

## FISH IN THE OLD RED SANDSTONE.

*To the Editor of the* Geological Magazine.

Sir.—Mr. Pengelly's answer is clear and definite. Such good authorities on fish remains give one the strongest reason to believe that this Upper Old Red fish really does occur in what we *believe* to be Lower Devonian.

On the Irishman's principle of coming for aid to-day, because he was relieved yesterday, I must ask three or four more questions. First, is it sure that the locality, Meadsfoot Bay, is the same age as the Meadsfoot Sands, which are certainly Lower Devonian, by their fossils. The country is awfully faulted; and as the Barnstaple beds (=Upper Old Red, as I have proved by their fossils) are everywhere likely to be unconformable, on the Middle and Lower beds, I think it is possible we may get patches of it here and there, and should like to know (it is years since I saw Meadsfoot) if the beds can be continuously traced.

Next, I should like to ask whether *Pleurodictyum problematicum* Goldf., one of the most characteristic of the Lower Devonian corals in S. Devon, and in the Rhine country, really ever does occur in the Barnstaple group, or the Coomhola grits of the south of Ireland? It has been frequently quoted of late years (I believe by Professor Jukes). Will my friend Mr. Baily re-examine his specimens; and any others who may possess this fossil make sure of it?

There is a *Dictyophyllia*, a Lower Carboniferous coral, allied to *Pleurodictyum*, common enough at Barnstaple, but not, I think, the same species as the Mountain Limestone fossil. This I have seen from various localities in the Uppermost Devonian. Is it possible that it may have been mistaken for the *Pleurodictyum*?

Again, has any one ever seen, in Mountain Limestone rocks, *Stringocephalus*, *Calceola*, *Pentamerus*, *Atrypa*, *Uncites*, *Strophalosia*, the various species of *Acervularia*, *Cystiphyllum*, *Smithia* (or *Streptastrea*), *Heliolites*; the forms of *Favosites*, allied to *F. cristata* and *F. cervicornis*, the Devonian types of *Hexacrinus*, *Sphærocrinus*, *Stylocrinus* (*Cupressocrinus is rarely* found, I know, in Carboniferous Limestone, but is *characteristically* Devonian for all that), the elongated forms of *Pentremites*, *Phacops*, *Prœtus*, *Harpes*, *Cyphaspis*, *Homalonotus*, *Bronteus*, *Cheirurus*, etc.

If none, or next to none, of these genera occur in Mountain Limestone localities: if *Productus* is everywhere common in the last, and absent in the first: and if the corals, crinoids, shells, trilobites, and fish, which characterize the Devonian, are absent in the overlying Carboniferous—and *vice versa*, what is the use of trying to make the one the equivalent in time of the other? Yours truly,

J. W. Salter.

P.S.—Since I wrote the above, Mr. Pengelly has brought up his specimens to London. The *Phyllolepis* from Meadsfoot is indeed like that genus. The fish-defences (*Ctenacanthus*?) are equally unquestionable; they are from Looe Island. There is nothing like asking questions to get at truth. Here have been some valuable data long buried;

and now my friend consents to have them figured and described by our best authorities. So I must invite geologists, if not Mr. Pengelly himself, to find for us what shells, corals, etc., occur *with* these actual specimens. They do indeed *appear* to lie in the lowest beds; but there is the possibility, I have above hinted at, of the Upper beds overlapping unconformably round the south coast, where hitherto we have not known them. Near Teignmouth, indeed, we have the Upper Devonian beds; and my note-book tells me there is a fault (one out of many in this district) between the Meadsfoot sandstones with Lower Devonian shells, and the pile of grey rocks which hold this fish-scale; and unconformity and faults will do *anything* but mix the fossils in the bed itself, especially in S. Devon.

But Looe Island with the fish, is not Looe with its Lower Devonian shells; and Meadsfoot fish-bed has not *yet* been proved to be the same beds as those which hold the trilobites and shells. Here is work for the local geologist; and as asking about the fish has produced so much, I hope asking about the geology will do more. We want now to know what are the exact relations of the beds which hold these fish: for fish they are—the only ones (the N. Devon one was a mistake) known in British Devonian rocks.—J. W. S.

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## BALA AND HIRNANT LIMESTONE.

*To the Editor of the* Geological Magazine.

Sir,—There is a point of much interest to be worked out in North Wales: viz., the exact relation and age of the upper or Hirnant limestone of Bala.

Some of the fossils in this remarkable band are known. It is the only example (so far as I know), in rocks below the Wenlock limestone, of a pisolitic structure; very marked in the neighbourhood of Bala. But beyond Bala, etc., it is not at present known.

I beg to suggest an excellent piece of work for one of the Clubs this year (unless Mr. Davies, of Oswestry, means to do it single handed). It is to work out *thoroughly* the geology of one mountain, close to Llangollen, and therefore easily accessible. If they would examine Mynydd-Fron-Frys, which is not a lofty one, and has good roads all round, it will be much better service than making what is called a section or a traverse. There are two beds of limestone there:—the Bala limestone, and an upper one, probably, the "Hirnant" limestone; and from this locality some of the very rarest of our Bala fossils have been obtained.

There is a huge *Loxonema* there, six or seven inches long; a fine *Lituites*, viz., *L. anguiformis*,—the only specimen known in Britain, yet, is that in the Woodwardian Museum. Then, again, there is a species, probably new, of *Bumastus* to be found; and such a crowd of Corals, *Bryozoa*, and other choice things, that it is like working in a museum; I had but two hours for it all.

Now what we want to know is the exact contents of each of these bands of limestone; for one is probably very different from the other. And if the above rare fossils are from quarries in the upper bed, no wonder we do not know them elsewhere in the great Bala (or Caradoc) series. Besides that, in all probability, the north end of the hill is made up of the Llandovery rocks. I will gage almost anything I have (and that is not much), that the Llandovery conglomerates and shales occupy the hill of Pentre, and the slopes above Tal-y-Garth. Beyond this I will not suggest, for the neighbouring ground looks terribly faulted; and no one knows what is the actual base of the Upper Silurian series in the valley,—seeing that the pale "Tarannon" shales are not traced there, nor are the Denbighshire grits: indeed the latter never were there at all.

I know no place within *easy* reach, (for that is something in the matter,) where a Club-meeting might do more good; but then they must make up their minds to *walk the hill across from north to south, and in several directions;* and not disperse their energies over a long section, or go in search of the picturesque. The geology is very simple in the hill itself; but outside of it, faults and unconformable junctions obscure everything.

1. Slates under the lower limestone.
2. Lower limestone (Bala).
3. Slates between the limestones (Upper Bala).
4. Hirnant limestone?
5. Soft slates—which may be Llandovery?
6. Llandovery conglomerates?

Will anybody set to work on it? J. W. Salter.

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## GENERAL GLACIATION OF IRELAND.
(WITH A MAP.)

*To the Editor of the* Geological Magazine.

Sir,—A number of copies of the accompanying map having been cast adrift by the unforeseen discontinuation of the Dublin Quarterly Journal of Science, for which they had been prepared, you have charitably consented to afford them harbour in the Geological Magazine. At your desire I give an explanation of the map, and a concise account of the paper which it illustrates (noticed by yourself in your April number, and to be contained in the forthcoming part of the Journal of the Royal Geological Society of Ireland). The facts have been derived from a variety of sources, including my own observation.

The black strokes give the direction of the parallel ridging, which is so well developed over much of the low ground in this country. The ridges usually consist of Boulder-clay with well scratched and blunted (not rolled) stones; but sometimes the parallel shaping seems to be partially wrought in the rock. The Boulder-clay ridges are totally distinct from Eskers (or Kames); their average length is about three quarters of a mile; they sometimes exceed one hundred feet in height. The red strokes represent parallel rock-scorings. When the scorings show clearly, of themselves, which way the grinding agent went along the line of its motion, the strokes representing them are made into arrows. Cross striations, later than the


To illustrate Mr. Close's paper on the General Glaciation of Ireland.

principal ones, are omitted; as also are the traces of the strictly *local* glaciation among the mountains. The dotted arrows indicate the direction of the drift transportation; in most cases, certainly, and in the rest most probably, it is the movement of the Boulder-clay which is given. Since the three kinds of phenomena always agree so remarkably as to direction, they must be effects of a common cause; and, therefore, they may be used jointly or separately, as opportunity occurs, in tracking the courses of the streams by which they have been produced.

Those streams must have consisted of *glacier* ice; because various considerations shew that no other agent is capable of doing *everything* that has been done, and of moving as the streams have moved. The universal glacier was, probably, not less than 3,000 feet in depth. It was, at its greatest development, but little dependent on the mountains, as sources of supply; it was sometimes inconvenienced by them as obstructions to its movement. Its tendency was to spread outwards in every direction, without much regard to the general slopes of the open ground. As a result of its great depth and magnitude, its mobility must have been vastly greater than might be supposed possible on first thoughts, and sufficient to enable its different flows to move as shewn on the map. Those flows formed a connected, though not single, system—their mutual interference has sometimes affected their movements quite as much as the resistance of the masses of elevated ground. Thus, the stream which flowed southward, near Carrick-on-Shannon (c), has divided, without having been compelled to do so by anything in the shape of ground thereabouts. The right branch of that stream has turned sharply away from the wide plain before it, and flowed directly towards, and then across, the (not very elevated) range of the Ox mountains, Sligo (xx). The stream, which flowed eastward from near Loughrea (L), has behaved in a somewhat similar manner. There were, however, radiating *district* ice-systems, belonging to some of the mountain groups; of which the most remarkable was that of Kerry and W. Cork. These may have existed during the height of the glacial development, or they may not have been established until afterwards. They were older than the submergence in the glacial sea; and older still than the *local* corry glaciers, of which we have evidence in so many places. To explain fully the movements of the flows of the general ice-envelope, it seems necessary to suppose that the west side of Ireland was formerly higher, relatively to the east, than it now is. Some independent considerations confirm this supposition. It is most probable that the ground near the head of what is now Galway Bay occupied a somewhat central inland position during the period of the general glaciation.—Faithfully yours, M. H. Close.

Newtown Park, Black Rock,
Dublin, *April 9th*, 1867.

## MR. TOPLEY ON ESCARPMENTS.

*To the Editor of the* Geological Magazine.

Dear Sir,—I should not have troubled you with another letter, were it not that Mr. Topley, in your last, unintentionally misrepresents my views so as to make them appear inconsistent. In reply, I shall endeavour to be as brief as possible.

*Revival of Old Theories.*—Mr. Topley regards with disrespect the act of a geologist going back to old times for an explanation of phenomena, as if conformity to prevailing fashion in a science were more philosophical than a simple desire for truth. In the history of geology, old fashions have often been revived. The glacial theory of the Parallel Roads of Glenroy was framed by Agassiz in 1840, during his Highland tour with Dr. and Mrs. Buckland. It was displaced by the marine theory, which lasted until 1863, when the glacial theory, as explained by Jamieson, received the sanction of the Geological Society. Mr. Topley himself, in his rain theory, has gone back to the days of Hutton and Playfair. The theory of "waves of translation" has found favour with eminent geologists within the last few years, and is still held by Sir Roderick I. Murchison. I do not think Sir Charles Lyell would object to a wave of translation, such as might be caused by an earthquake capable of upheaving a sea-beach to a height of 40 or 50 feet, or that he would assent to the extreme form in which Mr. Topley has stated his protest against "large bodies of water."

*Lyell on Marine Currents.*—I never regarded waves as more important denuding agents than currents, and Sir Charles Lyell, so far from disclaiming the latter, lays the main stress on them. He says (if I rightly remember his words) "the chief influence of the ocean is exerted at moderate depths below the surface, on all those areas which are slowly rising, or are attempting, as it were, to rise above the sea." Currents may have formed the extensive escarpments and terraces revealed by soundings in the Atlantic Ocean, and currents may have commenced those long lines of subaërial escarpment which are rarely paralleled on modern sea-coasts; but most of the escarpments with which I am acquainted show traces of having been at least modified by coast-action. Assuming their littoral origin, England would not be a likely area to present fac-similes of them at the present sea level. Such can only be expected on coasts where the sea is "deep to;" where it is not prevented, by the task of silting up shallows, from following the strike; and where, beneath the line of cliff and the influence of waves, there must be a sloping submarine talus of angular materials, similar to that forming the lower part of many inland escarpments.

*So-called Strike Escarpments.*—The mode of action assigned by subaërialists to rain and frost involves an entire dependence on structure. Rain and frost can only originate and carry on the work of denudation in conformity to the strike; but on minute inspection it will be seen that many parts of so-called strike escarpments show a dip along the face of the cliff which proves that the denudation in these parts must have proceeded obliquely to the strike. In those escarpments which consist of a succession of headlands, bays, and combes, a very considerable part actually runs unconformably to the strike; in other words, the bedding is oblique to the planes of marine denudation either above or below the escarpment (instances—the great Cotswold escarpment, the Eglwyseg line of cliffs near Llangollen, etc.). With regard to Mr. Topley's statement that the line of cliff now in course of being formed by the sea in N.E. Yorkshire is unparalleled by any inland escarpment, I think reasons might be assigned why a perfect parallelism should not be found in Britain. It is not true, however, that all the escarpments of this country exhibit a continuation of the same beds. The Lias escarpment N.E. of Taunton may be regarded as a continuation of the Greensand escarpment to the south. The escarpment extending from Uphill, near Weston-super-mare, towards the E. and N.E., embraces, in horizontal succession, a repetition of limestone, Trias, Lias, and, if I remember right, Permian conglomerate.

*Short Lines of Obliquely-stratified Cliffs.*—These may be met with almost everywhere in the Lake district, and in many parts of Wales, Somerset, etc. (Instances—some of the cliffs of Cader Idris; several cliffs on the S.E. side of the railway, between Penmaen Pool and Barmouth Ferry Station; cliffs in the upper valley of the Wye, at high levels above the river: the cliff behind Clevedon; many cliffs at high levels on the Mendip Hills, especially between Shuteshelf and Longbottom Passes, and on one side of the latter; parts of the celebrated Cheddar Cliffs, etc.).

*Strike following Sea-coasts.*—Among the instances in which the sea shows a tendency to follow the strike, may be mentioned the cliffs to the south of Clevedon, in Somersetshire. On the sides of Brean Down, near Weston-super-mare, the sea pays about equal regard to dip and strike. On many parts of the west coast of Wales the sea shows a preference for the strike. A whole article, detailing instances in other places, might be written. It is still true, that the sea pays comparatively little "regard to dip and strike," and equally true that dip and strike solely determine the direction of the denudation effected by rain and frost.

*Synclinal Hills.*—Though to Mr. Topley it may be sufficiently clear, I cannot understand how a hill, consisting of a perfect synclinal basin with the strata dipping inward on *all* sides (in the same paragraph, in speaking of the same hills, Mr. Topley uses the term *most* sides) can show a dip in any part of the face of the surrounding escarpment, as they do in Eston Nab and Upleatham Hill.[1] I venture to believe that the strata of many of the so-called synclinal hills dip towards each other only from two points of the compass, in which cases they do not form basins, but synclinal axes. It is certain that some of these hills have this structure, and that the denudation by which they have been left, has followed the strike on two sides only. In their case the atmospheric theory furnishes no more than half an explanation. They can be fully accounted for by

[1] Topley, Geol. Mag. Vol. III. (Oct. 1866), p. 438.

the sea, which shows a versatility not possessed by subaërial agents, and which can breach through and overcome almost any exception to its main mode of action. Many detached hills near escarpments appear to be *decapitated headlands*, and can be at once explained by the well-known tendency in the sea to enlarge bays laterally, until connecting passages are formed. D. Mackintosh.

Teignmouth.

P.S.—As the work of excavation for villas proceeds, the proofs of the marine denudation of the hills and valleys of the Torbay district assume a more and more demonstrative character. On this subject you will soon hear from me again.

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## GRAPTOLITES.

*To the Editor of the* Geological Magazine.

Sir,—I am sorry to have again to beg for a portion of your space, but I am unwilling to let pass, without brief comment, certain statements advanced by Mr. W. Carruthers in his letter on Graptolites in your last number (page 187).

I do not find it necessary to enter here into any further discussion, as to the nature, or connexions, of what I consider to be the ovarian capsules of the Graptolites. I am now in the possession of a large number of specimens, proving, as I think, conclusively, that there is, in some species, an actual organic connexion, and I trust shortly to publish the results of my investigations on this point.

As to the error, whereby Mr. Carruthers inserted the name of *D. Whitfieldii* for that of *D. marcidus*, I should be inclined to think that this change does not much improve his position, as *D. marcidus* does not seem to agree with *D. tricornis* in anything except the common character of possessing three processes at the base.

Mr. Carruthers appears not to be fully acquainted with the true nature of a "radicle," as defined by Hall, or, I think, he would not assert that *D. Whitfieldii* is provided with more than one. The two lateral spines, to which he alludes, are found in *D. pristis*, and in various other species, and are simply processes from the first two cellules on each side, and not "radicles" in any sense of the term. My statement, that *D. tricornis* possesses three "mucronate" radicles, was simply made in deference to Mr. Carruthers's figure of this Graptolite, where the nature of the lateral spines cannot be made out; and, also, on the supposition that he would not have chosen a specific name expressive of a character common to several species.

Mr. Carruthers still seems to think that the cellules in *D. pristis*, of Hisinger, are mucronate. My assertion to the contrary, if wrong, is at any rate supported by all the descriptions of this species to which I am able to refer. In neither the figures nor descriptions of Salter, Hall, M'Coy, Harkness, or Geinitz, is there any mention of anything of the nature of spines to the cellules of *D. pristis*. As Mr. Carruthers has simply repeated his statement, and has not seen fit to bring forward any proofs of its accuracy, he must permit me in the meantime to adhere to the opinion I formerly expressed; since I am constrained to believe that the above-mentioned palæontologists must have had opportunities of studying this Graptolite as good as those enjoyed by Mr. Carruthers.

Finally, I am sorry that anything I have said should have led Mr. Carruthers to the belief that I wished in any way to dogmatize as to there being a connexion between the capsules and the Graptolites; and I should have thought I had stated with sufficient plainness that I considered that my views were as yet conjectural, and that Mr. Carruthers' opinions might "ultimately be proved to be correct." I am likewise sorry that I should need to recal to Mr. Carruthers' recollection, that the existence of capsules, "vertically compressed," does not rest simply upon my "ipse dixit;" but that Professor Harkness had seen my specimens, and had come to the same conclusions about them as I had. I am, Sir, etc.,

H. Alleyne Nicholson.

Edinburgh, *April* 13*th*, 1867.

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A WAVE OF VOLCANIC DISTURBANCE IN THE MEDITERRANEAN.

*To the Editor of the* Geological Magazine.

Sir,—The accounts of Earthquakes, Volcanic Eruptions, etc., which have reached us from the Mediterranean coasts and islands, during the latter part of the past, and the earlier part of the present year, have been so numerous that they lead me to suspect that they are attributable to one common origin, and are the result of a plutonic agent which convulses the whole Mediterranean.

These disturbances seem to date from the eruption of the islands at Santorino last year. Professor D. T. Ansted was the first to point out the connection of this phenomenon with the eruptions of petroleum, which soon after took place at the sides of Mount Etna. Again, M. Mauget recently sent a paper to the Paris Academy of Sciences, stating that last July the wells and springs of Naples and the neighbourhood suddenly diminished their supply; whilst, by the injection of carbonic acid from the fissures diverging from Mount Vesuvius, the fish were poisoned. This year the earthquake at Algiers has been succeeded by the eruption of a "geyser;" *i.e.*, a column of steam, fifteen or twenty yards high, has burst forth from an aperture three feet in diameter, near the sources of the Ain-Bada. Earthquakes at Cephalonia and Malta I mentioned in my last letter. A more fearful shock, killing thousands of persons, and submerging great part of the land, has been felt at Mytelene, on March 6th. This earthquake was even experienced as far as Constantinople and Smyrna. A volcanic eruption has occurred very lately at Pantellaria, between Sicily and Africa. Recent telegrams announce an earthquake at Naples. The ship "Sidon" announced that on March 7th, being seven miles off Mytilene, they experienced two shocks of a submarine earthquake.

Now does it not seem that all these phenomena point to a great wave of volcanic agency disturbing the Mediterranean, its coasts, and its islands? It is said that nine proofs are sufficient to substantiate a case, and as we have fully that number, I think we may safely credit the theory. The difficulty is perhaps to find the centre of the disturbance. An eye-witness of the earthquake at Algiers supposes the centre of that shock to be in the Atlas Range; but as that would be too distant to affect the whole Mediterranean, I think it is more likely to be between the volcanoes of Etna and Vesuvius.

Yours, etc.,

THE CRESCENT, SALFORD, L. C. CASARTELLI.
*April* 10*th*, 1867.

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## MISCELLANEOUS.

REMARKABLE HARD FORM OF ANTHRACITE.—M. Dumas has called attention, in the Comptes Rendus, to some nodules of anthracite, remarkable for their hardness, which were placed at his disposal by the Count Douhet; who found them at a dealer's, and secured them for scientific investigation. These nodules have apparently a concretionary structure, and are hard enough to scratch glass, and even harder bodies, with ease. Leaving out the ash, the composition is found to be :—carbon 97·6, hydrogen 0·7, oxygen 1·7, which agrees with the composition of anthracite. Its density is 1·66. With the opacity, density, and composition of anthracite, these nodules possess the hardness and take the polish of the diamond. M. Dumas was not the first to notice this interesting form of carbon. Several years ago M. Mène experimented on some anthracite from Creuzot, Dept. Saóne-Loire, France. When this coal was raised to a high temperature in a muffle, it was converted into a friable steel-grey mass, in appearance somewhat metallic. When this high temperature was continued about two hours, the fragments in the crucible were nearly always sufficiently hard to scratch glass and steel with the peculiar sound of the diamond. The composition of this substance was found to be :—volatile substances 1·0, carbon 96·8, ash 2·2; and its density 1·637. At first M. Mène could not procure this hard form of carbon from the anthracites of Valbonnais in Savoy, and Abercraf in South Wales; but by continuing the high temperature for four hours he obtained similar results to the previous experiments. Some pieces of coke, prepared from ordinary bituminous coal, mixed with anthracite, with a view to the utilisation of the latter for blast furnaces, presented numerous brilliant points, which scatched glass. The endeavour to apply this carbon in a powdered state to the polishing of metals like steel was unsuccessful, as the powder always scratched the metal. It is to be hoped these important researches may be continued, the "Société d'Encouragement" having offered a prize for chemical investigations on the production of carbon analogous to the black diamond.—*Comptes Rendus.* T. D.

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THE

# GEOLOGICAL MAGAZINE.

**No. XXXVI.—JUNE, 1867.**

## ORIGINAL ARTICLES.

### I.—On the Distribution beyond the Tertiary Districts of White Clays and Sands subjacent to the Boulder-clay Drifts.

By George Maw, F.G.S., etc.

(Part I.)

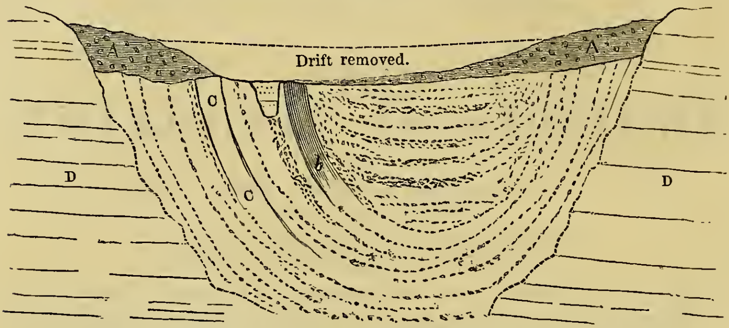
THE object of the following paper is to record some further observations on the distribution in North Wales of deposits of White Clays and Sands older than the Boulder-clay and its accompanying gravel drifts, similar to those in the neighbourhood of Llandudno, described in the Geological Magazine of May, 1865, and also to give a condensed summary of what records I have been able to collect of the occurrence of similar deposits in other parts of the kingdom.

The well-defined and compact geographical disposition of the recognized Tertiary deposits of Great Britain renders the occurrence of beds of similar physical character inferior to the Boulder-clay, in outlying districts, a matter of no little interest, and with a view to a more exact comparison of these deposits in different parts of the kingdom with each other and with their possible analogues in the Tertiary districts, I have endeavoured to bring together in a condensed form all that has been hitherto observed of these singular formations.

*North Wales.*—Since publishing in the Geological Magazine of May, 1865, a description of the Clay- and Sand-Pockets near Llandudno, I have learned from Mr. Binney that he made some observations on them several years ago, and published a short account in the Transactions of the Manchester Geological Society, but I have not yet seen his Memoir.

The only other locality in Carnarvonshire where I have observed similar deposits, is at a place called Werndow at the back of Conway Mountain, about a mile and a half from Conway, where white clay and sand are visible in several of the ditches. Some pits were opened a few months ago with the object of working the clay for pottery purposes, but there were no sections exposed at the time of my visit. The fundamental rock is here Lower Silurian, and it is the only instance that has come under my observation of these deposits occurring off the Mountain Limestone.

Fig. 1. Sand and clay pocket, about 180 feet in diameter, in Mountain Limestone, near Longrake Mine, Halkin Mountain, Flintshire.




A. Drift. *b.* Dark laminated clay. C. Tenacious light-coloured pipe-clay, interstratified with white and black sands with occasional layers of soot-like carbonaceous matter.

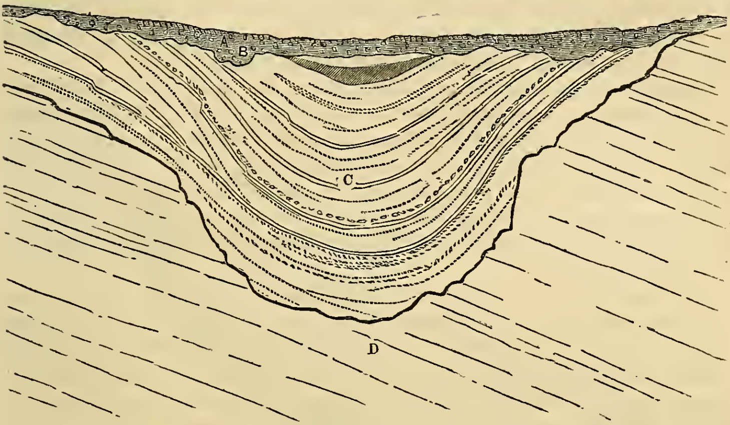
Passing to the eastward, several pockets containing white clays and sands occur in the Mountain Limestone of Halkin Mountain and the range of hills to the south of Holywell in Flintshire, sections of two of which are given in Figs. 1, 2, and 3.

Fig. 2. Sand and clay pit, Bwlch Farm, near Nannerch, Flintshire.


A. Surface soil. B. Drift. *c.* Dark clay with much carbonaceous matter. *d.* Thin bed of small white pebbles. *e.* Thin layers of tough white pipe-clay. *f.* Dark sand coloured with carbonaceous matter interstratified with white and buff sands forming the bulk of the deposit.

No. 1 occurs about half a mile to the east of Longrake Mine at an altitude of about 900 feet above the sea. The cavity appears to be about 150 feet in diameter *judging from the position of the surrounding limestone on the surface,* though the walls are not visible. The superficial drift, now nearly all removed in working the sand, must have been from 20 to 30 feet thick, under which the contents of

Fig. 3. Supposed general arrangement of Pocket, containing sand and clay in Mountain Limestone, Bwlch Farm, near Nannerch, Flintshire.




A. and B. Surface soil and drift. C. White sand interstratified with grey buff and black sand and thin layers of tough pipe clay. D. Mountain Limestone.

the pocket consist of stratified white, black, grey, and variegated sands containing carbonaceous particles, also a layer about a foot thick of soot-like carbonaceous matter, and strata of dark grey laminated clays, and nearly white pipe clay: the contents of this pocket being but partially exposed, it is not easy to make out their general arrangement; in places they are very unconformable, perfectly horizontal sand beds terminating abruptly against almost vertical strata of tough plastic clay, and in another place a little pouch of level layers of sand lies in the midst of similar beds very much inclined. I have endeavoured to represent the arrangement in Fig 1. The great variety of gradual shiftings and slippings, which the contents of this singular cavity appear to have undergone, have produced a complexity of arrangement not easy to explain.

The section represented in Figs. 2 and 3, occurs at a height of about 850 feet above the sea on Bwlch Farm, between Nannerch and Longrake Mine, one mile to the south-west of the example just described. Fig. 2 represents in detail the portion actually exposed, and Fig. 3 what is most probably the general arrangement of the beds in the limestone cavity. The limestone is not visible in immediate contact with the sand; but as the sand and clay has been sunk through forty feet, and the limestone appears within a short distance on all sides, they must occupy a complete "Pocket," similar to those near Llandudno. The individual strata in this section quickly alternate, and are very thin, consisting of quite white, grey, yellow, and black sands, separated by layers of tough white clay, very regular and continuous, but not more than two or three inches thick.

The darker beds of sand and clay contain a great deal of carbonaceous matter, and here and there, in contact with the clay-beds, are layers of very black carbonaceous earth. Some of the white sand-beds contain thin layers of small white pebbles, about the size of a pea, which appear to have been derived from the Millstone Grit: on the west side of the section the strata are nearly level, but at a very short distance to the east, they dip at a high angle.

There is a curious arrangement towards the bottom of the Sand-pit, in which the overlying inclined beds are cut off suddenly against some more level strata under them; the whole of the strata are also full of slight dislocations, faults, and slips, which irregularities appear to have been produced by restricted movements within a small area, and are disposed as though the beds had been gradually lowered *after their deposition* into the Limestone cavity during its slow excavation.

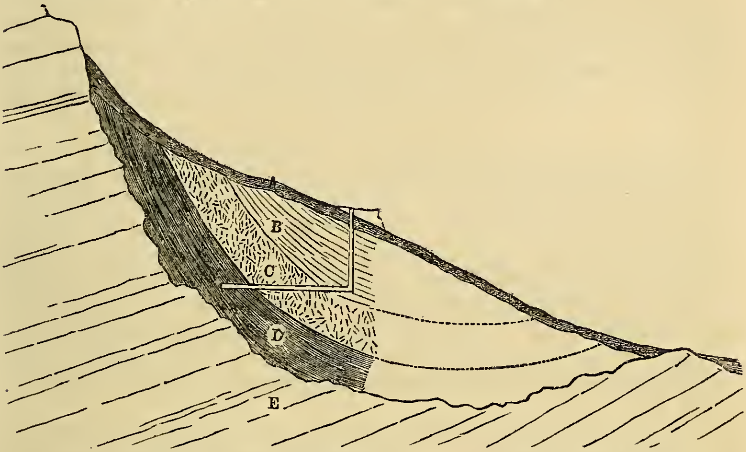
At Craig Vraddoc, between Bwlch Farm and Nannerch, on the southern margin of the Mountain Limestone range of Flintshire, similar sand is also found of a character different from that of the Glacial drift of the neighbourhood, but I had not an opportunity of examining the locality, or ascertaining the position of the beds.

Two or three cavities in the Mountain Limestone have been partly emptied of sand and clay at Ty Coe, near Fridd Garreg Wen, $1\frac{3}{4}$ miles due north of Caerwys. One that has been abandoned for some time appears to be about 150 feet in diameter; I was informed that it contained, with the sand-beds, a considerable proportion of white clays, which were sufficiently tough for the manufacture of tobacco pipes. I also observed a small exposure of dark laminated clay strata near the circumference of the pocket, dipping at a steep angle towards its centre.

A little to the south-east of Langynhafal, in the vale of Clwyd, an adit driven for the purpose of working Hæmatite, exposed a deposit of dark laminated clay, filling up a fissure in the Mountain Limestone, of the same character as the clays on Holywell and Halkin Mountains, and in mineral aspect closely resembling some of the Eocene Clays of Dorsetshire, and the Miocene beds of Bovey Tracey, in Devonshire.

Another example in North Wales, of which I have obtained a section (Fig. 4) occurs at Pant du, near Llanferris, Denbighshire, five miles to the south-west of Mold, at an altitude of about 900 feet above the sea. It appears to be a lodgment that has been protected from denudation in the angle of a sort of amphitheatre of Mountain Limestone rocks, one side being open to the main valley. The clay has been worked for pottery purposes from a shaft sunk into it seventy-five feet deep. The upper five feet is through limestone débris and drift, succeeded by a mass of tough white clay, the base of which was not reached, and consequently the position of the fundamental limestone is uncertain. A head driven from the bottom of the shaft towards the Mountain Limestone escarpment, intersected horizontally 21 feet of white clay, 84 feet of soft chert breccia, similar to that on the Great Ormes Head (described in Geological Magazine for May, 1865), and 27 feet of black laminated Clay, the limit of which was not reached. All these beds dipped at a high angle towards the north, and from the general lie of the ground and the position of the Limestone rock to the south and north of the pit, appeared to occupy a large pocket as represented in the accompanying diagram.

Fig. 4. Clay Pocket, Pant du, near Llanferris.




A. Drift and Limestone Débris. B. White Clay. C. Breccia of Decomposed Chert. D. Dark Laminated Clay. E. Mountain Limestone.

The bed D closely resembles the dark clay at Llangynhafal and Fridd Garreg Wen, and appears to occupy the same position in relation to the pocket and its contents, as in the latter locality.

At Maes y Safon Mine, about one mile and a half to the north of Pant du, a similar bed of white clay was found in digging the foundation for a windlass, but the depth and extent was not ascertained.

I am informed by Captain Cooke, of Colomendy Hall, that about a mile further to the north, near his house, a shaft was sunk many years ago, and said to have penetrated white clay for more than forty yards without reaching the limestone; but exact particulars are wanting. The probable existence of the clay is rendered evident by a sinking of the ground, below the general level, on all sides—a phenomenon almost invariably accompanying these deposits. A shallow pit sunk on the spot a few years since proved the existence of the clay on the surface, though the full depth was not ascertained.

Similar white clay has been found in sinking mine shafts in several localities near Mold, in each case, as far as could be ascertained, resting on the limestone under a considerable thickness of Boulder-drift and limestone débris, and generally at a height of from 800 to 1000 feet above the sea. At a pit a little to the west of Trinity Church, three miles to the west of Mold, under 93 feet of drift and loose limestone boulders, 45 feet of white clay similar to that at Pant du, was penetrated; and at Vron Hall Mine, at a depth of 140 feet, a layer of white clay was found under the limestone débris.

All the examples of these white clays and sands in North Wales, though varying much in the relative proportion of sands and clays, bear an unmistakeable affinity in mineral character. To the west, in the neighbourhood of Llandudno, sand strata predominate with but slight traces of clays. In the neighbourhood of Holywell the proportion of argillaceous strata is larger, though the sand beds are still in the ascendancy, and in the most easterly examples about Mold the sand strata are almost absent, and replaced with considerable masses of white clays, with occasional layers of dark laminated clays.

*Derbyshire and North Staffordshire.*—For the followings facts I am indebted to Mr. E. W. Binney, F.R.S., of Manchester, and Mr. E. Brown, F.G.S., of Burton-on-Trent. Mr. Binney has placed at my disposal his notes of several years' observations on the distribution of white clays and sands, similar to those in North Wales—over the Mountain Limestone district of Derbyshire and North Staffordshire; and Mr. Brown permits me to print a portion of his paper "On the Drifts of the Weaver Hills," read before the British Association at Nottingham—the result of independent observations in the same district; and has obligingly supplied me with the section of the Weaver Hills (Fig. 6).

Mr. Binney observes: "In a good many of the mines and fissures of the Mountain Limestone of Derbyshire, clay, sand, and gravel are found; at Bolsover and Lindric common, near Worksop, beds of clay of a light colour occur on the top of the Magnesian Limestone, but they contain no sand or gravel."

The earliest notice of the white clays, in the Mountain Limestone district of Derbyshire, appears to be in Farey's "General View of the Agriculture and Minerals in Derbyshire," published in 1811. In Vol. i., page 249, he says: "Faults, as before observed, range along and have broken the vein stuff and rake and *pipe* veins, and introduced rounded Quartz pebbles, gravel and *alluvial clay*, and other extraneous mineral matters below the Tick holes, *which connect with the surface*, and such are often called soft veins or are said to be filled with 'softs.'" These "*Tick holes*," connected with the surface, would appear to be analogous with the "Pot holes" or Pockets of the Mountain Limestone district of North Wales. Farey gives a list of mines in which, what he terms "Alluvial clay and other extraneous matter" derived from the surface have been met with; but in many cases it is difficult to distinguish whether the white clays and sands resting on, and contained by pockets in the limestone, are referred to. The following mines taken from his list appear to be the localities of the white clays, sands or gravels underlying the Glacial drift:—

"Bald Mare," in Brassington, is given as the locality of China clay and gravel.

"Bonds Vein," North-West of Wirksworth; in 3rd Lime—gravel.

"Clay-pit Dale," near Hartington—China clay, and gravel.

"Dale Top," in Wirksworth—Gravel.

"Green Linnet," West of Brassington—China clay.

"Hill Top," South of Middleton, by Wirksworth—Gravel.
"Leas Vein," North-West of Wirksworth—Gravel.
"Lime Kilns" and "Drake," in Winster—3rd Lime— Gravel.
"Mossey Meer," in Winster—Ochrey clay.
"Nursery," North of Hopton in Dunstone—Soft clay.
"Portaway Pipe," in Elton and Winster—Gravel.
"Sand-hole Pipe," South-West of Wirksworth—Gravel.
"Seven Rakes," near Matlock Bridge—Gravel, bones, and teeth.
"Solms," in Wirksworth and Middleton—Gravel.
"Suckstone," in Brassington—China clay.
"Upper Field," in Brassington—China clay.

In speaking of China clay, at page 447, the same author says: "China clay of a most beautiful white colour is procured in small quantities in Bald Mine, Green Linnet, Suckstone and Upper Field Mines; in the 4th Lime at Brassington; in Clay-pit Dale Mine in Hartington, etc.; in a lum or fissure in the 4th Lime, a quarter of a mile east of Newhaven House; also in a similar lum at Milk Hill Gate, one mile and a half east of Caldon in Staffordshire; and perhaps in other places in this stratum."

At page 298, Farey observes: "In large open fissures in this rock (Toadstone), most beautiful white china clay is found, and many coarse sorts mixed with quartz pebbles, and other alluvia, near Newhaven House, in Hartington, and at Milk Hill Gate, near Caldon, in Staffordshire; good fire-clay being also procured at the latter place, and used at Whiston Copper Works." Again, at p. 279: "Just by (The Harboro Rocks in Derbyshire) the Yellow Dunstone seems to produce pits of scouring sand, and near them excellent clay for brick and tile making."

Mr. Binney observes in his notes: "I have many years since seen a good bed of potter's-clay in the Millstone Grit at Spitewinter, near Stannage, on the west side of the turnpike-road leading from Chesterfield to Matlock. This may be only of one of the fire-clays of the lower coals, or it may be like that at Caldon; I cannot say positively."

"The whole of the Mountain Limestone district of North Derbyshire and the Millstone Grit and Coal-measure strata are free from foreign drift. I have never seen Till or Boulder-clay in the district."

Mr. Binney has furnished me with the following sketch (Fig. 5) of the Fire-clay "pocket," at the Caldon Hill Limestone Quarry, and observes—"The vertical bed of rounded pieces of grit and white Quartz pebbles mixed with sand proves that the whole of the Clay and Sand now found in the hollow of the limestone was the dêbris of the Millstone grit formerly lying above them; but there must have been some strange commotion to account for the position of the bed of pebbles. It is about five feet wide, and the diameter of the pocket about thirty feet. The fine sand is used for the iron furnaces, and the clay, when mixed with sand, for the manufacture of fire bricks."

The following description of the distribution of this deposit on the Weaver Hills, which form the southern extremity, in Staffordshire, of the Pennine Chain, is from a paper read before the British Asso-

Fig. 5. Sand and Clay Pocket, Caldon Hill Limestone Quarry, Weaver Hills.[1]


Scale about 16 feet to 1 inch.

AA. Mountain Limestone. B. Vertical mass of White Quartz Pebbles lying in the midst of contorted layers of black and light coloured Clay mixed with Sand.

ciation at Nottingham, by Mr. Edwin Brown, F.G.S., to whom I am indebted for the section of the locality (Fig. 6).

"The Weaver Hills have an elevation of 1200 feet above the sea level. Now it so happens that, owing either to a roll in the strata or to a fault, there exists in front of the Weavers, and at a distance of about a mile from their summits, a ridge of Yoredale rocks, stretching north-west and south-east. This ridge maintains an elevation of about 1050 feet above the sea, and between this ridge and the limestone-hills there is a shallow valley. In this valley, in a trough as it were, there have been preserved the remains of what I cannot but think is the most ancient Drift of the district. It consists of white sands and clays in a roughly bedded condition—nearly the whole substance of this drift appears to have been derived from the denudation of the Millstone Grit and other beds that lie to the westward; it is mostly composed of very fine white silicious sand, the grains of which are so far cemented together, that it may in some parts be cut from the pit in blocks, whilst in others the sand is loose and incoherent. Here and there the bed consists of fine white clay, which has much the aspect of pipe clay, or impure Kaolin. There are interposed also, irregular layers of quartzose pebbles, and in some parts angular blocks of Millstone Grit, Bunter Conglomerate, and Keuper Sandstone are to be found."

"The area of this bed, owing to subsequent extensive denudation, has a very irregular outline: it extends more or less over a stretch from N.W. to S.E. of two miles, and is found in the folds of the limestone valleys at a lateral distance of a mile and a half from the principal bed: its upper surface varies in elevation above the sea level from 1000 feet to 1050 feet, its depth has only been tested in the outlying portions. At one pit or quarry at Ribden, a perpendicular face of some 30 feet has been worked without reaching the bottom, and the bed is here so white and pure that the pit looks singularly like a freshly opened Chalk quarry.

[1] From an error in this engraving, the sand beds interstratified with the clays are represented as pebbles.


Fig. 6. Section of Weaver Hills, North Staffordshire, including the Ribden Pit.

Horizontal Scale, six inches to a mile. Vertical Scale, four-fold.

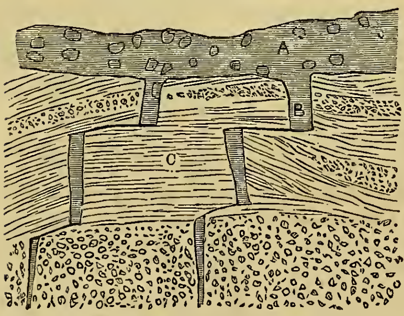
A. Mountain Limestone. B. Yordale Shales. C. Weaver Sands and Clays. The dotted line indicates the probable extension of this bed. D. The Ribden Pit. E. Thin layer of Boulder-clay Drift resting on the White Clays or Sands.

"The commercial value of the material has only lately been discovered. It is now extensively worked for various purposes. The best sandy varieties are used for building and lining smelting furnaces, the coarser, for the making of fire-bricks, and the plastic clay when carefully selected will probably be found applicable to the making of earthenware. It is well adapted to these various purposes and is composed almost exclusively of silica and alumina.

"Below Caldon Low this deposit betrays its existence by deep sinkings on the surface of the ground, or by 'Swallows,' as the inhabitants of the neighbourhood term them. These are miniature valleys that converge towards deep central depressions in which, without any apparent hole, the surface water disappears suddenly into the ground. This is, no doubt, owing to the existence of fissures in the subjacent Limestone rock, and down which the water is carried mixed with particles of clay. A curious instance occurred a few months ago, shewing the insecurity of this material to build upon. The landlord of the village inn had been entertaining some guests in his best parlour until a late hour on a Saturday night, when on the following Sunday the room fell into an unsuspected chasm in the foundation."

"The question now presents itself, at what time was this bed deposited? To this I can only answer, that it is my belief it was deposited before the first glacial action took place, and that it may be possibly coeval with some of the later Tertiaries, as, for instance, the Norwich Crag. It occurs beneath all other drifts; it is unmixed with Boulder mud. The fragments of contained rocks are mostly angular, and although I have bestowed much time in the search for indications of glaciation, yet, in so far as I can see, the blocks are unmarked by striæ or groovings. I further consider this deposit to be a very ancient one, from the circumstance of the absence of calcareous matter from its composition, for it can scarcely be imagined that a marine deposit of this character could have been formed upon and among calcareous rocks without embedding some fragments of limestone in its substance. Yet I have failed to find any limestone at all amongst the pieces of rock that are scattered through it; and the clay and sand yield only the most infinitessimal trace of lime, when exposed to the most delicate of all tests—oxalate of ammonia. I infer that there was a very long period after the deposit of this bed, and prior to the deposit of the Boulder-clay, during which rain-water permeated it in all its parts, and gradually carried off all calcareous matter. It is owing of course to the absence of lime that this clay is so capable of being used as a fire-clay. I need not remark that I have not found any shells in this bed; as if they ever existed there, which is not very probable, they would have been long since dissolved and carried away."

Fig. 7. White-clays, Sands, and Pebble Beds overlain by Glacial Till, Ribden Pit, Weaver Hills.




A. Boulder-clay Till. B. Ditto filling up a crack in (c) White-clay Sands and Pebble-beds subsequently shifted.

Under the direction of Mr. Brown, I have recently had an opportunity of examining some of the pits on the Weaver Hills, and was much struck with the close resemblance of the deposit, both in position and mineral character, to the white clays and sands of the Mountain Limestone district of North Wales. Some of the complications of arrangement were very remarkable. The sand and clay strata occupying the limestone cavities being sloped and twisted into strange contortions, here and there standing almost vertically, and nearly level beds ending abruptly against those steeply inclined. The superposition of the Boulder-clay was invariably evident, and in one or two places I observed thin layers and seams of the dark Till running in amongst the subjacent lighter deposit, as though it, at the time of the deposition, had contained open cracks on its upper surface, as in Fig. 7.

In one case it was evident that the deposit had moved after the deposition of the Till, the continuity of the thin dark lines being abruptly broken by what appeared to be small slips in the white sand and clay beds containing them. This is a point I shall have further occasion to refer to in the latter part of the paper.

Mr. Brown informs me that—"Somewhat to the east of the Ribden Pit" (from which the example in Fig. 7 was taken) "is another exposure of the white clay, superimposed by several feet of Boulder-clay Till: the locality is known in the neighbourhood as the Wredon or Sally-Moor Pit; leading up from this past the Ribden Pit, towards the Red House, are several other interesting pits in this deposit. At the south-west base of Caldon Low, and close to the road leading to Caldon village, are two or three pits of rather impure deposit. From the top of Caldon Low you may trace by the eye the extension of the bed as marked by the sinkings mentioned in my paper. North of Caldon Low are two or three other newly opened excavations."

[*To be concluded in our next Number.*]

## II.—On a Bed of Phosphate of Lime, N.W. of Llanfyllin, North Wales.

By D. C. Davies, Oswestry.

At the meeting of the British Association held in Birmingham in 1865, Dr. Voelker directed attention to the discovery of a bed of Phosphate of Lime in North Wales, and entered into particulars concerning its chemical composition, and economical value.

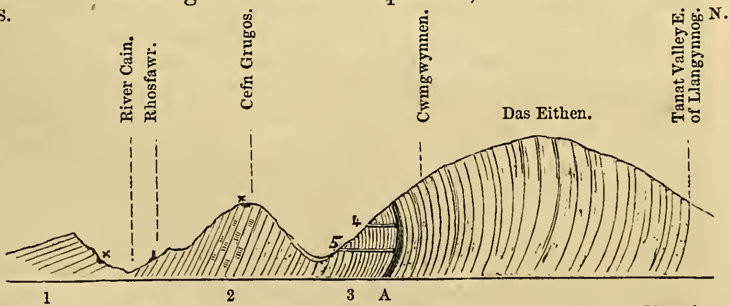



Fig. 1. Section showing the general structure of the country near the Phosphate bed, north-west of Llanfyllin.

1. Rubbly shales, passing upward into soft sandstone, containing Retepora, Favosites, Orthis elegantula, O. parva, Leptæna simulans, L. teniucincta (Llandovery beds).
2. Schists, in centre of the hill, passing into impure limestone (Uppermost, or Hirnant band, of Bala limestone).
3. Blue rubbly schists, passing into solid limestone, with bed of Phosphate, A.
4 and 5. Levels driven into the hill, the lower one (5) showing the return of the beds to their natural position. x Quarries.

As this bed occurs in a rich geological district with which I am familiar, I may be allowed, perhaps, to direct the reader, as briefly as I can, to a few points of geologic interest connected with it.

The bed occurs in the midst of what I have elsewhere described as the middle and principal band of Bala limestone; it was first discovered at Cwmgwynnen, on the road leading from Llanrhaiardar to Llanwddyn, and has since been traced as a continuous bed south-west of this spot about two miles, and north-east about the same distance to Penygarnedd, where, following the course of the limestone, it bends sharply to the south, in the hill Llechwed Llwyd. I am informed that it has also been found in several places in the broken lines of Bala limestone north of the town of Llanfyllin.

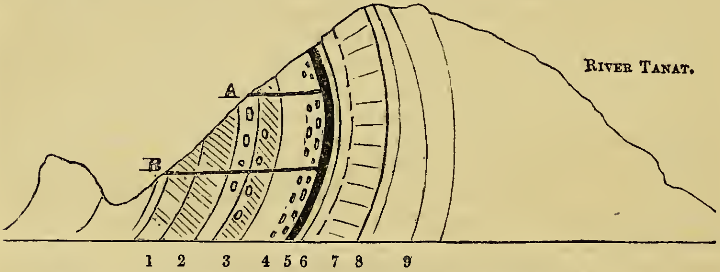



Fig. 2. Section of strata at Cwmgwynnen mine, north-west of Llanfyllin.

1 and 2. Dark blue limestone and shales, Orthis elegantula, Lingula longissima.
3. Dark green schists, with Echinosphærites, Caryocystites; passing into blue limestone with Phragmoceras arcuatum, Illaenus Davisii.
4. Black phosphatic limestone, full of concretionary masses, and iron pyrites, with Orthis flabellulum, O. porcata, Illaenus Davisii.
5. Black Phosphate bed, eighteen inches thick.
6. Layer of Kaolin, passing into solid felspar, sprinkled with copper pyrites.
7. Solid limestone, containing much phosphate.
8. Sandy ash, containing casts of Pterinea.
9. Compact Calcareous ash.
A. B. Levels.

It has been worked somewhat extensively at Cwmgwynnen, and here it may be studied best. It is black in colour, has an average thickness of about fifteen inches, and occurs in a *bed*, as will be seen by a reference to the accompanying sections, and not as a *vein*, as is sometimes stated by our chemical friends. There are plenty of traces of former life in the bed: thus, I have obtained from it numerous casts of *Modiola, Aviculopecten, Orthoceras, Orthis, Lingula,* and fragments of Trilobites; but the fossils are not well preserved, their organic structure having apparently been destroyed by chemical agency. We may then, I think, regard this Phosphate bed as the remains of a Laminarian zone of sea life, just as the wide stretching, ferruginous sandy fossiliferous layers, in the same formation, with their fossils often broken and confusedly huddled together, are the remains of the Littoral zone of the same period. The bed, as far as it has already been explored, gives us an area of four miles long, by about eighty yards in width,—this being the depth to which it is worked at Cwmgwynnen, in the nearly vertical strata, and at all the points hitherto examined it maintains much the same thickness and relationship to the adjoining beds. We thus infer that it was deposited in a somewhat shallow sea, not much varying in depth, or subjected to disturbing influences. The strata in which it occurs are rightly marked upon the government maps as "reversed," dipping, as they do, away from instead of towards the adjacent Llandovery and Wenlock beds. A level which has been recently driven through the beds near the base of the hill clears up this seeming anomaly, for at this depth the beds are seen to bend towards their true position (as seen in Figs. 1 and 2), thus showing the upheaving force to have operated from the north or Llangynnog side, turning up the edges of the strata, as we sometimes, with thumb and finger, deflect the edges of the leaves of a book. I enumerate the principal fossils found here, in my explanation of the sections. I may however note, that *Phragmoceras arcuatum* is here found at a point much lower than its usually assigned limit, it having, I think, been tabled as an Upper Silurian form only. The number of Cystideans, too, which are found in the schists above the limestone, is deserving of notice. There are some very nice specimens of *Echinosphærites* and *Caryocystites*, and also a Cystidean, which to me seems identical with that figured by Prof. M'Coy (Pal. Rocks and Fossils, plate 1 *d*, fig. 6), as an undetermined Cystidean from Coniston. The country around possesses many attractions for the geological rambler.

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## III.—Notes on some Perforated Palæozoic *Spiriferidæ*.

By Professor W. King.

*Spirifer cuspidatus.*—As I am somewhat committed to the opinion lately enunciated by Mr. Meek,[1] that this species is characterized with a canal-system, I may be permitted to make a few observations on the subject.

In a foot-note appended to page 126 of my "Monograph of the Permian Fossils of England," published in 1850, there occurs the following passage:—"Dr. Carpenter states that *Spirifer cuspidatus* is a non-perforated shell, which, I suspect is an oversight." As his "original determination" is still maintained by Dr. Carpenter,[2] it behoves me to adduce what I consider to be in favor of my suspicion.

An imperfectly testiferous specimen, unmistakably belonging to the species under consideration, and now in the Geological Museum of Queen's College, Galway,[3] displays under a hand-magnifier, here and there, particularly on the protected parts—as the medial furrow—patches of faint slightly-raised oval impressions: they are delineated as faithfully as I could in the accompanying figure (See Woodcut, Fig. 1). I do not mean to maintain that the appearances

[1] See Silliman's American Journal of Science, May, 1866.

[2] See "Ann. and Mag. Nat. Hist.," 3rd Series, Vol. xix. January, 1867.

[3] The specimen was found in Carboniferous limestone, near Tuam, by Mr. John Birmingham, F.R.G.S.I. (who will ever be honoured by his discovery of the remarkable star "*T. Coronæ Borealis*"), and has been presented by him to the Museum.

represented are to be accepted as positive evidences of a perforated structure; but they bear so strong a resemblance to rather ill-defined markings, undoubtedly arising from perforations, often seen on metamorphosed specimens of *Dielasma hastata*, and other allied carboniferous species, in their form and arrangement, as to render the existence of such a structure extremely probable.

To show the resemblance between the impressions in *Spirifer cuspidatus*, and those due to the canal-system in *Dielasma hastata*, I have given a representation of the latter (See Woodcut, Fig. 2). They consist, in both cases, of ovals slightly in relief, and separated from one another by narrow depressed interspaces; without, however, any traces of perforations: they are present on different sub-surface shell-layers.

In palliobranchiate shells, as they usually occur, the outer-surface of the valves often exhibits the opposite condition, being marked with *excavated* ovals, each of which shows a perforation in the middle:

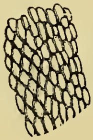

Fig. 1.

Fig. 2.

Fig. 3.

the internal layers, however, present precisely the same general appearances observed in the above-named fossils, with the exception of being perforated. The condition alluded to is clearly caused by the fibres or prisms, which compose the shell-substance of the valves, rising up around the walls of the perforations, as may be readily seen in sections, both horizontal and perpendicular, of *Waldheimia Australis*, and other recent species. Suppose the perforations and fibres of the latter to be obliterated by metamorphic action, or mineralization, there would then be presented simply the raised impressions similar to those occurring in the fossil species.

Sufficient evidence has now been adduced to show my suspicion to be well grounded; also, that Mr. Meek's opinion is so far strongly supported.

Like Mr. Davidson, I am not disposed to place *Spirifer cuspidatus* in the genus *Cyrtina*; but if it be really perforated, and there be any physiological value in the perforations, genus-makers will find in this species another of the many puzzles that beset their labours. Perhaps, after all, it may be an aberrant species of *Cyrtina*, the median or arch-supporting plate having been arrested in its growth through atrophy, as appears to have been sometimes the case with the dental plates in the genus *Spirifer*.

No doubt Dr. Carpenter had some grounds for introducing my name into his letter which has lately appeared in vindication of his "original determination," on account of the mistake I made in asserting that certain imperforate palliobranchs are perforated,—a mistake which was duly acknowledged in one of my papers published long ago.[1] But it remains a secret with Dr. Carpenter, why he has been so remarkably reticent on the errors—grave ones too—committed by himself in connexion with the histology of these same shells.[2] And why Mr. Davidson should have thought it prudent, or necessary, to mention my name in his *testimonial* of "most implicit belief" in favour of Dr. Carpenter, appended by the latter to the letter referred to, is another matter which requires at least a passing notice.

CYRTINA HETEROCLITA.—From what has been published of late years respecting this species, and the genus in which it has been placed by Mr. Davidson,[3] justice to myself requires me to make the following statement.—The principal portion of the apophysary system of the shell under notice was first made known, I believe, by myself many years since. I described the large valve as possessing a median plate, to which are attached, one on each side and at a little distance from its free margin, the dental plates, so as to form an arch-shaped process, similar to that in *Pentamerus*, *Camarophoria*, and some other genera.[4] I also announced that its valves are distinctly perforated.[5] Any one referring to Davidson's British Fossil Brachiopoda, the Sandberger's Die Versteinerungen in Nassau, and certain other works, in which *Cyrtina heteroclita* is described, published since my "Monograph" appeared, will fail to find a single sentence indicating that its internal structure and histology had been previously described by myself.

Mr. Davidson has placed Phillips' *Spirifer septosus* in his genus *Cyrtina*; but he appears to have overlooked the question, as to whether, or not, it is perforated. Suppose this species to be imperforate: How are we to reconcile its being placed congenerically with *Cyrtina heteroclita*, which has well-marked perforations? Should *Spirifer septosus* prove to be unprovided with a canal-system, I would, in this case, have no hesitation in removing it from *Cyrtina*; for, although I am no believer in the view which assigns the function of respiration to the perforations, I attach sufficient importance to them to consider that they form a good generic character.[6] Perhaps they are even diagnostic of a family, or sub-family?

As the canal-system of *Cyrtina heteroclita* has only been imperfectly illustrated by other observers, I have given a transverse

[1] See "Ann. and Mag. Nat. Hist.," 2nd Series, Vol. xviii. April, 1856.

[2] See "Reader," August 19th, 1865; and the paper cited in the last foot-note, with reference to the "thin sharply-folded micaceous plates" (now admitted by Dr. Carpenter to be fibres, or prisms), forming the shell-substance of the Palliobranchiata; also "Ann. and Mag. Nat. Hist.," 2nd Series, Vol. xix. p. 214, etc., respecting the "mere *pits* upon the internal surface" of *Rhynchopora Geinitziana* (now proved, as I originally considered them, to be perforations of the canal-system,—See, *op. cit.*, 2nd Series, Vol. xvii. p. 506; 3rd Series, Vol. xvii. p. 230–233).

[3] Is this species the type of *Cyrtina*?

[4] See "Ann. and Mag. Nat. Hist.," Vol. xviii. p. 86, 1864; and pre-cited "Monograph," p. 68, 123, and 124.

[5] See my "Monograph on Permian Fossils" (Pal. Soc.), p. 126.

[6] In a memoir, in course of publication, "On the Histology of the Test of the Palliobranchiata," I have given some facts and evidences which are strongly opposed to the *respiration* view.

view of it (See Woodcut, Fig. 3). How remarkably similar are the histological elements—perforations and fibres—of this species with those (particularly the "mere pits") of *Rhynchopora Geinitziana*![1]

According to Mr. Davidson, "it is certain that no vestiges of spiral coils have hitherto been noticed by any author" in species of *Cyrtina*:[2] possibly they *will always remain unnoticed* in the so-called *Cyrtina septosa*, M'Coy's *Pentamerus carbonarius*, and certain other presumed congeners. However, be this as it may, *Cyrtina heteroclita* is undoubtedly a *Spiriferid*; as one of my old specimens, of the set which disclosed to me the apophysary system previously noticed, exhibited the spiral appendages very distinctly.

*Spiriferina*, D'Orbigny, 1847.—This genus, which was separated by its author from *Spirifer* in a great measure on account of being perforated, appears to have its nearest affinities to *Cyrtina*, as typified by *C. heteroclita*. Both genera have the normal canal-system. In *Spiriferina* the dental plates are not attached, as in *Cyrtina*, to the median plate: the latter is large, situated between, and independent of, the former,—as was shown in my previously cited paper of 1846.[3]

I urged sundry objections against *Spiriferina* in 1850, one of which arose out of the mistake I committed in concluding that all the *Spiriferidæ* are perforated; but I have for some time past thought, with Mr. Davidson, who was not hampered with this error, that the genus is a good one.

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## IV.—On a new Genus of Graptolites, with Notes on Reproductive Bodies.[4]

By Henry Alleyne Nicholson, D.Sc., F.G.S.
Baxter Scholar in the Natural Sciences in the University of Edinburgh.

(PLATE XI.)

The Graptolite which I am about to consider is perhaps one of the most remarkable of all our known British forms, and was originally described by Mr. W. Carruthers,[5] under the name of *Cladograpsus linearis*. The genus *Cladograpsus* is one which was proposed by Geinitz to include certain forms of *Didymograpsus*; but Mr. Carruthers seems subsequently to have seen that the reference of *G. linearis* to this genus was inappropriate, as he has recently alluded to it,[6] under the title of *Dendrograpsus linearis*. The genus *Dendrograpsus* of Hall includes certain branching Graptolites, which are peculiar to the Quebec group in America, and which do not occur, as far as is yet known, in the Skiddaw slates—our undoubted representative of the Quebec series. The genus, in fact, appears to be characteristic of the Lower Llandeilo period, the only known British

1 See a similar view of the histology of this species given in the "Ann. and Mag. Nat. Hist.," 2nd Series, Vol. xvii. plate xii. fig. 11, 1856.

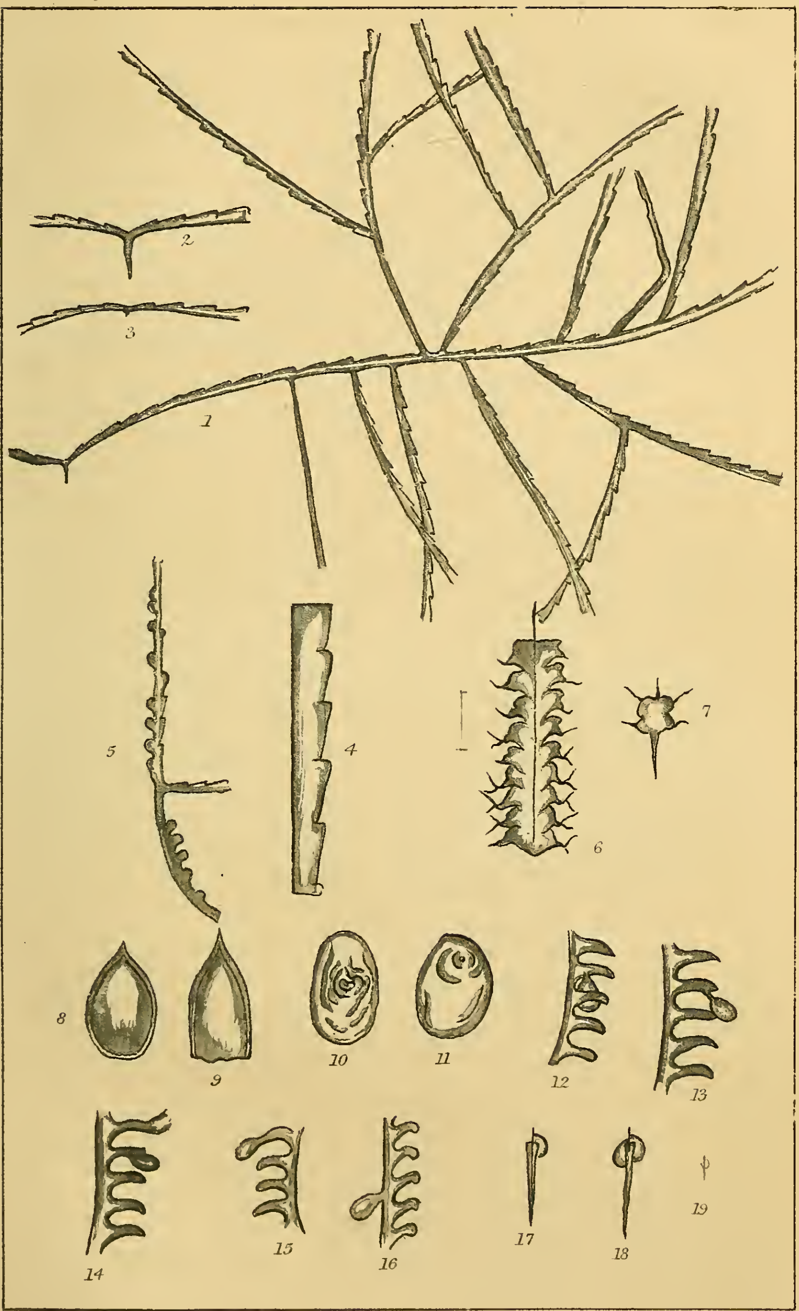
2 See "British Carboniferous Brachiopoda," p. 68.

3 See "Ann. and Mag. Nat. Hist.," Vol. xviii. p. 86; also pre-cited "Monograph," p. 68 and 123.

4 Read before the Geological Society of Edinburgh, March 21st.

5 Annals and Magazine of Nat. Hist., Vol. iii. No. 13.

6 Geol. Mag., Vol. IV., No. 2, p. 70.




H. A. Nicholson delt. E. F.

GRAPTOLITES FROM DUMFRIESSHIRE

species—the *Dendrograpsus furcatula* of Salter—occurring in rocks of this age in Wales.[1] The generic characters of *Dendrograpsus* are the possession of a strong foot-stalk, sub-dividing more or less dichotomously into numerous branches and branchlets, which are but slightly divergent. Neither the main stem nor the primary branches are celluliferous, and the whole forms a "broad, spreading, shrub-like frond."[2] *Dendrograpsus*, in fact, more nearly approaches in external appearance to some of the Hydroid polypes of our own seas than, perhaps, any other of the true Graptolites. In referring *G. linearis* to *Dendrograpsus*, Mr. Carruthers appears hardly to have appreciated its peculiar and perfectly unique character, and an examination of a large number of specimens has led me to the conclusion that it cannot possibly be ranged with any genus yet described, but that it must be considered as constituting the type of a new genus, which I propose to term *Pleurograpsus*, and of which the following are the generic characters:—

*Pleurograpsus*, gen. nov. (Plate XI. Figs. 1–5).—Entire frond consisting of two celluliferous stipes, diverging horizontally, or nearly so, from a common point (which is usually radiculate), and giving off branches at uncertain intervals, sometimes from one side, and sometimes from the other, with an irregular alternation. Both the main stem and the branches are uni-serrate, or monoprionidian. Branches coming off, usually, nearly at right angles, extending for a considerable distance, and sometimes giving off secondary branches, in a manner strictly analogous to that seen in the parent stipes.

If we imagine a long *Didymograpsus*, such as *D. flaccidus*, Hall, extended into a straight line, and giving off branches from both sides nearly at right angles, these in some cases again, and similarly, sub-dividing, we shall have some idea of the general plan of *Pleurograpsus*. The existence of secondary branches seems not to have been noticed by Mr. Carruthers; but, though rare, I have observed them in a well-marked form in more than one specimen. Even tertiary branches may possibly exist, though I have never seen any traces of them. The parent stipes diverge from an initial point, round which the parts of the frond are grouped with something like bi-lateral symmetry, and which is usually marked by a long and slender radicle (Fig. 2). The radicle is, however, not infrequently absent or inconspicuous (Fig. 3), when the base of the organism is only to be detected by the existence in the main stipe of a point, from which the denticles are given off in different directions. The absence or presence of the radicle is not, however, a matter of generic importance.

From the description I have given it will be evident that *Pleurograpsus* presents us with a compound Graptolite, branching in a manner totally distinct from that known in the complex ramose species of the Skiddaw slates and Quebec group, and equally different from any hitherto described species from other formations. The essential point of distinction lies in this, that in all the genera of the branching Graptolites yet described, (with the exception of the *Didymograpsi*), there is a non-celluliferous stem—the "funicle" of Hall—of which the celluliferous branches are secondary or, rarely, primary offsets. In *Pleurograpsus*, on the other hand, the primitive parent stem is itself celluliferous, and is therefore functionally distinct from the "funicle," as defined by Hall; the latter, if represented at all, finding a rudimentary homologue in the radicle of *Pleurograpsus*. This total absence of the funicle in *Pleurograpsus*, alone of all the

[1] Mem. Geol. Survey, Vol. iii.

[2] Hall, "Graptolites of the Quebec Group," pp. 126, 127. Plate xvii.

branching Graptolites, is of itself sufficiently important to constitute a generic character, and a distinction of equal weight is found in the mode of branching. The compound Graptolites of the Quebec group either radiate from a central, non-celluliferous, branching funicle, as in *Dichograpsus*, *Tetragrapsus*, and *Retiograpsus*, or divide repeatedly from a basal, non-celluliferous stem, or foot-stalk, as in *Dendrograpsus* and *Callograpsus*. The only Quebec species which show any affinity to the genus *Pleurograpsus*, as above defined, are *Graptolithus Richardsoni*, and *G. ramulus*,[1] which are placed by Hall in his extremely comprehensive and ill-defined genus *Graptolithus*. It is very possible that these might, with propriety, be grouped under *Pleurograpsus*; but such an arrangement would at present be premature, as they are only known in part. Leaving the Skiddaw and Quebec group, one branching complex form alone remains for consideration, and this—the *Graptolithus gracilis* of Hall—is found in the Utica state of America.[2] This small but beautiful Graptolite has lately been recognised in Ireland, and I am informed by Professor Harkness that it is probably identical with the *Rastrites Barrandi*, described by himself from the Dumfriesshire shales.[3] It should form the type of a new genus, and is at once distinguished from *Pleurograpsus* by the possession of a non-celluliferous stem, or "funicle," from which celluliferous branches are given off with perfect regularity and on a definite plan.

The genus *Pleurograpsus* cannot at present be asserted to contain more than a single species, viz., *P. linearis*; some specimens are more robust in their habit than others, and some, as I have said, sub-divide more than once; but I think these should be considered as mere varieties.[4]

*Pleurograpsus linearis*, Carruthers sp., *Spec. Char.*—Frond spreading and compound, consisting of two stipes diverging usually from a long and slender radicle, and giving origin to primary, and sometimes secondary, branches in the manner described under the genus. Both the main stipes and the branches are monoprionidian, narrow at their origin, and gradually widening out, till a breadth of nearly one-twentieth of an inch may be attained. The main stipes appear to terminate by curving upwards in the manner of a branch. Solid axis usually invisible, or seeming sometimes to exist as an impressed line along the back of the stipe. Common canal well marked, about half the breadth of the stipe. Cellules eighteen to twenty in the space of an inch, narrow, inclined to the direction of the axis at a very small angle. Denticles remote, angular, projecting slightly beyond the margin of the stipe; their upper margins at right angles to the axis, and extending about half-way across the breadth of the stipe (Plate XI. Figs. 1–4).

*Loc.*—Hart Fell and Glenkiln Burn, in Dumfriesshire.

The length of this beautiful and very remarkable Graptolite appears to have been almost indefinite, and Mr. Carruthers states (op. cit. supra) that he has succeeded in tracing one specimen for nearly three feet. In connection with this species I have observed a very

[1] Hall, op. cit. supra, pp. 107, 108. Plate xii.
[2] Pal. New York, Vol. i. and iii, [3] Quart. Journ. Geol. Soc., Vol. xi.
[4] Since the above was written I have come across a small Graptolite in the Skiddaw slates, which I think is referable to the genus *Pleurograpsus*. I shall, however, reserve the description of this species for the present, as belonging more properly to a paper, which I am preparing, on the Graptolites of the Skiddaw series.

curious phenomenon, which is of importance if duly confirmed by further researches. In a specimen kindly lent me by Mr. D. J. Brown of Edinburgh, the stipe is studded with small rounded tubercles, about as large as the head of an ordinary pin, and apparently springing from the common canal on either side (Plate XI. Fig. 5). As nothing of this kind normally exists in any Graptolite, I am inclined to believe that we have here an instance of ovarian vesicles in their young condition, which may either remain permanently attached, or may possibly become free at a later stage. If this conjecture should prove to be correct (and it is difficult to see to what else these bodies could be referred), it will form another, and a strong, confirmation of the view that the Graptolites should be classed among the *Hydrozoa*. I am, however, bound to admit that this is the only instance in which I have succeeded in detecting these bodies, so as to be able to speak with certainty as to their existence. I certainly think I have seen similar tubercles in other specimens of *P. linearis*, and also in *Diplograpsus bicornis*, Hall; but the difficulties of observation are very great, and I should not like to make any positive assertion on this point.

This leads me to make a few remarks upon the bodies recently described by myself, as being probably the "gonophores," or ovarian vesicles, of Graptolites (Geol. Mag., Vol. III. p. 488, Plate XVII), concerning which I have been fortunate enough to obtain further and more conclusive evidence, in a series of well-preserved specimens. When perfect, and compressed laterally, these bodies are oval, bell-shaped, pyriform, or rounded, provided with a mucro at one extremity (the proximal?), and surrounded entirely by a filiform border resembling in texture the axis of a Graptolite (Plate XI. Fig. 8). When more advanced in growth the capsule apparently ruptures, and the distal margin then becomes ill-defined and irregular, owing to the destruction and absence of the border above mentioned (Plate XI. Fig. 9). When compressed from above downwards, the mucro is to be found somewhere within the circumference, as an elevated point surrounded by several concentric, circular, or elliptical rings (Plate XI. Figs. 10–11). The resemblance in these cases to orbicular Brachiopods is purely mimetic and illusory, and could not deceive anyone who had examined a large series of specimens. They are at once distinguished by their often large size, by the irregularity of the concentric rings, by the variable position of the mucro—which is sometimes centric, sometimes eccentric—and by their total want of any persistent figure, outline, or striation; while their texture is graptolitic, and entirely different from that of any Brachiopod, such as the *Siphonotreta micula*. In the case of that variety—if variety it be—of *Graptolites Sedgwickii*, described by Professor Harkness[1] under the name of *Rastrites triangulatus*, I believe I have now made out with certainty, that these capsules are reproductive in function, having obtained them in attachment in such numbers, and under such circumstances as seems to preclude the possibility of accident. They seem, however, to become detached before they attain their

[1] Quart. Journ. Geol. Soc., Vol. vii.

full growth and size, and the specimen, which I figured in the paper I have alluded to,[1] appears really to have been an instance of mere juxta-position. The mucro would seem to be the point of attachment, and the organ whereby it is effected, as we might expect from analogy; but I have no certain evidence in support of this view. The capsules apparently arise from no absolutely constant point of origin, some springing from the common canal (Plate XI. Fig. 16), others from the apex of a cellule (Plate XI. Figs. 14–15), and others from the under-surface of a cellule (Plate XI. Figs. 13–14); the last two modes being the most frequent. The largest capsule which I have seen attached in this way has not measured more than one-tenth of an inch in diameter, many being much smaller. After attaining this size they seem to become detached; numbers, often nearly half an inch in length, occurring in this condition in the shales, along with innumerable germs. The sequence of pheuomena thus described has not been observed by me in any other Graptolite except *G. Sedgwickii*; but it accords perfectly with the excellent description and figures given by Hall of the reproductive process in *D. Whitfieldii.*[2] I have myself in many instances seen bodies essentially similar to those described by Hall, though not so well preserved, attached to the stipe of this same species from the Dumfriesshire shales, and their occurrence appears to me to be inexplicable, except on the hypothesis that they are reproductive.

In certain other beds in the same locality (viz., Garple Linn), in which *G. sagittarius* is the prevailing form to the almost total exclusion of *G. Sedgwickii* (*Rastrites triangulatus*), and in which the capsules occur in the greatest profusion, I have, nevertheless, failed to detect any organic connexion between the two. I should be inclined to explain this by the belief, that the gonophores of *G. sagittarius* were thrown off when still extremely minute, subsequently attaining their full developement. This view is borne out by the occurrence of these bodies in all stages of growth, from small rounded bodies, not bigger than a pin's head, up to nearly half an inch in length, and it is further supported by analogy with many of our recent *Hydrozoa.* I may observe, too, that in the rare instances in which *G. Sedgwickii* is found in this bed, the capsules are found attached just as in the specimens from the beds, in which it is the dominant species. If this view is not correct, it is still possible that in the case of *G. sagittarius* and, perhaps, other species, the gonophores were attached to the sides of the polypites, or to "gonoblastidia," as in many living *Hydrozoa.* In this case the capsules would, of course, never be found in organic connexion with the Graptolites in a fossil condition. Another difficulty is presented by the existence of beds like those of Hart Fell, where Graptolites are very abundant, but where the capsules do not appear to occur at all. Here, however, all, or almost all, the known species except *Pleurograpsus linearis* are referable to the genera *Diplograpsus* and *Didymograpsus*; whilst *G. sagittarius, G. Sedgwickii,* and other common monoprionidian

[1] Op. cit. supra, Plate xvii. Fig. 3.
[2] "Graptolites of the Quebec Group," p. 33. Plate *B*, Figs. 6–11.

species are, as far as my experience goes, totally absent. In the case, then, of the Hart Fell species, such as *Diplograpsus pristis, D. teretiusculus, D. mucronatus, Didymograpsus flaccidus, D, sextans*, etc., it might be assumed with some probability, that the gonophores were unprovided with a corneous envelope, and were therefore incapable of leaving any traces of their existence. I do not, of course, assert that this absolutely was the case; I merely start it as an hypothesis, capable of explaining the apparent absence of the capsules in certain localities. Whilst cases such as the above occur, it should be borne in mind that the capsules have never yet been found except in rocks where Graptolites abound; whilst they present the most striking similarity in form to the gonophores of many recent *Hydrozoa.* Further, if the capsules do not stand in some relation to the Graptolites, but are to be considered as independent organisms, it appears to me that the palæontologist will be compelled to create a new family for their reception; since, I venture to say there is no known genus, or family, to which they could with any likelihood be referred. I may add, finally, that even in the total absence of reproductive bodies, or of any proofs of their direct connexion with the Graptolites, I should still think the evidence very strong against the view, that the *Graptolitidæ* are referable to the *Polyzoa.* I rest this statement upon the fact, that the true Graptolites (omitting *Dictyonema*, and with the possible exception of *Dendrograpsus* and *Callograpsus*) are all free, whilst the *Bryozoa* are invariably fixed; upon the undoubted presence of a "common canal" in many,[1] if not in all, of the former; upon the mode of growth and nature of the embryonic forms; upon the absence of calcareous matter in the test; and upon the existence of allied forms, like *Corynoides.* Should the views, which I have briefly expressed concerning the nature of the "capsules," be confirmed by future and more extended observations, the zoological position of the *Graptolitidæ* will no longer be a matter of doubt, and they can unhesitatingly be classed amongst the *Hydrozoa.* This is a subject which I trust to take up hereafter in greater detail, and I must at present content myself with stating that I do

[1] I altogether question the absence of the "common canal" in any true Graptolite; though Mr. W. Carruthers has recently denied that it exists as a distinct structure, referring especially to *Diplograpsus pristis*, His., *D. folium*, His., *D. cometa*, Gein., and *Graptolites sagittarius*, Linn. (Geol. Mag. Vol. IV. p. 70). In this opinion Mr. Carruthers stands, I believe, alone amongst those who have written on the subject; and Hall's observations in particular appear to be almost conclusive against it. Thus Hall has shewn ("Graptolites of the Quebec group," p. 28, pl. *A*, figs. 4, 5, 9) that the cell-partitions may extend to the axis, and may, nevertheless, leave room for a common canal, as in *D. bicornis.* The mere fact, therefore, that the cell-partitions reach the axis, as they certainly seem to do in *D. folium* and in *D. cometa*, does not justify us in asserting that there is no common canal, in the absence of sections such as those made by Hall. In the case of *D. pristis* and *G. sagittarius* I believe that Mr. Carruthers is in error, and that the cell-partitions do not really reach the axis, at any rate in full-grown specimens. In *D. pristis*, His. I have observed conclusive evidence of the existence of the common canal as a distinct structure, since the axis, where prolonged beyond the distal extremity of the stipe, is in some specimens bordered by the common canal on both sides, the cellules alone being wanting, either because they have fallen off previously to fossilization, or because they had not yet been developed.

not think the Graptolites can be referred to any known order, or even sub-class, of the recent *Hydrozoa.* In many external characters they certainly appear to approximate closely to the order *Sertularidæ*; but they are at once excluded from the entire sub-class of the *Hydroida* by the fact that the polypidom (in the true Graptolites at any rate) was free, and was not fixed by a "hydro-rhiza," there being other important differences as well. As far as the evidence yet collected goes, I should be disposed to believe that the *Graptolitidæ* will have to be placed in a new sub-class, which will occupy a position intermediate between the fixed and the oceanic *Hydrozoa.*

I may conclude this paper by a short description of a species of *Diplograpsus,* seemingly distinct from any known form, which I have named after my friend Professor Harkness, to whose researches we owe most of our knowledge of the Graptolitic rocks of Dumfriesshire. The characters of the species are so peculiar that I feel quite justified in describing it as new, though I possess but a single specimen.

*Diplograpsus Harknessii,* n. sp. (Fig. 6), *Spec. Char.*—Stipe three-tenths of an inch in length, and about a line in breadth, celluliferous on the two sides. Solid axis projecting slightly beyond the end of the stipe, slender and inconspicuous. Cellules about thirty in the space of an inch, alternating slightly with one another; united internally; but free externally on both sides for about half their length. In the lower half of the stipe the cellules are more closely set, and are only free below. The cellules form somewhat quadrangular tubes, the free extremities of which are bifid, or bi-labiate. In the lower cellules the inferior prolongation of the cell-mouth is furnished with a bi-furcate spine or mucro, one arm of which is directed upwards, the other downwards; but in the upper cellules the spines are not well-preserved, and sometimes appear to be undivided.[1]

*Loc.*—Hart Fell, near Moffat.

*Germs of Graptolites.*—On the surface of the same slab as the preceding are two or three germs apparently belonging to the same species. Each of these (Plate XI. Fig. 7) consists of a delicate mucro, or radicle, surmounted by an oval mass, which is indented at the sides, the primary cellules being furnished with spines at their apices. In the shales of Dobb's Linn I have recently observed certain bodies exactly resembling in form the di-prionidian germs, so common in all the Dumfriesshire beds, but of a very much greater size. They consist of a long and slender radicle, about four-tenths of an inch in length, with a central solid axis, and with a semi-circular lobe at the top on one side (Fig. 17). Another lobe soon appears alternating with the first, and on the opposite side of the axis (Fig. 18); and when more advanced two more lobes are super-added to these. These bodies would seem to be the germs of some di-prionidian Graptolite, perhaps of *D. teretiusculus*; but their great size is very remarkable and anomalous, the ordinary germs (Fig. 19) being little more than one-twentieth of an inch in length.

## EXPLANATION OF PLATE XI.

Fig. 1. *Pleurograpsus linearis* (Carruthers sp), nat. size. The denticles are made much more distinct than they are in nature, for purposes of illustration, and the radicle is put in—though not shown in this particular specimen.
Fig. 2. Commencement of *P. linearis,* showing the long and slender radicle. Enlarged.
Fig. 3. Ditto, without a radicle. Enlarged.

[1] I take this opportunity of stating that I now am inclined to believe that one variety, at any rate, of the *Diplograpsus tubulariformis,* which I lately described from the Moffat shales (Geol. Mag., Vol. IV. p. 109, Plate VII. Figs. 12-13), is really identical with *D. cometa,* Geinitz, and must therefore be abandoned as a distinct species. Geinitz's description, however, and figures have been founded on imperfect specimens, and do not recognise the essential characters of the species.

Fig. 4. Portion of *P. linearis*, enlarged to show the cellules.
Fig. 5. Fragment of the stipe of *P. linearis*, showing reproductive (?) tubercles. Enlarged.
Fig. 6. *Diplograpsus Harknessii*, n. sp. The straight line beside it shows the natural size of the specimen.
Fig. 7. Germ, probably of the same. Enlarged.
Fig. 8. Ovarian capsule, or Gonophore, unruptured, showing the strong external border. Enlarged.
Fig. 9. Another, after rupture has taken place. Enlarged.
Figs. 10 and 11. Ovarian capsules, compressed vertically. Enlarged.
Figs. 12 to 15. *Graptolites Sedgwickii* (*Rastrites triangulatus*, Harkn.), with ovarian capsules attached to the cellules. Enlarged.
Fig. 16. Another specimen, where the capsule appears to come from the common canal. Enlarged.
Figs. 17 and 18. Germs of a di-prionidian Graptolite (?). Natural size.
Fig. 19. Ordinary germ of the natural size, introduced for comparison.

## NOTICES OF MEMOIRS.

### I.—On the probable Duration of the South Staffordshire Coal Field.[1]

By W. Stanley Jevons, Esq., M.A.

For some years there had been considerable anxiety concerning the supposed exhaustion of the Coal-fields, but it was only since 1860 when Mr. Hunt published his work upon the subject that the nation seemed to have been aroused to a sense of its importance. But this feeling of interest might be traced back as far as 1789, when John Williams seemed struck not only with the inestimable value of coal as the chief motive power of the country, but he also seemed to understand that it was necessarily of limited quantity. Previous to this time it was supposed that coal was a constant growth, filling up again the vacant places in the strata where it had been taken out. The fallacy of this theory, however, was soon discovered; and from that time the unfortunate circumstance that coal was necessarily limited was known and acknowledged. Mr. Jevons referred to the various writers and speakers who had of late shown so much interest in the great question as to the probable exhaustion of our coal fields, which had aroused the attention of the whole nation, and had now culminated in the appointment of a Royal Commission to investigate it. Mr. Jevons explained the method of proceeding by which this commission are prosecuting their enquiries, referring to each of the sections into which it is divided, and specifying the particular class of information which each section more especially seeks to obtain. On that occasion he did not intend going over the ground which had been trodden by other gentlemen, who were far better acquainted than he was with the resources of this particular locality. He wished, however, to offer some suggestions relating to the more economical use of coal in this country. First, he must notice the results of the inquiry of Mr. Mathews, contained in a paper published in the Transactions of the Society of Mechanical Engineers, which put the geology and the technical data in the clearest possible light.

[1] Being the substance of a Lecture delivered by Mr. Jevons at the Midland Institute, Birmingham, 25th March, 1867.

That gentleman considered that in the eastern part of this field, which lies north of Dudley, the unworked part consisted of only 1,160 acres, and allowing 20,000 tons per acre for the first and second workings, the total remaining in 1860 was 23,200,000 tons. Now the rate at which coal is being drawn annually was stated at 550,000 tons, and a simple division gave the probable duration of this part of the field as only forty-two years. In the western district, which lies upon the opposite side of that range of which Dudley forms a part, there are estimated to be 2,785 acres, which at 20,000 tons of coal per acre gave 55,700,000 tons. The rate of working was $1\frac{1}{2}$ millions of tons per annum, and a simple division gave thirty-seven years as its period of duration, supposing the demand and consumption to remain as it was. Thus it might be fairly said, that in less than half a century the thick coal of South Staffordshire, which is the most perfect store of fuel any nation has ever possessed, will be perfectly exhausted. The question now arises whether pits can be pushed down upon the flanks of this field with a chance of finding the thick coal again. The South Staffordshire field, however, had not the advantage of some other fields, where the strata dip gently and continuously down, and where you may be almost certain of meeting the original beds of coal, but the strata in the South Stafford field were much more irregular. This field is described by Mr. Beete Jukes as a Palæozoic island, pushed up through the Red Sandstone which extends over the larger portion of the centre of the country. The field had been forced up by volcanic power, which alone was a great obstacle to the exploration of coal, since they did not know at what depth down the strata might be found. Thus, in some places 1,000 to 15,000 feet of Permian strata might intervene between the coal, whilst at other times it might be absent. The lecturer went on to remark how greatly this part of the country depended for its industry upon the coal to be obtained in its neighbourhood, and proposed that the sinking of deep shafts for the purpose of discovering coal, should be undertaken at the public expense, when, if the coal was found, the owner of the field should be required to return the money expended, perhaps even with some interest. Mr. Jevons alluded to the shafts which had been sunk in the outskirts of the coal district for the purpose of ascertaining whether coal was to be met with, making special allusion to the workings of Mr. Dawes, at Halesowen, which, however, had not at present proved very successful. The great quantity of coal used in this district was called attention to, and the gradual rise in price of coal, and the iron trade generally, of this part of the country, and its probable decline, were touched upon.

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## II.—The Coal Resources of India.

By Dr. T. Oldham, F.R.S., F.G.S., Superintendent of the Geological Survey of India. Calcutta, January, 1867.

[Being a Return called for by the Right Hon. the Secretary of State for India.]

VIEWED as a coal-producing country, the British territories in India cannot be considered as either largely or widely supplied with this essential source of motive power. Extensive fields do occur, but these are not distributed generally over the districts of the Indian empire, but are almost entirely concentrated in one (a double) band of coal-yielding deposits, which, with large interruptions, extends more than half across India from near Calcutta towards Bombay. Dr. Oldham has illustrated the areas from which supplies of coal may be looked for with any prospect of success, by a map, on which are marked those parts of the country of which sufficient knowledge is known to enable him to assert, that there is no probability whatever of any deposits of coal being found within their limits, or where, if coal do exist, it must be found at such a depth below the surface that it could not be economized. On the same map he has indicated, so far as the scale will admit, the true limits and outline of those coal-fields which are known. Of a very large portion of these coal areas detailed examinations have been made, and descriptions published by the Geological Survey of India. Until all the fields have been carefully mapped, any estimates of the coal resources and production of British India must be defective. Up to the present time it may be said that little more than surface workings have been carried on in India. The deepest pits scarcely exceed seventy-five yards, while certainly one-half of the Indian coal which has been used up to the present date, has been produced from open workings or quarries. In forming an estimate of the value of the coal before it has been worked to a sufficient extent to admit of its quality being tested by practice, Dr. Oldham has been guided by a series of analyses of specimens obtained from the several coal-fields. The average composition of 74 specimens of the coal gives—Carbon, 52.2 ; volatile matter, 31.9 ; ash, 15.5. Now as the relative duty or effective power of coals may be taken to vary directly as the amount of fixed carbon which they contain, Dr. Oldham concludes that, out of the whole series of Indian coals, the very best of them only reach the average of English coals, and that on the whole they are very inferior to them.

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## III.—The Coal of Russia.

By Lieut.-General G. de Helmersen.

[Des gisements de Charbon de Terre en Russie. 8vo. St. Petersbourg, 1866, pp. 58.]

In this small pamphlet the author discusses the properties, geographical distribution, and present applications of the Russian coal, and points out in what localities it may profitably be worked. Although our knowledge of the geological constitution of Russia is far from complete, yet sufficient is known to determine the extent of the workable coal deposits. They have been met with of Tertiary, Jurassic, and Carboniferous age.

Beds of Tertiary coal occur on the right bank of the Dneiper, near Kier, where they have been worked with profit. Tertiary Lignite beds are found in the neighbourhood of Orenbourg; they are, however, poor in quality.

The Jurassic coal is met with near Koutaïss, in the Trans-Caucasian region. It is, however, neither sufficiently abundant nor of such a quality as to be worth the cost of working.

Coal of Carboniferous age is developed—

1. On the eastern and western slopes of the Oural mountains.
2. In the governments of Novgorod, Iver, Moscow, Kalouga, Toula, and Riazan. The coal occupies a large elliptical basin, six hundred versts in length and four hundred in width, in the centre of which the town of Moscow is situated.
3. In Samara, a little peninsula formed by the river Volga, near Stavrpool; and
4. In the government of Ekaterinoslav, where the coal-beds form a chain of low mountains called the Donetz, and are associated with abundant deposits of iron, which latter have not at present been worked for economic purposes; though they would well repay the cost.

The Carboniferous beds of Russia all belong to the lower member of the Carboniferous system, equivalent to the "Carboniferous limestone" of Great Britain. The Russian beds, however, are mainly composed of sandstone, with intercalated beds of limestone and coal.

In a map which accompanies the pamphlet, the author has carefully indicated the extent of Carboniferous strata in Russia, and has inserted, also, the railways in order that their respective relations may be understood. It is to the want of railways that the coal and iron resources of the Oural, and of the Donetz mountains, have not been rendered available to anything like the extent to which they are capable.

The author concludes by expressing a hope that before long Russia will not be dependent upon foreign countries for the supply of iron and coal it requires, when it is so largely developed in its own dominions.

## REVIEWS.

I.—Physical Geography. By Professor D. T. Ansted, M.A., F.R.S., F.G.S., etc. Wm. H. Allen and Co., 13, Waterloo Place, Pall Mall, London. 1867.

THE well known author of several geological works has recently given to us this highly interesting volume upon Physical Geography; attaching a very wide signification to the name, and entering at considerable length into statements of a multitude of subjects belonging to, or connected with, physical science.

The impossibility of treating this science in such a manner as to render it light reading is noticed in the preface, and the object of the volume is stated to be to enable the general reader to obtain an outline of its main facts, in language as simple and definite as possible. It is further said to involve "not only a statement of numerous facts, but a great classification of facts, and much close reasoning," and also, "it needs an effort on the part of the reader to appreciate the array of facts and observations on which it is based;

the labour of reducing such observation to systematic results and the deductions drawn from the facts and generalizations."

In expressing deductions from the facts, the author says he has perhaps in some cases "given his own views without pointing out that other physical geographers and geologists have expressed, and still hold, different opinions. It was not his object to enter into a discussion upon any subject, and he believes that where the conclusions arrived at differ most from popular notions, they are not inconsistent with the views of those who are recognised both in England and on the Continent as the ablest pioneers of science." The preface concludes with a recommendation to use Johnston's Physical Atlas as a companion to the work, in order to supply a very important deficiency in the absence of all maps or illustrations.

No special list of authorities consulted is given, though several acknowledgments of quotations, etc., occur as foot notes or in the body of the work; and, indeed, the "array of facts" which have been collected with great apparent care from the latest and best sources of information, would, it may be presumed, render a general list anything but an easy task to compile. The author's personal observations are seldom separated from those collected from other sources; and while the whole volume contains the record and classification of a vast number of these, special cosmical theories are in general but obscurely or partially advocated, and the labour of drawing deductions respecting them is left largely to the reader.

The volume is divided into six parts, under the headings, Introduction, Earth, Water, Air, Fire, and Life. Of these, if we except sundry passages in other parts of the work, the three called Earth, Water, and Fire—comprising less than half of the volume—are devoted to those subjects vulgarly or popularly supposed to constitute the science of Physical Geography.

In the first chapters the earth is considered as a planet, and physical forces are treated of. Here, within thirty-two pages, more than eighty subjects,—astronomical, terrestrial, chemical, electrical, or otherwise physical,—are dealt with; so that thus far the general reader has to thank Professor Ansted for a rather comprehensive outline of such matters in connexion with physical geography. In this place also (p. 7), on the subject of the earth's interior, we find the following:—"There is no reason to suppose that any granite with which we are cognizant has been formed even at so great a depth as twenty miles, a distance so small compared with the earth's diameter, that it fails to have any value in guiding us to a knowledge of the more distant material of the real interior. At that greatest depth it seems clear that the ordinary surface conditions, acting upon ordinary surface materials, might and would have produced the rocks we find. They may, therefore, be nothing more than altered conditions of such rocks as are still formed and deposited in our seas." But while the views of Professor Thompson and Mr. Hopkins, regarding the earth's rigidity, find favor, and the likelihood is stated that, at least, half the distance from the surface to the centre of the earth, or two thousand miles, is solid and rigid, readers are left to evolve theories for themselves as to our planet's condition when the, perhaps, altered rocks of the remote interior, or even at a depth of two thousand miles, were, it may be, formed at the surface.

Chapter third is geological, dealing with the succession of rocks and metamorphosis, setting forth with regard to the latter that "it is certainly by, and with water, that all essential change must be traced. . . . . . Water has compacted the loose particles; water has opened large cavities; water has filled them with quartz and other crystals; and water has carried in the metals. A little heat would have caused other combinations."

To currents of heated water and electric currents all the transformation and metamorphosis of the richest metalliferous rocks of countries where mining is carried on in slate are attributed; while nervous energy in the animal system is said to be represented in the globe by currents of earth-magnetism mysteriously obtained from the sun, and vital heat by the higher and equable temperature at moderate depths.

In part the second, under the heading Earth, we have an able but short summary of the distribution of the land, and its forms, its mountain chains, hills and valleys, plateaux and low plains. This portion of the work, the smallest but one, treats essentially of the geography called physical, and is pregnant with matter so interesting to the student of this science that its condensation will be regretted though it consists mainly of statistics, so to speak, and touches lightly upon theories relative to the causes which may have governed or produced the present arrangement of the great physical features of the globe. Denudation is said to have played an important part in all the phenomena of Switzerland and the Tyrol; but its effect in forming the high detached mountains of the Alps is not discussed, nor is its powerful agency in producing mountain forms prominently put forward.

There are said to be valleys of fracture or fault, and valleys of erosion,—mountain gorges being referred to the former, but no examples given; and though it is not stated which are the most frequent, all valleys are described as more or less distinctly valleys of erosion.

From the part treating of low plains, we extract a passage refering to the Steppes of the south-east of Europe, which will warrant the wish that we had more instances of such vivid description in the volume:—

"In these Steppes the seasons are very strongly marked. In the spring and early summer the land is carpeted by flowers. In the summer it becomes parched, after yielding as food or hay a fair supply of mixed grasses, which may be stored for winter use; but in the latter part of summer and autumn it is perfectly bare and burnt up. In winter, which begins in October, the whole area becomes covered with snow, and this remains until spring. There are no trees on those great plains, and no enclosures of any kind; but at intervals the surface is broken by hollows scooped out of the plain, to a depth varying generally from fifty to one hundred feet: and in most of these are villages and some cultivation, especially on the borders of the plain, and in the vicinity of the coast, or of the great rivers. There are, however, no roads, and indeed there is no material for making them.

One may travel for hundreds of miles over the level surface of the ground,—over the turf in spring, through the thick dust in summer, and over the snow in winter—without seeing a single object rising above the general surface of the plain. The post-houses, at equal and distant intervals, are the only signs of humanity and civilization; and the cry of the bustard is one of the few sounds that break the terrible monotony and stillness. The dead level of thin pasture, even if luxuriant, soon fatigues the eye; and when the horses and cattle are away there is absolutely nothing for the eye to rest upon. The travelling across the steppes, conducted with great rapidity, in a kind of light cart, is thus not so difficult as it is tiresome; but it is only safe in summer: and when the snows cover the ground, not only does it become dangerous, from the wolves who take refuge in the hollows, but almost impossible, owing to the absence of land-marks. It is understood that an entire *corps d'armée* was lost in the steppes, between the Dnieper and the Don, while attempting to reinforce the Russian army in the Crimea, during the war with England and France.

Throughout the southern part of the steppes, and in much of the country to the east, there is either a thin soil or no soil at all. This condition, however gives place in the interior to a remarkable and extremely black soil, of extraordinary richness, capable of yielding inexhaustible supplies of wheat without any artificial treatment, or any agriculture except of the rudest kind.

These parts of the steppes now supply enormous quantities of corn to the great markets of the world, and when opened, as they soon will be, much more completely by railroads and steam navigation on the great rivers, it is certain that both Russia and the rest of Europe will be great gainers. A wide range of the plains is, however, hopelessly barren, and all of them depend much on the occasional rains; when these fail the heat is excessive, and the sun rises and sets like a globe of fire, while during the day a thick mist covers the earth. The drought soon becomes excessive; the small supplies of water found at other seasons in the hollows fail altogether; the air is filled with dust and impalpable powder, and the cattle and horses perish by thousands.

In the winter the case is equally bad: fearful storms often sweep over the desolate plains: the dry snow is driven by the gales with a violence which neither man nor animal can resist; but the sky remains bright, and the sun shines cold and clear in the blue vault of heaven. These storms are especially frequent in the vast Aralo-Caspian plain, which is depressed below the general level of the sea, and which is to a great extent an ocean of shifting sand."

Oceans, rivers, lakes, ice, and springs, receive a somewhat more extended notice in part the third, under the heading Water. The existence of organic life at the greatest ocean depths is shown from the deposits there consisting largely of foraminifers which have been found half-digested in the stomachs of living star-fishes brought up from a depth of nearly two miles in the mid-Atlantic. The fact of many lakes in both the old and new world having a depth reaching below sea-level is stated; but slight allusion is made to any connexion between the frequency of lakes and a former glacial period; the viscous theory of ice is not advocated, its progressive movements being attributed to regelation; and thermal springs are regarded as a kind of aqueous volcanos.

The fourth division of the book is headed Air, and is eminently meteorological, treating of the atmosphere, winds, dew, and climate; storms, trade-winds, cyclones, clouds, rain and rain-fall, magnetic storms, etc.

Among many points of interest the difficulty of accounting for why the heavier atoms of water in the form of clouds, which lose their power of wetting at certain altitudes, remain "permanently in contact with the lighter atoms of oxygen and nitrogen of the air" is noticed, and it is not thought necessary to assume that the water is present in any other than its most ordinary condition.

Part fifth, FIRE, treats of volcanos and earthquakes; the account of the distribution of the latter in space and time being chiefly taken from Mr. Mallet's report to the British Association, "On the Facts and Theory of Earthquake movements," as stated in a foot-note.

In the last part, called LIFE, a connection is sought to be established between organic existence and physical geography, through that which exists between matter and motion, vital energy being taken to be a form of force. This is considerably the largest sub-division of the work; and however slight or profound the reasons may be considered which connect it with the subject of the book, the part is, in itself, a comprehensive treatise upon the distribution of plants and animals in different countries, and in time, with a concluding chapter on the effects of human agency upon inanimate nature.

The length of this notice of a book in which so many important subjects find places, has left little room for further comment. Its teachings will serve to introduce the student to a wide field of research; and while it so well deserves a place in every library, no one who reads at all should be ignorant of the various and numerous interesting facts affecting the physical geography of our globe, which are placed before him by Professor Ansted in so readable a form.

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II.—BANCA AND ITS TIN STREAM-WORKS. By P. VAN DIEST, Mining Engineer. Translated from the Dutch, with the Author's permission, by C. LE NEVE FOSTER, B.A., D. Sc., etc. With Two Geological Maps and Two Woodcuts in the text. 8vo. 85 pages. Truro: Heard and Sons.

AS it is possible that the name Banca will not be familiar to all our readers, we will begin by saying that Banca is an island between Sumatra and Borneo. It belongs to Holland, and for a long period has been an important tin-producing country. The average annual production of metal during the last fifteen years has been more than 5000 tons, and consequently Cornwall has found Banca a formidable rival in the tin trade. This has naturally caused a strong desire in the county of Cornwall to know what the resources of Banca are; how long Banca can go on producing tin at a sufficiently low price to compete with England; indeed, it has been seriously proposed to send out a commission to investigate the resources of the island. While much discussion was going on, Dr. Le Neve Foster ascertained that Mr. P. van Diest, a mining engineer in the employ of the Dutch Government, had written an account of his seven years' stay in Banca, and it is a translation of this work which forms the subject of the present review.

The first two chapters are beyond our province, as, to quote from the preface, they "make us familiar with the country, the inhabitants, and the mode of working the stream-tin." The remainder of the work is largely devoted to a description of the geology of the island, and as the work is accompanied by a chromo-lithographed geological map of the northern half of the island (scale one inch to eight miles) there is no difficulty in following the author's descriptions, though it must be confessed that a few sections across the country, no matter how rough, would have made the work more complete.

The Island of Banca consists largely of clay-slate, and sandstone, with intermediate varieties of rock. These rocks contain no fossils, and Van Diest supposes that they are pre-Silurian; but as he relies solely on the absence of fossils the opinion is not of very much value. According to the author, these stratified rocks have been broken through by granite, which has altered them into mica-slate, quartzite, and other metamorphic rocks. Tin occurs in Banca in the solid rock and also as stream tin. The former mode of occurrence is summarized as follows:—

"1. In Northern Banca tin occurs in the granite in various ways and over a large extent of country.

"2. The rocks which surround the granite are impregnated with ores and other minerals occurring in the granite for some distance, usually not more than a mile and a quarter.

"3. These minerals and ores are chiefly deposited in little veins or bunches in the direction of the planes of bedding or in the joints.

"4. It is chiefly the sandstone which has taken up these minerals, especially where the rock appears to be the most metamorphosed."

Van Diest comes to the conclusion that there are no veins of tin ore or tin lodes in Banca which will pay for working.

With regard to the origin of the tin ore the author supposes that the granite was once in a melted state, and contained tin "equably disseminated through it." The granite near the sedimentary rocks cooled quickly, and by its solidification prevented the escape of the metallic particles, though not before some had found their way into the surrounding rocks; where the granite cooled slowly the heavy metallic particles sank down and were not fixed.

However simple this theory may be it is hardly quite satisfactory. Every theory accounting for the formation of the tinstone in lodes should at the same time explain the origin of the peculiar minerals which accompany it so universally. Van Diest does not attempt this, and one is tempted to suppose that he is not acquainted with Daubrée's masterly essays, where the whole subject of the origin of tin deposits is fully dealt with.

The description of the mode of deposition of the stream-tin is clear and worthy of attention. The author fully realises the effect of gradual weathering and of rain. He does not, however, follow English "subaërialists" in supposing that the form of the ground is mainly due to subaërial influences; for in a note (p. 67), after giving an instance of rapid weathering which came under his notice, he says: "From this it may be inferred that the hills when first formed were very much higher and larger and the ravines deeper and steeper then at present." He explains thoroughly the occurrence all along a valley of a bed of *tin-ground*, *i.e.* stanniferous gravel. It used to be supposed that this bed had been formed all at once by sudden floods or great rushes of water. The diagram (p. 70) shows very plainly that this tinny gravel or tin-ground must not be looked upon as a deposit formed all at once, but, on the contrary, as a very gradual one. Whilst tinny gravel was being deposited at the head of the valley, fine silt was settling down at the lower end of the valley ten or twenty feet above previously deposited tin-ground. The tin-ground at the lower end of a valley may therefore have been deposited thousands of years before a similar deposit situated a mile or two higher up.

There is next to nothing to interest the palæontologist. Remains of an elephant have been found in one place in Banca in the tin-ground. At the present day the elephant is living in Sumatra but not in Banca. The fossil, therefore, points to an ancient connection between the two islands. The following summary is good:—

"1. The stream-tin of Banca is derived from the granite and the rocks that surround it to a distance of nearly two miles.

"2. The valleys and tributaries[1] which take their rise in these rocks, and also the plains close by them, carry stream-tin; but the valleys which are found elsewhere contain no tin.

"3. A deposit of tin derived from one source seldom extends further than two miles along a valley."

On the whole, the work forms a useful addition to our knowledge of the geology of the Indian Archipelago, and persons interested in tin will find plenty of details concerning the working and smelting of the stream-tin of Banca.

## REPORTS AND PROCEEDINGS.

Geological Society of London. — April 17th, 1867.—Sir Charles Lyell, Bart., M.A., F.R.S., Vice-President, in the chair. The following communication was read:—

"On the Physical Structure of North Devon, and on the Palæontological Value of the Devonian Fossils." By Robert Etheridge, Esq., F.R.S.E., F.G.S., Palæontologist to the Geological Survey of Great Britain.

The Lower, Middle, and Upper groups of sandstones and shales of West Somerset and North Devon were described in this paper as occurring in a regular and unbroken succession from north to south; namely, from the sandstones comprising the promontory of the Foreland, at the base, to the grits and slates, etc., overlying the Upper Old Red Sandstone of Pickwell Down to the South. The author was unable to see any traces of a fault of sufficient magnitude to invert the order of succession, or that would cause the rocks of the Foreland at Lynton to be upon the same horizon as those south of a line of high ground that passes across the county from Morte Bay on the west to Wiveliscombe on the east.

The Foreland grits and sandstones are overlain by the Lower or Lynton slates, and form a group equal in time to the Lower Old Red Sandstone of other districts, but deposited under purely marine conditions.

[1] There is evidently a word left out here. The sentence should doubtless stand thus: "The valleys of rivers and their tributaries," etc.

The author then showed that above the Lower or Lynton slates there is an extensively developed series of red, claret-coloured, and grey grits, from 1500 to 1800 feet thick; these form a natural and conformable base to the Middle Devonian or Ilfracombe group. The highest beds, containing *Myalina* and *Natica*, insensibly pass into the gritty and calcareous slates of Combe Martin, Ilfracombe, etc.; this Middle group Mr. Etheridge unhesitatingly regarded as the equivalent of the Torquay and Newton Bushel series of South Devon.

Mr. Etheridge gave detailed Tables of the organic remains of the two groups (the Lower, or Lynton, and the Middle, or Ilfracombe), and collated to them those species found in equivalent strata in Rhenish Prussia, Belgium, and France. He was inclined to believe that these two marine fossiliferous groups represent in time the unfossiliferous Old Red Sandstone (Dingle beds) of Kerry, and the Glengariff and Killarney grits of the south-west of Ireland.

The author then endeavoured to prove that the Pickwell Down beds are the true *Upper* Old Red Sandstone only, not the whole of the formation, as was lately proposed.

Arguments were also brought forward to show the probability of the Carboniferous slate (in part) and Coomhola grits being the equivalent of the English Upper Old Red Sandstone, or Upper Devonian, and that the North Devon beds only are to be regarded as the true type, to which the Irish must be compared, and not *vice versâ*.

Physical and Palæontological evidence distinctly proves, the author states, that the whole of the slates and limestones of Lee, Ilfracombe, and Combe Martin underlie the Morte Bay red sandstone.

The author compared the whole of the Devonian fauna of Britain with that of the Rhine, Belgium, and France, by means of a series of tables based upon the British types. These marine Devonian species were compared with those of the Old Red Sandstone proper, the Silurian and Carboniferous, and analyses were made of all the classes, orders, genera, and species, with relation to the groups of rocks in which they occur—the result being the conclusion that the marine Devonian series, as a whole, constitutes an important and definite system.

The Geological Society of Glasgow.—The concluding meeting of the present session of this Society was held in their room in Anderson's University on Thursday evening, the 18th of April.—Professor Young, President, in the chair. The following papers were read:—

1. "On the Entomostraca of the Carboniferous Rocks of Scotland." By Professor T. Rupert Jones and Mr. James W. Kirkby, Honorary Members of the Society.

The observations of the authors had reference only to the Bivalved Entomostraca of the Ostracodous and Phyllopodous groups, of which *Cypris* and *Limnadia* are the recent types. Upwards of seventy years ago the Rev. David Ure figured and described four species of these little Bivalved Crustacea from the Carboniferous Limestone of

East Kilbride. The discovery of these species by Ure bore evidence to his close powers of observation, and in this respect he compared favourably with many who had followed him in the path of palæontological research. With the exception of Hibbert, who described two species from the limestone of Burdiehouse, this group of fossils remained unnoticed in Scotland, until the subject was taken up by some of the members of the Society within the last few years; and to their very close researches the authors have been largely indebted —the list now embracing upwards of fifty species. The leading features of the various genera—*Cythere, Bairdia, Leperditia, Beyrichia*, and *Kirkbya*—were then sketched, and Tables exhibited, showing their range in the Carboniferous strata of Clydesdale. An examination of these Tables showed that, with a few exceptions, all the species had been found in the Lower Limestone Series of that district. Several of them do not extend beyond the limits of that division, though the majority range into the Upper Limestone; and only four are known to occur in the shales and ironstones of the Upper Coal Series. It was interesting thus to notice this group of species in their life-history in the Carboniferous era. Their appearance and dying out was not a regular unbroken process; nor did they all appear to have ever existed in one area at any one period of time, notwithstanding their presence in nearly all the beds of one series. For example, in a limestone or calcareous shale, with marine fossils, certain species of the above-named genera were generally found. Above these strata might be either arenaceous rocks or alum-shales, in which these species were absent. The next stratum might be one of those termed "freshwater limestone," containing Fish remains, *Spirorbis*, and vegetable fossils. The Entomostraca in this bed might be three or four *Cytheres*, of species different from those in the first-named deposits. Higher in the series occurs another bed of shale, containing marine fossils, and with them all, or most of the *Bairdiæ*, some *Beyrichiæ*, that had occurred before, with, perhaps, one or two forms to take the place of others that had not returned. The species all vanish again with the second bed of shale; and probably the next occurrence of Entomostraca would be considerably higher up, when one of the *Cytheres* of the "freshwater limestone" would return, and abound alone in a single thin stratum. This interchange of species continued time after time; not, perhaps, always to the same extent, but always with some variation in the distribution. Nevertheless, there is considerable persistence in many of the species that return at different intervals—the same groups of species appearing and re-appearing many times without any essential change in their constitution. They always, moreover, re-appeared under exactly the same condition. Several examples of this were quoted. The authors concluded their valuable communication by discussing the physical conditions which had prevailed during the deposition of the Carboniferous series of rocks in Scotland.

To illustrate the paper, Mr. John Young exhibited his interesting collection of mounted specimens of Entomostraca from the Carboniferous Limestones and Shales of the West of Scotland.

2. "On the Change in the Obliquity of the Ecliptic: its Influence on the Climate of the Polar Regions and Level of the Sea." By Mr. James Croll. The reading of this long and valuable communication, which will be published in full in the next part of the "Society's Transactions," was followed by some observations by the President and the Rev. H. W. Crosskey.

Dr. Young exhibited a new Crustacean from the Upper Silurian Rocks of Lesmahagow, which had been kindly lent him by Dr. Slimon. He believed that it belonged to the genus *Hemiaspis*, which Mr. Woodward is at present studying. The specimen is interesting as being the first which has occurred in the Lesmahagow district.

Mr. James Thomson then exhibited a new genus of Carboniferous Corals, of which beautiful photographs of polished sections were shown by the oxyhydrogen light.

Before declaring the session closed, the President congratulated the Society on the number of important papers which had been read during the winter, and on the wide range of subjects which had engaged the attention of members. The Society, since it was founded, had cautiously abstained from rash generalisations; it had, on the contrary, devoted itself to the careful observation of facts; and it had at once rendered the best service to science, and earned for itself a distinctive character by the ready generosity with which its accumulated results in physical geology and palæontology had been placed at the disposal of those who were engaged in special studies. The Transactions of the Society contain the testimony of Davidson, Woodward, Kirkby, and Rupert Jones, to the success and the liberality of Glasgow collectors; while the records of other Societies often show that not a few contributions have been founded on materials derived from the West of Scotland. The only purely theoretical paper of the session, that by Mr. Croll, "On the Influence of the Obliquity of the Ecliptic," had been read this evening. Discussion on such an admirable and exhaustive memoir is impossible; but the Society may well be proud that such a memoir will be found in its publications. On questions of physical geology, Messrs. Dougall, Skipsey, J. Bryce, LL.D., Bennie, J. Young, and J. Young, M.D., had contributed papers referring to the Southern Highlands, the Rocks of Ayrshire, of the Kilpatricks, Arran, and of the vicinity of Glasgow. In chemical geology, Mr. J. Wallace Young has from time to time given us the results of his analysis of rocks from the Carboniferous strata, and brought into notice some remarkable peculiarities in their composition. The palæontological contributions come under three groups—1st, The faunas of different periods have been illustrated by the Rev. H. W. Crosskey in the case of the Glacial beds; by Mr, Young in that of our Limestones; by Mr. Dairn in that of the Southern Silurians. 2nd. Descriptions of species and of genera have been given incidentally at nearly all the meetings, and have formed the subject of two very important papers—that by Mr. H. Woodward, and that read this evening by Messrs. Jones and Kirkby. 3rd. At every meeting specimens have been shown from the human remains of the Clyde alluvium to the earliest Silurian fossils. The ranges of some species have been shown to be more extended than was formerly supposed, and for others new localities have been announced. The admirably prepared corals of Mr. James Thomson have further indicated, as was seen this evening, that nature-printing can be applied with success in the representation of fossils, and that the lantern can be used to make clear the minutiæ of structure. The enumeration of problems in Scottish geology at the opening of the session was a well-timed reminder of what remains yet to be done. It is from no disregard of Mr. Page's advice that none of the difficulties he spoke of have been attacked; it only shows that there is a very wide field to go over before the materials for the higher generalisations, such as he alluded to, can be amassed. In conclusion, the President expressed his conviction that the labours of members during the summer would render next winter's session at least as fruitful of instruction as that which had now drawn to a close.

The Society then adjourned till the first Thursday in October.—J. A.

## CORRESPONDENCE.

### THE DRIFT DEPOSITS OF THE EASTERN COUNTIES.

*To the Editor of the* Geological Magazine.

Dear Sir.—The communications from Mr. Hull and Mr. Searles Wood, junr., in the April number of the Magazine, called forth by my remarks on the relative ages of the Boulder-clays of the Eastern Counties, seem to invite a few further observations from me. I wish, in the first place, to state that the object of my paper in the March number of the Magazine was rather to show that an order of sequence of the coast and high-level clays, fitting in with Mr. Dawkins' views of the Thames valley deposits, was as probable as that supported by Mr. Wood, than that the evidence was absolutely conclusive as to the order of succession I suggested.

The individual members of the Glacial series contain scarcely any distinctive characters based on organic remains, and the constantly recurring local variations of their mineral character seems to render it almost hopeless to attempt any general classification on mere lithological evidence. This makes me view with less confidence than Mr. Wood the means of identification by which it is attempted to connect, in distant localities, the various subordinate members of the Drift series. With reference to the superposition of the Boulder-clay of High Suffolk on that of the Norfolk coast; in the absence of an unbroken section, there seems to be scarcely sufficient available proof either that the green clay referred to by Mr. Wood is the equivalent of the Cromer Boulder-clay, or of the red loam south of Norwich; or, again, that there is an unquestionable identification between this red loam and the red sand which underlies the beds in the lower part of Dunwich cliffs, assumed by Mr. Wood to be the equivalents of his Middle drift. Moreover, this Middle drift is nothing but a mass of sand and gravel of constantly varying character, and having by itself no distinctive aspect.

I wish to explain that in referring to the general uniform altitude of the bed I termed "high-level Boulder-clay" (Mr. Wood's Upper drift), I did not suppose that this was any distinctive test of its age, as the original irregular basement line upon which it was deposited would to a certain extent determine its altitude; indeed, there are, I believe, several isolated patches in the neighbourhood of Tunstall, Chillesford, etc., at a much lower level than the general mass forming the higher ground of Suffolk; but whilst a deposit having a great range of altitude *may* extend down to any point towards the sea-level, a uniform limitation of height (which is, I believe, the case with most of the Boulder-clays on the coast-line) may result from having been deposited by an agency that never attained beyond a certain level, and may therefore, in one sense, be taken as a distinctive test of age.

The clay which extends so widely over High Suffolk to an altitude of from two hundred to three hundred feet above the sea, never attains anything like this height in any coast section, and as you descend from the flat table-land it appears to be abruptly cut off by the general denudation-contour of the country.

The general level of the Chalk-surface in Suffolk is from eighty to one hundred feet above the sea, and on Mr. Wood's classification his Lower drift occurring on the coast, would have formed with the Chalk a tolerably level basement line for the future superposition of his Middle and Upper drifts. How is it, then, that the clay on the high ground of Suffolk, which is so uniform in level and mass for many miles inland, disappears (or, on Mr. Wood's view, becomes attenuated) as the lower ground is reached? I believe it is only to be accounted for by the denudation of the clay on the higher level previous to the deposition, as a sort of fringing terrace, of that on the coast, which throughout the whole circuit of the country never, on the coast, attains the height of the inland drifts. If it is a mere extension, coastwise, of the drifts occurring at higher levels, the lower level of the base at the coast on which it was deposited would account for it; but the coast Boulder-clay and drifts frequently occur where the higher ground, as you recede from the sea, is driftless. If this coast-clay is as Mr. Wood supposes, a more ancient deposit than the higher drifts occurring inland, it seems difficult to account for the higher drifts which were deposited within a few miles inland on the Chalk, not being also superimposed on the coast-drifts—the surface of which would have formed a foundation of about the same height as the inland Chalk.

Again, if it is assumed that the high-level Boulder-clay and subjacent gravel-beds (Mr. Wood's Upper and Middle drifts) form a portion of the cliffs on the Norfolk coast, descending towards the coast on a sloping base line, why should they become so attenuated in mass as in no instance to attain, with Mr. Wood's Lower drift, a collective thickness greater than that without the so-called Lower drift on the higher ground? as the attenuation of its mass would be likely to take place where the fundamental base was highest.

The following section (for which I am indebted to Mr. Rose, of Great Yarmouth) of Corton cliff, between Yarmouth and Lowestoft, is one of the cases cited by Mr. Wood as an example of the supposed occurrence of his "Upper" and "Middle drifts," superimposed on his "Lower drifts."

The cliff is from thirty to fifty feet high, and consists of the following beds:—

*a.* Vegetable soil.
*b.* Warp of Mr. Trimmer, and "Upper drift" of Mr. Rose.
*c.* Boulder-clay, three to nine, or twelve feet thick. Boulders abundant, and varying from a few pounds to several tons in weight. Color of the clay various, occurring in extensive patches of blue, drab, and yellow.
*d.* Sand having in places false stratification, with shingle at its lowest portion fifteen to twenty feet thick.
*e.* Loamy clay, uniform in colour. Erratics small and scarce.

The bed *c* is, I presume, that which Mr. Wood would correlate with his Upper, and *d* with his Middle drift. From what I have seen of the cliffs south of Cromer, I must demur to the opinion that there is anything like a uniform succession of the beds for any distance along this coast. As a general rule, tough Boulder-clays occur towards the base of the cliffs, and sand, gravel, and silty beds, more or less contorted in its upper parts; but beyond this there is nothing like uniformity, and various sections could be described that it would be impossible to trace any kind of resemblance in, to that given above. Sand, gravel, Boulder-clay, and silt-beds interlace in endless variety, and I must take exception to an occasional resemblance in the order of superposition of the clays and sands along this coast, being adduced in support of their being the equivalents of the Boulder-clay and its underlying gravel bed, covering the higher ground of Suffolk.

The very variety of these coast-beds seem to distinguish them from the clay of High Suffolk: the high-level clay is generally uniform in color, and the materials smaller, and more even in size than in that of the coast, and it is seldom interstratified with sand beds. I have not seen the Corton Cliff section, but from Mr. Rose's description, I should judge that the series of beds there superimposed bears little resemblance to the High-Suffolk drifts.

Mr. Hull suggests a relationship between the order of sequence laid down by Mr. Wood for the Eastern Counties, and the drift series in the neighbourhood of Manchester, expressing a hope that the drift question may be simplified by Mr. Wood's classification being found applicable to both sides of the Island. I fear the test of facts will scarcely support so simple a classification as the subdivision of the whole Glacial series into upper and lower Boulder-clays, separated by a mass of sands and gravels. Such a uniformity over so great an area would be highly improbable, and scarcely consistent with the lithological changes observable within much smaller areas in the other Tertiary strata; furthermore, it seems to reduce the whole Drift era into one uniform progressive accumulation, and to ignore those complications of arrangement which might result from repeated periods of submergence, and the fresh distribution and reformation of the materials composing the earlier deposits. There are two obvious difficulties in the way of working out a uniform sequence on lithological evidence. 1st. The constantly varying character of each individual bed, clays and sands passing into each other, through gradations of clayey sand and sandy clay, which, unless you have an absolute continuity of section, renders certain identification impossible. 2nd. That after the coast line is left, the various levels at which the same bed may occur (following an irregular basement line, as pointed out by Mr. Hull, in his paper on the Manchester drifts), complicates the difficulty, rendering it impossible to pronounce with certainty to which division an isolated mass may belong.

The following particulars of a few drift sections with their range of altitude above the sea, will illustrate the extreme difficulty of identifying the individual sub-divisions in distant localities—

*Strethill, near Ironbridge, Severn Valley.*—From 100 to 310 feet above sea; 210 feet thick. A stratified hill of drift, consisting of 70 feet of sand and gravel at its base, 70 feet of Boulder-clay, and capped by a further bed of sand and gravel 70 feet thick.

*Buildwas, near Ironbridge, Severn Valley.*—From 100 to 270 feet above sea, and a range of altitude of 170 feet. Within about a mile of Strethill, on the opposite side of the Severn Valley. Sands and gravels lying against the sloping side of the valley. No distinct bed of Boulder-clay.

*Bridgnorth.—St. James' Gravel Pit, Severn Valley.*—Eight miles below Strethill. 70 to 250 feet above sea level, and range of altitude of 180 feet. Terraces of gravel and shingle, with no distinct Boulder-clay. At Quat, two miles lower down the valley, the drift is almost wholly made up of the detritus of Bunter Sandstone, and in the cuttings of the Severn Valley Railway, at the same level on the west side of the valley, the drifts consist of loamy gravel of constantly varying character.

*Ryden Hill, Benthall, Shropshire.*—From 530 to 600 feet above the sea; range of altitude aud thickness 70 feet. An isolated knoll of clean sand and fine gravel.

*Gravel-hole, Willey Park, near Broseley.*—350 to 400 feet above sea; range of altitude, 50 feet, sand and gravel.

*Burton, near Much Wenloch.*—750 to 800 feet above sea; range of altitude about 50 feet. Loamy sand and gravel, with transported boulders, but no tenacious Boulder-clay.

*Middletown Railway Station, Montgomeryshire.*—Cutting west of station, 310 to 530 feet above sea; thickness 120 feet, consisting of 65 feet of tough clay, overlain by 45 feet of gravel and pebble beds, intermixed with clay and boulders.

*Crowfield, near Coddenham, Suffolk.*—From 100 to 200 feet above sea, thickness 100 feet, consisting of about 45 feet of sand and gravels, resting on the Chalk; overlain by 55 feet of tough Boulder-clay.

*Moel Tryfan, Carnarvonshire.—Alexandra Slate Quarries.*—1270 to 1320 feet above sea, range of altitude 50 feet, consisting of from 20 to 30 feet of clean sand and gravel beds, containing shells, overlain by from 6 to 15 feet of Boulder-clay, containing transported stones or boulders. some of large size.

*Moel Tryfan, Carnarvonshire (foot of the hill).*—From 500 to 600 feet above sea-level, range of altitude about 150 feet. Boulder-clay skirting the base of the hill, of similar character to that near its summit.

This list of examples might be extended *ad infinitum*, but will suffice to show the extreme difficulty of distinguishing on any certain basis, and identifying in distant localities on mere lithological character, the individual subdivisions of the Drift series. If compared with the sections, enumerated by Mr. Hull in his memoir on the drift deposits of the neighbourhood of Manchester, it will be seen that the correlation of the individual subdivisions is utterly hopeless. If, for example, the Strethill Severn Valley Section, where there is the unusual consecutive thickness of 210 feet, is compared with the full series given by Mr. Hull in the neighbourhood of Manchester, it will be found that there is no possible correspondence in lithological subdivisions. At Strethill there is but one Boulder-clay separating two masses of gravel, and in the Manchester district one sand and gravel bed intervening between an upper and lower Boulder-clay. Both series seem to have about the same range with reference to sea level, but to bring them into possible correspondence as to lithological subdivision, it must be assumed, not only that one of the Manchester Boulder-clays is absent in the Severn Valley, but that one of the Severn Valley gravel beds is missing at Manchester. These changes will, however, be more easily explained by recognising the extreme local character of the great mass of the materials making up the drifts, and consequently the continual variation of their lithological condition, depending on the sources of materials and the local circumstances of surface contour under which each was deposited.

The extreme uniformity in the mineral character of the higher Boulder-clay of the Eastern Counties is remarkable, and contrasts with the varying composition of the drifts in other parts of the kingdom. The fact that there is nowhere to be found, on the immediate coast, such a thickness of drift as frequently occurs on the higher ground, seems to render it probable that the comparatively uniform terrace of clay, fringing the coast, was deposited during a limited submergence, when the coast outline differed little from what it is at present. If the coast clays and drifts are merely a seaward prolongation of those occurring at much higher levels inland, it seems difficult to account for its never capping the coast cliffs of the older formations that exceed 200 feet in height, and if it is the same drift on the coast that rises within a few miles (as for example on Moel Tryfan) to more than 1000 feet, it would be expected to rise over the older formations on the coast cliff line, and if the coast clay is older than the drift on the higher ground, how is it that the higher is not superimposed on the lower, forming a collective mass somewhat approaching the height of the inland drifts superimposed on the older formations? Another point to be noticed is, that the fringing terrace of clay is often present (as for example on the Yorkshire Coast) along the coast where the adjacent higher ground is driftless. In connection with this point may be noticed the occurrence of erratic boulders at Pagham and along the coast, west of Bognor, Sussex, the ground a little above the coast line being entirely without drift; indeed, nearly the whole coast circuit affords evidence of this limited submergence. The driftless area of Devonshire is on the south coast fringed with gravels, which seldom reach more than 150 feet above the sea, and on the north the great deposit of clay and an underlying gravel bed, near Fremington and Barnstaple, betokens a similar limited amount of submergence.

The general absence of drift at a high level on the coast—as, for example, on the top of high coast cliffs—can only be accounted for by its having been denuded previously to the deposition of the fringing terrace of low level clay and drift, and of this there seems good evidence, as the contour of much of the higher drift partakes of the general denudation contour of the older rocks, implying a deposition previous to the excavation of some important river-valleys, and to the existence of the present surface contour.

GEORGE MAW.

BENTHALL HALL, BROSELEY,
*April 12th*, 1867.

*Note.*—Since the above was written Mr. Fisher's article "*on the Ages of the Trail and Warp*" has appeared in the Magazine. As I have had but little opportunity of examining the deposit designated by Mr. Fisher as "Trail," I must defer to his opinion that it is identical with what Mr. Dawkins considered to be a Glacial deposit overlying the Brick-earths of the Thames valley; at the same time if it is a subaërial deposit, arranged by the action of land-ice, it does not seem improbable that it may be the equivalent in time of the coast Boulder-clay.

If I rightly understood Mr. Dawkins' observations in the discussion on his paper, he seemed rather to consider the supposed Glacial deposits of the Thames valley as a submarine than a subaërial formation. Under any view, the facts brought forward by Mr. Fisher seem consistent with a long interval between the deposition of the Boulder-clay on the higher ground of the east of England, and that of the supposed Glacial beds of the Thames valley. As the high-level Boulder-clay is intersected by the present valley system, whilst Mr. Fisher's "Trail" follows its denudation contour, I believe there is evidence that the Till of the Norfolk coast was also deposited after the Boulder-clay of the high ground had been considerably denuded.

The deposit in the valley of the Yare, described as "*a Third Boulder-clay*," in Mr. Harmer's paper, just published in No. 90 of the Quarterly Journal, appears to occupy a similar position to that which I believe the coast clay of Cromer, Mundsley, etc., bears in relation to the Chalk, Crag, and High-level Boulder-clay, and may merely be an inland extension of the beds on the coast, deposited after the land surface received its present denudation contour.

Similar beds of Brick-earth to that numbered 5 in Mr. Harmer's section, occur interstratified with the bed of gravel (Mr. Wood's Middle Drift), underlying the Boulder-clay of High Suffolk, and its identification with the coast clay seems to me scarcely supported by sufficient proof.—G.M.

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## ON THE PARALLELISM OF THE DRIFT DEPOSITS IN LANCASHIRE AND NORFOLK.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—Mr. Hull has very faithfully drawn, although in somewhat rough outlines, a parallel between the Drift deposits in Lancashire (with which he is so well acquainted) and those in the Eastern Counties.[1] I do not known whether Mr. Hull has ever visited Norfolk, or whether he has been guided by Mr. Wood's description alone. I have had the privilege of studying the deposits in both districts, and can testify to the surprising parallelism which obtains between them. The differences are even such as we should have expected, *à priori*, to result from local causes, and, instead of detracting from the general resemblance, rather corroborate the opinion that the deposits in both districts were formed under analogous circumstances.

Mr. Searles Wood's outline of Norfolk Drift is correct. We have the three great divisions of Lower, Middle, and Upper Drift—the last but one consisting of mingled sand and gravel. These are the broad features which distinguish the Drift deposits of the North. The principal distinction between the two is that those of the North are considerably thicker than those in the East. True, the Lower Boulder-clay along the coast attains a great thickness, but it is somewhat singular that it should so rarely be found inland, and then only in bands of a few feet thick. Whether this has resulted from the thinning out or denudation of this deposit in a south-westerly direction or not, I cannot say. The coast Boulder-clay has been formed principally by the wreck and denudation of the Lias,[2] insomuch that it obtains its blue colour from that circumstance, and literally teems with the re-deposited shells of the Lias, such as *Gryphæa* and *Ammonites*. Its great thickness along the coast, and its thinning inland, would argue that it formerly extended in the North-east, over what is now the German Ocean. The boulders are of Scandinavian rocks in almost every instance. It is more argillaceous, and consequently resembles its relative in Lancashire much more than the Upper Boulder-clay does. In Lancashire it is largely developed, and is extensively used for making bricks. Its almost entire absence inland in Norfolk, therefore, prohibits any such application.

As regards the Middle Drift in Norfolk, it resembles that in the North more than either of the other two members. Like its northern representative, it is found in alternate layers of gravel and fine or coarse sand, is often false bedded, and the pebbles are much water-worn. These are singularly enough composed of granite, quartz, and trap, as the same bed in Lancashire, and I have even detected portions of the silicious grit known there as the "Gannister rock." The shells found in the Middle Drift of Norfolk complete the resemblance. At Stoke and Saxlingham (within ten miles of Norwich) I have found *Turritella communis*—a shell which I myself found in a similar position in the Middle Drift sands at Reddish and Hyde, in Lancashire; as well as in the sands at Crewe, in Cheshire. Other shells, many of them fragmentary, were also of similar species in both localities.

The Upper Drift or Boulder-clay of Norfolk differs from that of Lancashire more than any of the other divisions. The boulders of primary rocks are not near so abundant as they are in the North. In fact they are generally Oolitic, or flint nodules little worn down.

[1] See Geol. Mag. Vol. IV., April, 1867, p. 183. [2] And Kimmeridge Clay?—Edit.

All seem to have come from a less distance than those of Lancashire. Mr. Hull gives the percentage (as determined by Professor Ramsay) of rock fragments found in the Upper Boulder-clay at Gorton, in Lancashire, as follows (*vide Geol. of Country around Oldham*: *Memoirs of Geological Survey*):

| | per cent. | | per cent. |
|---|---|---|---|
| Silurian Grits ... ... | 37 | Granite ... ... ... ... ... | 6 |
| Felspar Porphyry ... | 31 | Porphyritic Conglomerate | 4 |
| Felstone ... ... ... | 2 | Carboniferous Limestone | 3 |
| Carboniferous Grits ... | 14 | Ironstone ... ... ... | 2 |

In this case the Silurian Grits, which are most abundant in the Upper Boulder-clay of Lancashire, may be taken to represent their having been conveyed from a distance (the Silurians of Cumberland and north of Lancashire) equivalent to the distance of the source of the Oolitic pebbles found in the Upper Boulder-clay of Norfolk (the Oolite of Yorkshire). The greater percentage of igneous boulders found in the Lancashire Drift beds may arise from the fact of their being nearer to their parent rock than those of the corresponding beds in Norfolk. The small percentage of boulders of local rock (sandstone) in Lancashire, as compared with the much greater percentage of flint boulders in Norfolk, may arise from the different nature of the two parent beds whence both were derived. It would be much easier for marine or glacial agency to disintegrate the Chalk and liberate the enclosed flint nodules, than it would be to break up a sandstone bed and to roll the fragments into boulders. But these exceptions seem to me to carry out the analogy between the northern and eastern deposits instead of detracting from their relation.

Mr. Binney very justly remarks[1] on the varying nature of the beds which compose the various members of the Drift or Quaternary formation. The same feature is, more or less, common in Norfolk, although it is not so decidedly shown as in Lancashire, owing to the absence of high hills, along whose base, in the North, the various drift beds usually split up into almost unrecognisable portions. At Sprowston in Norfolk, in the Upper Boulder-clay, there are thin seams of sand intercalated, in which Mr. T. G. Bayfield and myself found numerous fragments of marine shells, among others of *Cyprina Islandica* and *Astarte borealis*. But both in Lancashire and in Norfolk these local deposits do not affect the general features of resemblance so broadly manifested in both districts.

I remain, etc.,

John E. Taylor.

Norwich, *May* 8*th*, 1867.

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BALA AND HIRNANT LIMESTONES AT MYNYD FRON FRYS IN GLYN CEIRIOG.

*To the Editor of the* Geological Magazine.

Dear Sir,—I am glad to find Mr. Salter calling attention in this month's Magazine to one of the most interesting spots in North Wales—especially so to students of the Lower Silurian group.

[1] See Geol. Mag. Vol. IV., May, 1867, p. 231.

As some of the features of this district (which Mr. Salter properly suggests, are deserving the attention of Geologists), have already had some attention paid them by myself, you will, perhaps, allow me to say that, in 1859,[1] I described the various beds of which this hill is made up, noticing some of their peculiarities and rarer fossils. In 1863, in a paper of mine on "The Bala Limestone of North Wales and its associated beds,[2]" I classed the Upper Limestone of the hill as "Hirnant Limestone," as Mr. Salter now proposes.

In a section which accompanied that paper, I represented the overlying schists "Pale shales very fossiliferous," as I called them (the No. 5 of Mr. Salter's letter) as conformable to the underlying beds. In a letter which I afterwards received from Professor Sedgwick, that gentleman—the value of whose labours in North Wales I estimate very highly—said, "the order of superposition is quite clear, yet there is, I believe, a *break* in the order of *succession;*" and he adds I should be grateful to you for more information respecting the group of "pale shales very fossiliferous." These remarks led me to review the matter, and the result was that I found the "pale shales of the Pentre hill and round about, to be unconformable to the Bala group below, as Mr. Salter now wagers that, upon examination, they will be found to be; and if your readers will refer to the GEOLOGICAL MAGAZINE for 1865, page 344, they will find, in a section of the beds referred to, that I have named the uppermost band of limestone, "Hirnant Limestone;" and that I have represented these pale shales of the Pentre as unconformable to those below.

Mr. Salter truly says, that working this district is like working a museum; and I may mention, in addition to the fossils he enumerates, a beautiful one once examined and named by himself *Ischadites tessellatus*, which I quite expected to see in the excellent plates of fossils that adorn Professor Ramsay's admirable memoir on North Wales.

Plenty yet remains to be done there, and I promise any geologists who may be willing to hammer for a day or two about Mynyd Fron Frys, a charming time of it. If gentlemen, who would like a joint meeting for the purpose of more fully exploring the spot, will communicate with me, I shall be glad to make the necessary local arrangements, and to join them on the occasion.

I am, Sir, yours very truly,
D. C. DAVIES.

CONEY-GREEN HOUSE, OSWESTRY,
*May 3rd*, 1867.

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## FISH IN DEVONIAN ROCKS.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—Can you favour me with space for a few friendly remarks on the P.S. of Mr. Salter's letter in your May number.

The fish defence spines in my collection are two in number,—one from Looe Island, and one from Looe; not both "from the

[1] Vide Proceedings of the Oswestry Field-club, pages 32-35. [2] Ibid., page 71. See also for section, Proceedings of the Liverpool Geological Society, 1863-4; for list of fossils, ibid., 1864-5.

island." It will be found, by turning over the Reports of the Brit. Assoc., the Trans. Roy. Geol. Soc. of Cornwall, and the "Geologist," that my "valuable data" have not been "long buried." Will Mr. Salter be so good as to say what is the evidence that "near Teignmouth we have the Upper Devonian beds?" I have no doubt that his reply will be that pebbles containing *Clymeniæ* are abundant in the Triassic Conglomerate at Shaldon, near Teignmouth, and that the Upper or Clymenia limestone must have existed close by. This, however, if admissible, would be evidence of not what *is*, but what *was*. But is it admissible? The *Clymeniæ* are found only in well-rounded pebbles, which have clearly travelled long—perhaps far; whilst the ordinary materials are but sub-angular, and are of immediate derivation. The Chesil beach at Portland contains, it is said, pebbles from the Torbay limestones. They must have travelled at least thirty-five miles, more likely double that distance, since, in all probability, they followed the sinuosities of the coast; a fact which suggests caution in drawing inferences from pebbles respecting the whereabouts of their parents.—I am, etc. WM. PENGELLY.

TORQUAY, *May* 2, 1867.

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## FOSSIL INSECTS IN THE CARBONIFEROUS ROCKS.

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR,—I see in the March number of the GEOLOGICAL MAGAZINE that you mention the occurrence of the "*Xylobius Sigillariæ*?" in the Upper Coal Measures at Kilmaurs, in Scotland; and in the same number Mr. Binney records the discovery of the same myriapod in the Lower Coal Measures near Huddersfield, and also the remains of a supposed Coleopterous insect. Now as the German and Belgian Carboniferous formations, especially the latter, and the American Coal fields have yielded in places numerous insects, and our own occasionally, I have very little doubt that a more careful search would largely increase the number; and I hope the many zealous collectors in our Coal-districts will keep a sharp look-out for any Annulosa which they may fairly expect to find associated with the plants in the shales and ironstones, especially in the latter, where they usually occur. The fine Curculionideous beetle in ironstone from Coalbroke Dale, and the scorpion from Cholme in Bohemia, long since figured and described by Buckland in the Bridgewater Treatise, are well known. There is also a fine wing of a "Corydalis" in the British Museum, from the same locality, figured and referred to in Murchison's "Siluria." I have in my collection a wing of a gigantic Neuropterous insect, in ironstone from the Derbyshire Coal Measures. Professor Dana, in the "American Journal of Science" (vol. xxxvii. January, 1864), describes and figures a remarkable fossil insect nearly entire, which he states to be like the *Semblids* among the *Neuropters*, and especially the *Chauliodes*, and a mutilated wing of another *Neuropter*, which approximates to the genus *Hemerobius*. Both these specimens were discovered by Mr. J. G. Bronson in the Carboniferous beds at Morris, Illinois. Sir

C. Lyell refers to the presence of wings of *Blatta* and *Acridites* in the coal in Westphalia, and to a still larger series of insect remains in the ironstone near Treves, among which are several *Blattidæ, Neuroptera, Termites,* one *Scarabæus,* and the wing of a large *Gryllus* which he figures under the name of "*Gryllacris lithanthracæ*" (Manual of Geology, sixth edition). The presence of spiders and scorpions, and the state of preservation of the oldest known fossil spider from the coal in Upper Silesia, is worthy of note. This specimen is remarkably perfect, and is embedded in a white kind of shale, and the body stands out in relief on the surface, showing the four pairs of legs, the two palpi, and even the coriaceous integument of the body (see Geol. Mag. 1865, Vol. II. p. 468).

I was glad to have an opportunity of examining this rare and interesting fossil when exhibited by the fortunate possessor, Professor Römer, at the meeting of the British Association in Birmingham, in 1865. Hitherto I have looked in vain for them in the series; but some day they will very likely be discovered, for we can hardly believe that such a number and variety of insects inhabited the land during the Liassic epoch, were not preyed upon by spiders and other creatures (Insectivorous mammals ?) associated with them.

P. B. Brodie.

Vicarage, Rowington, Warwick,
*April 7th,* 1866.

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## *DIPLOGRAPSUS TERETIUSCULUS* IN THE UPPER LLANDOVERY OF HAVERFORDWEST.

*To the Editor of the* Geological Magazine.

Sir,—A short time ago Mr. Lightbody and I, when on our way to St. David's to look at the old rocks there, availed ourselves of the opportunity of examining the two celebrated fossil localities near Haverfordwest, Sholes' Hook, and the Gas-works cutting.

In the latter we met with a fossil very much about the position which has hitherto been assigned it. The strata at the Gas-works have generally been regarded as Upper Llandovery; and in them we found the following fossils,—*Nidulites favus, Petraia subduplicata* var. *crenulata,* very abundant; *Stenopora fibrosa, Tentaculites Anglicus, Orthis biforatus, O. calligramma,* var. *Walsalliensis, Strophomena antiquata, S. pecten, S. expansa, Leptæna sericea,* and *Murchisonia gyrogonia.* This is an association quite common. But along with these occurs *Diplograpsus teretiusculus,* a form hitherto unknown higher than the Upper Llandeilo; and of which Mr. Salter says, "is a characteristic Llandeilo species never falling, as I believe, below or rising above that formation" (Appendix to Memoirs of Geol. Survey, vol. iii. page 330).

Double graptolites have also been met with in the Lake country, in the Coniston flags of Broughton Moor strata, which are probably near the horizon of those of the Haverfordwest Gas-works. I am not, however, aware that *D. teretiusculus* has been found here; careful looking may very probably discover it.

Yours truly, Robert Harkness.

Queen's College, Cork,
*9th May,* 1867.

## ON THE METAMORPHIC ORIGIN OF CERTAIN GRANITES, &c.

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR,—Will you kindly indulge me with space for a few words in reply to Mr. D. Forbes' letter in the last number of the MAGAZINE.

The position which I have all along taken up, and from which I do not in the smallest degree recede, is, that the field-geologist is capable of affording valuable assistance towards the elucidation of metamorphic phenomena. To show this was the main object of my papers. My arguments were founded upon certain geological evidence which, however objectionable and unsatisfactory to Mr. D. Forbes, was, nevertheless, not of my own creating, but may be seen by any one who shall take the trouble to examine in detail the regions described by me.

With regard to the petrological terms employed, I can only say that I never made any pretensions to be a reformer of our nomenclature, and Mr. D. Forbes' rather warm invectives might therefore have been spared. The looseness of our terminology is to be regretted, but I have only used the terms in the sense in which they have been for many years understood by British geologists.[1] I shall have no cause to regret this correspondence however, if he who knows so much about the subject, and who finds that even Phillips, Lyell, and Dana are, or ought to be, ready to confess their errors, will

[1] Mr. D. Forbes takes me to task about my definition of greywacké as applied in a general way to the great mass of the Silurian rocks of southern Scotland, and twits me with the fact that Jameson and Macculloch understood by the term "greywacké" a definite rock-species. But however definite an idea might attach to "greywacké" some fifty or sixty years ago, that term ceased ere long to have any such precise meaning, and came to be applied to the whole series of strata in our southern uplands, formerly known as the "Transition-rocks." "There was a barbarous word," says Mr. Jukes, (Manual p. 431,) "once in use as a kind of synonym of the term 'transition,' this was 'grauwacké,' a word now altogether discarded, even in a lithological sense. It was one of those words that meant anything or nothing, and served merely to conceal our ignorance of the true history of the rocks to which it was applied." My critic "expected to have been referred to works specially devoted to the subject" of petrology, but the reader will see that the terms complained of were purposely used in the vague and general way in which they are commonly understood. It was, therefore, quite unnecessary that I should make allusions to those authors whose names Mr. D. Forbes so abundantly scatters through the pages of the Magazine. I may just add, that my excuse for using the word greywacké at all, was the want of some convenient general term which should not mean more than words like "Sandstone," "shale," etc. Some such term is necessary. Recurring for a moment to another of my critic's complaints, the reader may be amused when he finds Mr. D. Forbes admitting that, if instead of the word "certain," I had used "possible or even probable," he would not have objected to the paragraph where I speak of the metamorphism of aqueous strata into crystalline rocks, like granite, diorite, hyperite, etc. Now I have already quoted (p. 181) the statement of one of our most eminent authorities upon this subject, Dr. Sterry Hunt. That gentleman has remarked of certain crystalline rocks that they "have by most geologists been regarded as rocks of igneous origin, whereas they appear to be for the greater part *undoubtedly* altered sedimentary layers or masses." Dr. Sterry Hunt, it must be supposed, is well acquainted with all that has been done in this department of science, and since he thinks the use of the word "undoubtedly" quite justifiable, I cannot see why the word "certain" should require to be so loudly protested against.

no longer retain locked up in his own mind such an invaluable store of knowledge, but will forthwith hasten to render it available for the edification of the geological world.

I am, dear Sir, faithfully yours,

JAS. GEIKIE.

KILMARNOCK, 13*th May*, 1867.

## MISCELLANEOUS.

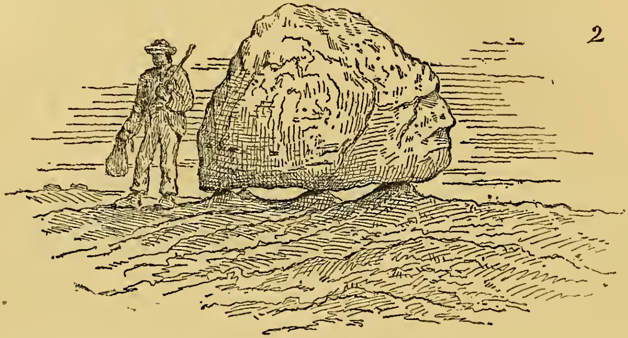
### ON THE "OCCLUSION" OF HYDROGEN BY METEORIC IRON.

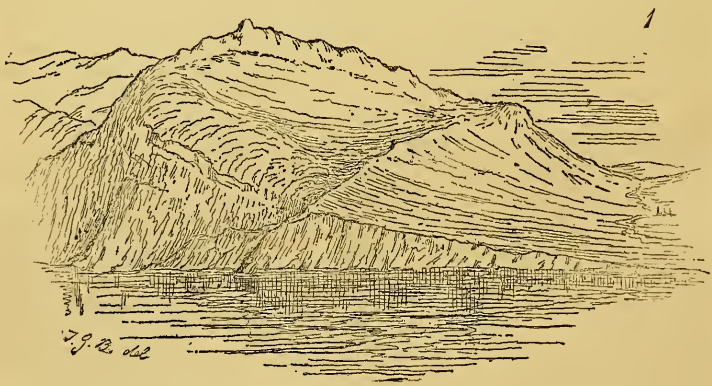
AT a meeting of the Royal Society, held on Thursday, May 16th, Thomas Graham, Esq., F.R.S., F.G.S., read a paper, the subject of which was suggested by a previous one communicated to the Society in June last.[1] The author has now examined the "natural gases" of meteoric iron. The Lenarto iron, when distilled in vacuo (by means of Sprengel's Mercurial Exhauster), gave 2·8 times its volume of gas—85 per cent. of which was pure hydrogen. It is evident that the iron must have "occluded" its hydrogen from a similar atmosphere to that proved by Messrs. Huggins and Miller to surround many of the fixed stars, of which Alpha Lyræ is the type. The discovery is a remarkable confirmation of the results of Spectrum analysis.—W.C.R.

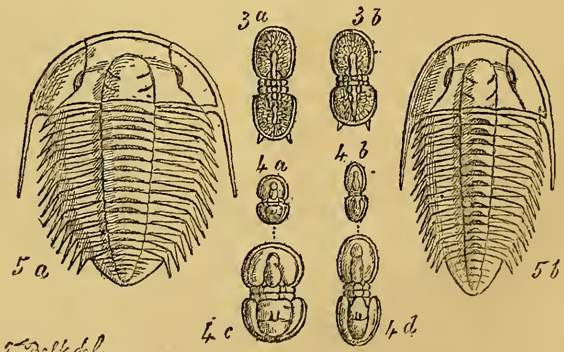
## OBITUARY.

DR. JAMES BLACK.—We regret to have observed the notice of the decease of Dr. James Black, an old geologist, at Edinburgh, on April 30th last, at the advanced age of 79. He formerly resided at Bolton-le-Moors and Manchester, where he was widely known and generally esteemed. He was a graduate of the University of Glasgow, and Fellow of the College of Physicians of London, and actively engaged in scientific pursuits, in addition to his profession, but chiefly devoted himself to Geology and Antiquities. He joined the British Association for the Advancement of Science at its commencement in 1831, and had the honour of being elected a Fellow of the Geological Society of London in 1838, and that of France in 1848. When residing in Manchester he belonged to its Geological Society, and took an active part in its proceedings, both as member and office bearer, and also to the Philosophical Society of that city. He contributed numerous papers to each, those to the latter being chiefly archæological, and among those to the former may be mentioned—"On the Object and Uses of Geological Research," in 1841; "View of the Geology of the Isle of Arran," 1846; "Eclectic View of Coal Formations," 1847; "Submerged Forests of Great Britain," 1843; "On the Diluvium of Bolton," 1845; "On the Elevation and Depression of the Crust of the Earth," 1851. He was an assiduous collector of rock and fossil specimens from South Lancashire, and presented a large number to public museums, besides keeping up a considerable private collection.—J.W.B.

[1] On the absorption and dialytic separation of gases by colloid septa.

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To illustrate papers by the Rev. T. G. Bonney, & Mr. Thomas Belt.

Figs. 1 & 2, Glacial action near Llandudno.

Figs. 3—5, New Trilobites, from North Wales.

THE

# GEOLOGICAL MAGAZINE.

No. XXXVII.—JULY, 1867

## ORIGINAL ARTICLES.

### I.—On Traces of Glacial Action near Llandudno.

By the Rev. T. G. Bonney, M.A., F.G.S.

(PLATE XII., Figs. 1 & 2.)

ANYONE accustomed to the peculiar outlines which ancient ice-action has produced in the Alps, cannot fail to be struck, at the first glance, by the contours of the upper parts of the Great Ormeshead and of the Carboniferous Limestone range which extends from near the village of Rhos to the Little Ormeshead; and a more minute examination only strengthens the conviction that, while the leading outlines of the hills are due somewhat to upheaval, but mainly to denudation—probably marine, the surface of the higher ground has in many cases been affected by ice.

The following notes were made during a brief visit to Llandudno in the month of April last. They refer chiefly to (*a*) the Great Ormeshead, (*b*) the Little Ormeshead, (*c*) the Coast section between the former and Conway. The bad weather and the shortness of my stay have made them less complete than I could have wished, but still they may be of use in calling attention to a neighbourhood at once so accessible and so interesting.

(*a*) The upper part of the Great Ormeshead is an undulating plateau of Carboniferous Limestone, in places almost bare of vegetation. Immediately on gaining this by the path which slopes up the steep south-western face of the hill, from above the ruins of Gogarth Abbey, one is struck with the general resemblance of the surface to that of some of the higher limestone districts in the Alps; for example, that between the Schwarenbach Inn and the Gemmi Pass. Large blocks of limestone are scattered about, especially in the neighbourhood of the north-western angle of the plateau. One remarkably fine mass (Plate XII., Fig. 2) is about 5ft. 7in. in height and 7ft. 2in. by 7ft. in breadth and thickness. It is very flat on the under side, and rests upon three or four projections of the rock below. Several of these blocks differ slightly in lithological character from the rock on which they lie; for they consist of a very hard kind of limestone, which, when broken by the hammer, does not exhibit the usual sharp and somewhat conchoidal fracture common in the Carboniferous limestones, but crumbles away more like indurated clay. It can be found *in situ* on a very slight eminence in the neighbourhood. I could not discover any distinct trace of moraines; which, indeed, could hardly be expected, owing to the absence of peaks. Probably in the glacial epoch the Great Ormeshead was a low island with its undulating icy cap (of no great thickness) broken here and there by a scarcely projecting ridge of rock.

The precipitous sides of the Great Ormeshead appear to me to bear distinct traces of the action of the sea in the form of steep lines of cliff with hollows and furrows at intervals. Its eastern face consists of two well-marked cliffs, separated by a sloping talus thinly covered by a reddish marly clay containing many angular fragments of limestone. The base of the lower cliff is washed by the sea; and it is instructive to compare the wave marks on it with those exposed some 200 feet or more above in the face of the upper cliff. Shells of *Patella vulgata* and *Littorina littorea* are not rare in the clay of the talus by the footpath near Pen-trwyn.

On the S.E. of the Great Ormeshead is a lower eminence called Pen-y-Dinas (on which are the remains of a British fort), separated from the main mass by a hollow, which opens out on the one side towards the town of Llandudno, on the south, and on the other to the sea, on the east. A deposit of reddish marly clay, with angular fragments of limestone, covers the lower parts of this, and is of considerable thickness in the neighbourhood of the sea. In the upper part of the hollow, near Gwydfyd Farm, is a bed or pocket of light-buff sandy marl, mixed with fragments of chert, which has been described by Mr. Maw in an interesting paper in this Magazine (Vol. II. p. 200).

This is covered by the clay, which is here from two to three feet thick, and contains shells in considerable numbers. In a few minutes I collected many specimens of *Patella vulgata, Littorina littorea, Mytilus edulis,* with an *ostrea* (both valves), and three separate valves of *Tapes* (*pullastra?*). This clay, both here and elsewhere, appears to have been deposited after the ground had pretty nearly assumed its present configuration, and to have not undergone much denudation during the process of upheaval.

Again, on the S.W. side of the Great Ormeshead, just beyond the house at present belonging to the Dean of Christchurch, we find, below the fine line of limestone precipices, a steep talus, the lower part of which has been destroyed by the sea, and a cliff of soil and clay thus formed. In the upper part of this cliff, beds of marine shells occur with partings of dark brown soil; as, however, I consider these to be kitchen-middens, I pass them by on the present occasion. Below these we have the following section: (1) reddish clay, with many angular fragments of limestone and rolled trap-pebbles—about 2ft.; (2) reddish sand, yellower in upper part, without pebbles—about 3ft.; (3) talus of fallen sand and clay—about 4ft.; (4) the pebbly shore. As the cliff is followed to the N.W., (1) is seen to thicken out rapidly and form a cliff some fifteen or twenty feet high, in which are many large angular limestone boulders.

(*b*) The undulating outlines of the chain of the Little Ormeshead are also strongly suggestive of glacial action, and upon that hill are two shallow but well-marked valleys, whose contours can, I think, be due to no other cause. One of these is on its western face, and is clearly seen from the neighbourhood of Llandudno (Plate XII. Fig. 1). It is enclosed by two low ridges; one of these falls rapidly down to the conspicuous gap which isolates the Little Ormeshead from the rest of the range; the other, descending seawards, ultimately forms a broken face of rock. The peculiar curves of these ridges and of their inner slopes, with the form of the bed of the valley, which in the upper part is scarcely masked by a thin turf, can only be explained by the action of a glacier. Nor is this all: about the lower third of the hill is covered by drift, the rock disappearing under a sloping bed of it, which sweeps gently down towards the west. The sea has eaten away a large portion of the northern side of this, and formed cliffs which, in places, cannot be less than 50 feet high. If we proceed along the shore to the place where this drift rests upon the limestone, we find that the latter forms a steep cliff or rapid broken descent, which still preserves the rounded contour indicative of ice-action. In the upper part of the clay cliff, a bed of large angular boulders, all apparently of limestone, is now exposed a few feet below the surface of the ground. This thins out on each side, and appears to be thickest in the part nearest to the middle line of the above-named valley. It was quite impossible to reach this bed, but its greatest thickness cannot be less than seven feet, and it bears a very close resemblance to a moraine. The clay below also contains many chert fragments, and boulders most of which are limestone, the rest trap and various metamorphic rocks from the district west of the Conway. One good sized trap boulder was resting in the clay, a dozen feet or so above the shore, almost in contact with the limestone rock. The land slips have made it difficult to examine the lower part of this cliff, but a little further on to the west a good section is exposed, which exhibits below the surface soil: (1) red clay, with but few pebbles or boulders; (2) a rather darker clay, containing large limestone boulders, but slightly water-worn, and many pebbles and boulders of limestone, trap, and metamorphic rocks; (3) a bluer clay, containing many small pebbles of slaty rocks. In many places the lime in (2) has cemented it into a hard conglomerate. Measurements were impossible owing to the steepness and wetness of the cliff. I did not find shells in any of these clays.[1] Again, on the southern face of the Little Ormeshead, a valley may be seen, which descends towards the marshy valley leading to Colwyn Bay, with contours, if possible, more suggestive of glacier action, and apparently with a similar clay in its lower part. A valley of the same kind may also be observed in the north-western part of the range, from the road between Rhos and Llandudno; and the new road from

[1] It may be worth mentioning that the great curving joints which seam the northern cliffs of the Little Ormeshead and contribute largely to their graceful outlines, present remarkably fine instances of slickensides. They can be examined from the shore when the tide is out.

the former place to Castell Diganwy Hotel cuts, on the northern slope of the Diganwy hill, through a regular ‘ subalpine ’ drift.

(*c*) We come lastly to the shore section in Conway Bay. Going from Llandudno, we pass a line of dunes of blown sand, and meet with the clay at Tremlyd Point. This is the extremity of a deposit which forms a slightly rising tract on the north-western face of the Diganwy hills, and appears to be connected with that described above, and to have once overspread the whole, or the greater part of, the level Morfa Rhianedd. Here it forms cliffs about 30 feet in greatest height, and extends along the shore for a distance of about 370 yards. It is capped by a sandy soil from 6 inches to 4 feet in thickness, which was deposited, after the clay had been reduced by denudation to its present form—a bank with gentle slopes north and south. On each of these we find (1) a red marly clay, with but few pebbles, which rises to the surface and disappears towards the middle part of the cliff. The upper part of this, immediately under the surface soil, is of a yellowish tinge, but the state of the cliffs prevented me from ascertaining whether this change in colour indicated a distinct deposit or not. Under this is (2) a bluish-brown clay, containing many boulders of trap and metamorphic rocks from the neighbourhood of Penmaenmawr; perhaps 25 feet in greatest thickness. Many of these blocks contain 20 or 30 cubic feet, or even more; and scratches, apparently the result of ice-action, may be observed on some. They are scattered over the shore for a considerable distance seawards. Below this is (3) a bed of tenacious dark blue clay, full of small pebbles of a dark slaty rock; it only rises one or two feet above the shore, but it may be traced for some distance below high water mark. On the south slope the red clay in like manner replaces (2) and then disappears under the sand; in which, on both sides of the clay, are seams of *Mytilus edulis*, beds of which occur at intervals along the coast-section; but, as these deposits are obviously of an age different from that of the Glacial drifts, I abstain from entering into particulars concerning them. A furlong or so beyond, the clay (1) rises from the shore, and here also is capped by sand, containing beds of *Mytilus edulis* and other shells; and we again find it, after another interval of sand-cliff, near the Castell Diganwy Hotel. I did not find shells in any of these deposits. They seemed to have a general correspondence with those bearing the same numbers in the Little Ormeshead Section.

To conclude. It would appear, from the above remarks that, after the limestone hills of the district had acquired their leading forms by upheaval and marine denudation, the whole district was depressed. The summits of the low rocky islets thus formed became capped with ice-fields, which, in places, descended in glaciers into the sea. At times, very probably, they were united to the mainland by pack or coast ice. The section on the Conway shore seems to favour the idea that, at this period, there were oscillations of level, during which the two lower beds were subjected to slight denudation. After the deposition of the uppermost bed of clay there must have been considerable denudation, either from the action of the retreating sea or of currents in shallow water. To this must have succeeded a period of depression, during which the mussel beds were formed, and then the whole was gradually upheaved above the sea, probably—at any rate in the case of the Great Ormeshead—not quite uniformly.

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## II.—Notes on a Collection of Recent Shells discovered among the Ruins of Pompeii, and preserved in the Museo Borbonico at Naples.

By Robert Damon, F.G.S.

AMONG the many singular discoveries made in the ruins of Pompeii, and deposited in that most interesting of Museums, the *Museo Borbonico*, in the city of Naples, are a variety of shells, principally species now found in the Mediterranean Sea, and so far of interest as an illustration of the persistency of certain known species within the historic period, no difference whatever being observable between the disinterred and living specimens. On a close examination I observed, besides those from the neighbouring seas, species from distant countries, for example:—*Conus textilis*, *Triton femorale*, *Meleagrina margaritifera* (Pearl Oyster), species only found in the Indian and Eastern seas. I think, therefore, that this may be regarded as part of a Natural History collection. Assuming the truth of this conjecture, its antiquity is without a precedent. Did the original proprietor form one of a Natural History Society of Pompeii, of which the distinguished Naturalist Pliny, who perished at Pompeii, was a member? It would also be curious, in these days of research for priority of names, to know how they were described. Such a discovery might disturb existing nomenclature, and increase the perplexity already felt in naming collections. But laying aside fanciful conjectures, the collection is further instructive from the condition and perfect preservation in which the specimens are found, after an interment of nearly 1,800 years. Besides the collection in the Museo Borbonico, there is still standing in a villa at Pompeii, a fountain decorated with shells of the Mediterranean, one species of which, viz. *Murex Brandaris*, retains its colour and general freshness and is not to be distinguished from living examples; while the same species, from the Italian Tertiaries, are colourless and in that friable condition characteristic of shells even of the most recent geological period, pointing, like other discoveries, to the great antiquity of the most modern Tertiary deposits as compared with the era of the human race.

The following is a list of the species which I was able to identify in the Museo Borbonico:—

*Triton nodiferum*, Lam.
„ *corrugatum*, Lam,
„ *femorale*, Lin. sp.
*Murex Brandaris*, Lin.
„ *trunculus*, Lin.
*Dolium oleare*, Lin.
*Cypræa pantherina*, Solan.
„ *lurida*, Lin.
*Turbo rugosus*, Lin.
*Conus textilis*, Lin.
*Pecten Jacobæus*, Lin.
*Pectunculus siculus*, Reeve *P. glycimeris* var Lam.
„ *violascens*, Lam.
*Meleagrina margaritifera*, Lin.
*Tapes pullastra*, Forbes & Hanley.
*Lutraria elliptica*, Lam.
*Cardium echinatum*, Lam.
„ *rusticum*, Lin.
*Helix pomatia* and other *Helices* of the district.

Weymouth, *April*, 1867.

## III.—On some new Trilobites from the Upper Cambrian Rocks of North Wales.

By Thomas Belt, F.G.S.

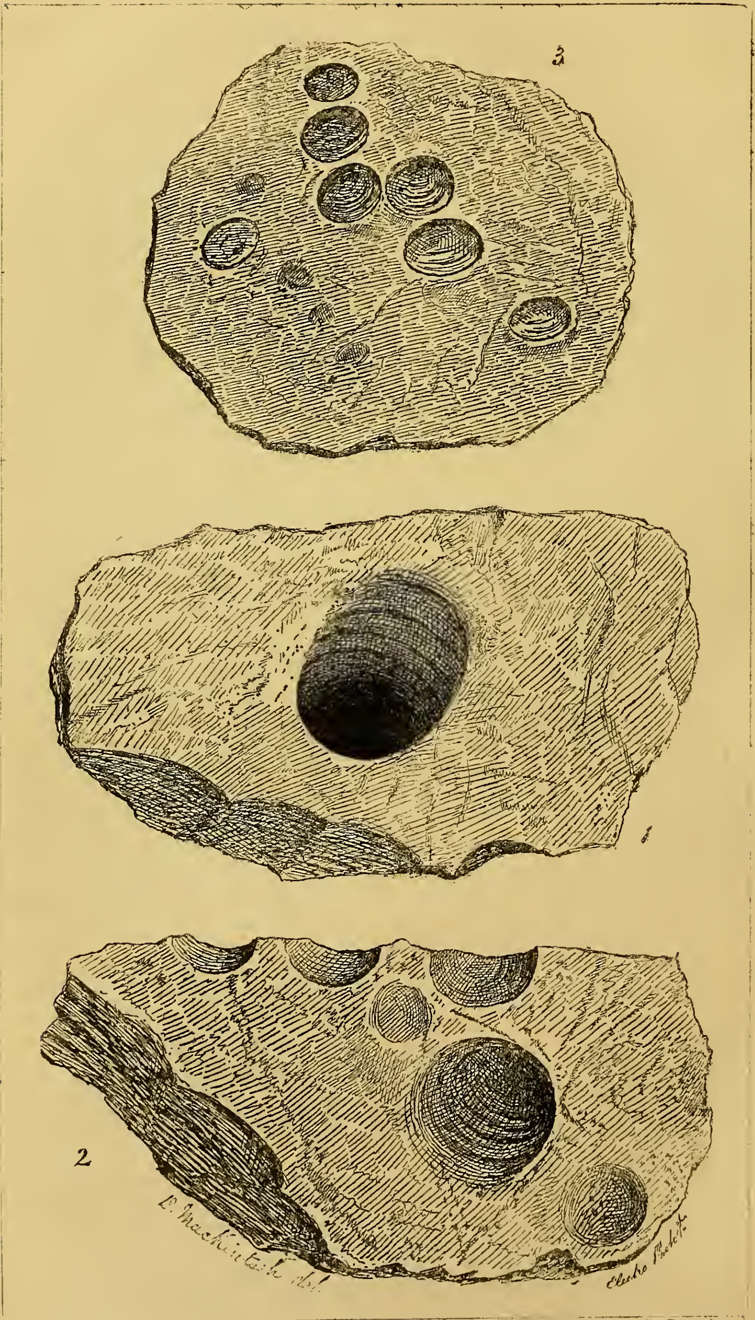
(PLATE XII., Figs. 3–5.)

In the autumn of 1864, Mr. Ezekiel Williamson discovered fragments of trilobites in some slaty beds belonging to the "Lower Lingula Flags" of the Geological Survey, on the right bank of the river Mawddach, a little above its junction with the Eden, and four and a half miles directly north from Dolgelly. Portions of an *Olenus* and of an *Agnostus* were found, but in too fragmentary a condition to be determined. Last summer Mr. J. Chamberlain Barlow, of Birmingham, found the same fossils in great abundance and good preservation on both sides of the Mawddach, opposite to Dolmelynllyn. During the present year I have, from these beds, added another species of *Agnostus* to the scanty fauna; and, after considerable trouble, in consequence of the rocks being greatly faulted, have been able to determine the true position of this new fossiliferous zone.

The fossils that have been found are *Olenus gibbosus*, Wahl., now for the first time recorded as British; *Agnostus nodosus*, sp. nov., and a strongly marked variety of *Agnostus pisiformis*, Lin. The beds containing these fossils lie about midway between the "Menevian group" of Mr. Salter, which forms the base of the Upper Cambrian formation, and a thick series of blue slaty beds characterized by a great abundance of *Olenus cataractes*, Sal., and *Agnostus pisiformis*, Lin., and separated from each, above and below, by yellow and yellowish grey flaky and flaggy beds that have received from Mr. Salter the local name of "Cwmhesian flags."

The following diagram will exhibit more clearly the position of these beds. The whole of the strata there shown form less than one-third of the great mass of rocks that have been called "Lingula Flags" by the Geological Survey, and the topmost of them lies several hundred feet below the beds containing the well-known *Lingula Davisii*. M'Coy.

| | |
|---|---|
| Lower Lingula Flags of Geological Survey. | Dark blue and blue grey slaty jointed beds about 1200 feet thick. *Olenus cataractes*, Salter, common. *Agnostus pisiformis*, Lin., common. *Lingula* sp., rare. |
| | Grey and yellow grey flaky and flaggy beds—about 600 feet. *Agnostus pisiformis*, Lin., in upper beds. |
| | Blue and blue grey jointed beds, about 300 feet. *O. gibbosus*, Wahl. *A. nodosus*, sp. nov. *A. pisiformis*, var. *obesus*. |
| | Yellow grey flaky and flaggy beds, with bands of hard grey grit—about 400 feet. |
| | Dark blue beds—about 500 feet. *Paradoxides*, *Conocoryphe*, *Agnostus*, *Microdiscus*, etc., etc. Menevian group, Salter. |




G. R. De Wilde. fecit. Halles & Co. Imp.

PHOLAS-BORINGS,

NEAR TORQUAY, DEVONSHIRE.

DESCRIPTION OF THE FOSSILS.—I. *Agnostus nodosus*, sp. nov. (Plate XII., Fig. 3, *a* long form, *b* broad ditto, natural size.)

*Head*, rounded in front, straight at sides, sharply rounded at posterior angles. Glabella oblong, obtuse, slightly constricted in the middle, entire, supported by a small angular lobe on each side at base; cheeks, covered with deep reticulating furrows, radiate next the outer edge; margin narrow.

*Thorax* consisting of two nodose joints. Axis strongly trilobate; central lobe of anterior joint with a strong obtuse tubercle.

*Tail* shaped like head; axis trilobate, nodose; central lobe two-thirds the length of tail, narrow in front, widening in the middle, then constricted strongly, and widening again towards the end; furnished with an oblong blunt tubercle one-third its length of its base. Lateral lobes each composed of two rounded triangular joints; limb covered with reticulating radiations, divided by a groove reaching from end of axis to margin. Margin narrow, probably furnished with short spines, but not sufficiently preserved to show them excepting obscurely in one specimen.

*Locality:* River Mawddach, above junction with Eden and opposite Dolmelynllyn, in "Lower Lingula Flags."

II. *Agnostus pisiformis*, Lin., var. *obesus*. (Plate XII., Fig. 4, *c* broad form, *d* long ditto, *a b* nat. size, *c d* magd. two diam.)

The typical form of this species is so well known, that I only append the characters in which the variety differs. In A. *pisiformis*, the axis of the tail is separated at its posterior end by one-fourth its length from the margin. In the variety, the axis reaches nearly to the margin, and in most of the specimens seems to touch it. In the typical form it is only a little more than one-third the width of the tail, including the margin; in the variety it is more than one-half the width, and is turgid and prominent. Lastly, the grooves in the middle of the axis are but faintly impressed in the typical form; in the variety they are deeply marked. The margin of the tail is badly preserved, but was probably furnished with short spines.

*Locality* with the above, in "Lower Lingula Flags."

III, *Olenus gibbosus*, Walh. (Plate XII., Fig. 5, *a* broad form, *b* long ditto.)

I have obtained very fine specimens of this well-known Scandinavian species from the Dolgelly district, and I give figures of the two forms, as Angelin,[1] Barrande,[2] and Salter[3] have all figured the species with the ocular ridge commencing from between the two glabella furrows instead of above them, and none of them have shown the strongly marked articular spaces between the joints of the axis, although Swedish specimens in the Museum of the Geological Society show both these points clearly. Burmeister has figured the ocular ridges correctly, but shows the thorax with fourteen joints instead of fifteen, and the tail with six joints instead of five.

It occurs in older rocks than any other of the English species of *Olenus*, and, taking the body and tail together, has a greater number of axial rings. It shows some resemblance to *Conocoryphe* in its strongly marked ocular ridges and articular spaces, as well as in its large pygidium and in the facial sutures turning slightly outwards above the eye; but its true affinities, as shewn by the pointed, unfacetted pleuræ, are decidedly with *Olenus*.

The occurrence of this species in England will most likely be of great assistance in correlating our rocks with those of Sweden.

*Locality* with the above, in "Lower Lingula Flags."

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## IV.—PHOLAS-BORINGS, DENUDATION, AND DEPOSITION IN S.E. DEVON.

By D. MACKINTOSH, F.G.S.

(PLATE XIII.)

THE structure and marine denudation of the district between Torbay and Babbicombe Bay has been so ably unravelled by

[1] Angelin, Pal. Suec. [2] Barrande, Systeme Silurian, Vol I., Pl. 3, Fig. 7.
[3] Salter and Woodward's Chart of Fossil Crustacea, Trilobita, Fig. 13.
[4] Burmeister, Organization of Trilobites, Tab. 3, Fig. 9.

Mr. Pengelly, as to leave any other observer comparatively little to say. Among his most important discoveries must be ranked that of lithodomous perforations in limestone rocks at considerable altitudes above the sea.

*Pholas-borings.*—I have lately been hunting for these perforations, which competent authorities regard as *Pholas*-borings, and have seen them in various positions and at different levels, but principally on the summits and sides of Kent's Hill and Asheldon (see Plate XIII). The extremely fresh appearance of the borings where they are only very slightly protected by vegetation, and even where they are exposed to the atmosphere, would seem, at first sight, to forbid our assigning to them any great antiquity. But if we are to refer them to the great glacial submergence, or (according to most geologists) a pre-glacial submergence, then the preservation of these borings clearly shows that the prevailing theory of the superficial (not internal) dissolution of limestone hills by subaërial action is a mere assumption. It may be asserted that the perforations have been preserved only in the hard parts of rocks, the softer parts of which have disappeared; but the following facts render it certain that little or no dissolution of the limestone has occurred since the perforations were made, or since this locality was last under the sea. On the summits and sides of the hills, and in the valleys, wherever natural or artificial exposures of rock occur, they exhibit undoubted wave-marks, consisting of smoothed and rounded surfaces, grooves, cells, pot-shaped cavities, etc., *on which the Molluscan-borings have been impressed, or by which previous borings have been modified, or partially effaced.* The most decided *Pholas*-borings do not, so far as I have observed, occur principally in cliffs, but on the sloping sides or summits of hills. The highest I have yet seen occur near the summit of Kent's Hill, at an altitude of at least 240 feet above the sea. Many apparent *Pholas*-borings, especially those which occur on the edges of limestone strata, or which are associated with a honey-combed rock-surface, cannot be relied on. When on the face of a solid mass, they may be more satisfactory; but the sea is capable (as may be seen on the rocky beach under the public baths at Torquay) of forming holes of so many forms and sizes, by the unequal disintegration of the rock, as well as by the gyratory movement of silt and stones, that it is scarcely safe to assume that any holes have been bored by organic agency unless they appear very cleanly cut, and of a uniform specific shape. The most decided *Pholas*-borings I have seen, occur in colonies, and vary in the widest part from half-an-inch to an inch and a quarter in diameter.

There is a truly wonderful natural arch[1] at Upton, near Torquay, the general form of which impressively points to the former action of the sea. There are numerous holes on the sides as well as on the roof of this arch. Many of the smaller holes are not unlike slightly weathered *Pholas*-borings, especially those which occur

[1] Mr. Pengelly has more than once referred to this arch as a monument of sea-action, and I noticed it in the Geol. Mag., No. 2, Vol. III. Feb. 1866, p. 68.

within the large pot-shaped cavities. Here, as elsewhere, some of the holes have been usurped by land-shells.[1]

The testimony of the above *Pholas*-bored, grooved, pitted, and honey-combed rock-surfaces to marine denudation amounts to this: they show that the sea has not only stood at various levels up to a height of at least 240 feet above existing mean water-mark, but that many of the larger features of land surface with which they are associated have been formed by the sea. The forms of the cliffs are evidently a part of the same class of effects, and are, therefore, likewise of marine origin, while the preservation[2] of wave-marks and *Pholas*-borings proves the extreme slowness of atmospheric action, and thus furnish a negative presumption in favour of the sea, and not the atmosphere, having been the primary or great denuding agent. Not only are the phenomena of denudation in this district clearly marine, but those of deposition or accumulation point in the same direction.

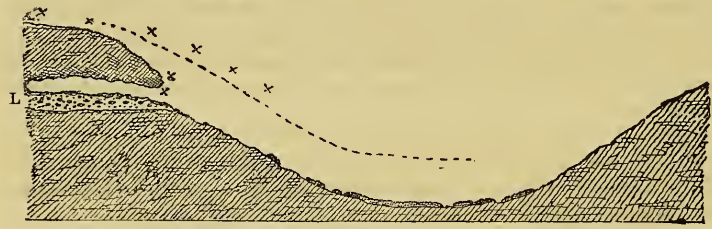
*Valley of Kent's Cavern.*—The main valley, on the west side of which this celebrated cavern is situated, runs S. and N. from sea to sea, or from Torbay to Ansty's Cove. It is a pass open at both ends, with too little inclination to give to any supposed former stream a denuding power. The principal tributary valley has a greater slope, but it merges into the valley which leads to Torquay. No watershed sufficient to supply this valley with a brook possessed of excavating power, could have existed in this district in post-glacial times, or since the ground acquired its present general contour. The first denudation of these and other valleys, is explicable by branching currents having a clear thoroughfare, supplemented by sea-coast action, producing cliffs. After their excavation, the valleys must have been filled at least to a certain height (Mr. Pengelly believes they were entirely filled up) with stony loam, which was afterwards removed, with the exception of the remnants now lining their sides, or covering their bottoms. The loam in Kent's Cavern is similar to that covering the neighbouring ground. In many parts it is full of stones, and very unlike a loess or re-deposition by freshwater floods, while the idea that the sea left the valley filled with loam up to the level of the cave, so as to furnish the brook with a bed to enable it to carry the loam and stones into the cave appears, to say the least of it, a forced explanation. There

[1] The late M. N. R. Bouchard, of Boulogne-sur-mer, wrote a paper entitled "Observations sur les Hélices Saxicaves du Boulonnais," printed in Vol. xvi. of the "Annales de Sciences Naturelles," in which he expresses his belief that these limestone perforations are the work of land-snails. M. Bouchard's observations were repeated and confirmed by Miss E. Hodgson, of Ulverstone (see Geologist, Vol. vii., Feb., 1864, p. 42). The late Dr. S. P. Woodward—than whom no higher authority upon Mollusca can be quoted—decided against the snail-theory, and referred the Ulverstone examples (presented by Miss. Hodgson, and preserved in the British Museum) to the decomposition of the rock by carbonic acid dissolved in rain-water—the form of the cavities often resulting from the former presence of fossils. The writer has seen numerous similar examples of weathered and perforated limestone rocks at Gibraltar and elsewhere.—H.W.

[2] The best preserved borings have retained the appearance of irregularly spiral ridges and furrows.

are difficulties connected with the marine theory of accumulation, but if we suppose the action of waves, currents, and storms at different tidal levels, and during possible variations of level, arising from oscillations of the land, many of the phenomena can perhaps be explained. Mr. Tylor (Quart. Journ. Geol. Soc. Nov. 1866) seems to be of opinion that the valley was filled with loam up to the level of the cliff above the cavern, to enable the Mollusks to pursue their boring operations, but this cliff is so small that a very slight accumulation of loam beneath it would give a nearly continuous contour to the side of the valley (see Fig. 1).

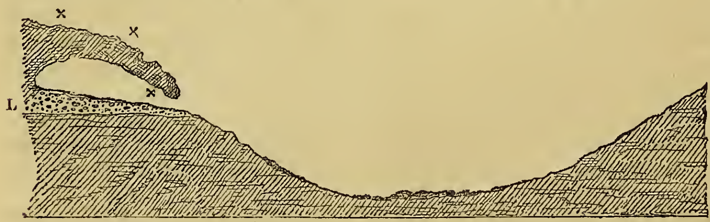
Fig. 1.—Diagram of the north entrance to Kent's Cavern.




L. Loam. x x. *Pholas*-borings. The dotted line represents Asheldon Hill.

That the cavern was originally excavated or enlarged by the sea is evident from the arched form of the south entrance, and the rounded shape of the recesses and parts of the roof. There are holes (referred to by Mr. Pengelly) on the projecting part of the cliff above the north entrance, and on the roof of the entrance; and within the arch of the south entrance (Fig. 2) there are somewhat similarly shaped holes, all of which may be slightly weathered *Pholas*-borings, though very far from decided specimens.

Fig. 2.—Diagram of the south entrance to Kent's Cavern.




L. Loam. x x. *Pholas*-borings. Above the loam there is a deposit of Stalagmite covered by a layer of dark-coloured earth.

On the slope beneath the cavern, if there are not decided *Pholas*-borings, there are convincing wave-marks on the projecting rocks. On Asheldon (the hill nearly opposite Kent's Hill), I have seen fresh-looking *Pholas*-borings at a lower level than the cavern. These facts furnish a strong presumption, in the absence of evidence to the contrary, that no flow of water capable of abrading rocks, has been in the valley of Kent's Cavern since it was last under the dominion of the sea.

NOTE.—Since the above was written I have found polished circular perforations, of the size of *Pholas*-borings, in Stoney Combe, immediately to the south of the railway between Newton and Totnes. They generally slant upwards on the protected or over-hanging sides of rocky projections. They are distinct from the *vast majority* of small deep holes in limestone rocks, which here, as elsewhere, are *structural* cavities, enlarged, *but never rendered perfectly smooth and circular*, by atmospheric action.—D.M.

EXPLANATION OF PLATE XIII.

Fig. 1. Specimen of perforated limestone from Asheldon, near Torquay (natural size).
Fig. 2. Borings from the summit of Kent's Cavern Hill, nearly 250 feet above the present sea-level (natural size).
Fig. 3. Group of *Pholas*-borings on part of a block of limestone on the side of Asheldon Hill, north of Kent's Cavern, about 190 feet above the sea (about one-third the natural size).

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## V.—ON THE DISTRIBUTION BEYOND THE TERTIARY DISTRICTS OF WHITE CLAYS AND SANDS SUBJACENT TO THE BOULDER-CLAY DRIFTS.

BY GEORGE MAW, F.G.S., ETC.

(PART II.)

*THE Pipe-clay beds of Tipperary* appear so closely to resemble in character and position the deposits of the Mountain Limestone district of North Wales and North Staffordshire, that it may not be out of place to record some observations made by Mr. C. D. Blake, of Newton Abbot, in 1862, and kindly communicated to me. There are also one or two previously published notices of these deposits, to which reference must be made.

The first record appears to have been made by Mr. (now Sir Richard) Griffith, in the form of a report in the minutes of the Royal Dublin Society, on the probabilities of finding coal in Tipperary, a copy of which has been obligingly communicated to me by Dr. Steele; it is as follows:

Mr. Griffith says, "Expectations of finding coal were also entertained by Lord Waterpark and his tenants on the lands of Scartana, three miles to the south-west of Cahir. In making a well at this place a considerable thickness of disintegrated Chert, a white silicious substance, similar in composition to Lydian Stone, was passed through without meeting with any solid rock; at the depth of 70 feet a black, sooty-like substance, arising probably from the decomposition of some vegetable matter, was met with; but as the surrounding country was wholly composed of Limestone and Lydian Stone without the intervention of any other rock, I have no hesitation in stating that the black substance found is not connected with, or likely to lead to the discovery of a bed of coal. So far my examination proved fruitless, but in exploring the country to the south-east of Cahir, in search of some pits, from which I understood white potter's-clay had previously been raised, I was enabled to trace an extensive and very valuable alluvial deposition of that substance, resting on the top of the Limestone strata. This clay occurs on the lands of Ballymacadam, Lough Logher, Morristown, etc.; the principal workings were made upwards of 25 years since on the lands of Ballymacadam, and Lough Logher. The first stratum of clay is said to be 30 feet thick; beneath it is a bed of Surturbrand, or Wood Coal, 10 feet thick, exactly similar to that at Bovey in Devonshire; below which is a second stratum of clay that has never been sunk through. The old workings, both at Ballymacadam and Lough Logher, were made close to the edge of the clay district, where it was not likely to be pure, and no trials have yet been undertaken in the interior of the valley, where it is probable a great body will be found."

A reference to these beds is also made by Mr. A. B. Wynne, (late of the Irish Geological Survey, and now of the Geological Survey of India), in the data and descriptions accompanying quarter-sheet 45 S.E. of the Irish Survey. A fuller account of the formation is also given by Mr. Wynne in a paper read before the British Association in Dublin (see abstract, p. 94, of British Association report, 1857), from which I abridge the following. "The clay is found under and about the mine of the old Castle of Ballymacadam. The mode of its occurrence is very strange; for when standing in the centre of the small hollow which it occupies, at a distance of about 100 yards on almost every side, the Carboniferous Limestone may be seen to protrude through the ordinary Drift, which is spread over the surrounding country, and which most probably once covered this isolated basin of Tertiary Clay, occuping an area of at most about an acre and a half. One small pit has recently been opened to a depth of 4 or 5 feet; and in this *in sitû* was found a lenticular mass of Lignite. The clay is usually white, more or less pure, and sometimes of a dun or bluish tinge, smooth to the touch, and extremely tenacious. The Lignite is brown, and occurs in different states of decomposition and alteration; but none of it remains sufficiently perfect to prove what kind of wood it was. Within the space occupied by the clay occur some of those natural drains so common to the Mountain Limestone of Ireland, expressively called by the peasantry Swallow-in-holes, they carry off all the surplus water accumulated in the pits; one in particular having been used to drain them wherever they were opened.

"Under about fifteen feet of white clay, containing small fragments of plants, a bed of Lignite is reached, of varying thickness, from which parts of trees four or five feet in length could be raised without difficulty; beneath this occurs the purest and best clay, which is white (with sometimes a pale shade of blue) and soft, and has a soapy feel. Lower than this no person has penetrated, as springs of water bursting up through the clay filled the pits, accompanied by so offensive an odour of sulphuretted hydrogen gas as could scarcely be endured; even now the place is not quite free from a mitigated form of this unpleasant effluvium, which, as stated by Dr. Griffith, attends the occurrence of potter's-clay in many other places in Ireland, as the south-eastern margin of Lough

Neagh, counties of Tyrone and Antrim; in the parish of Clonoe, in county Tyrone; and near Lough Ree, in Roscommon. The Lignite gives forth a heavy and peculiar smell whilst burning, and is associated with black shales, traces of which were seen near the mouth of one of the pits; no shells were met with in any part of the clay.

I am indebted to Mr. Charles D. Blake, of Newton Abbot, for the following detailed description of the Ballymacadam-clay deposits, the result of some borings undertaken so recently as 1 82 with the object of ascertaining the value of the clay for pottery purposes.

"This deposit, probably the remains of a more extensive one, of which the chief part may have been removed by floods, occurs in depressions, or hollows, in the grey limestone rock, from 100 to 200 feet in diameter, and to a depth of from 40 to 100 feet. Their form is irregular, and it was not ascertained whether the sides of the pockets were smooth or rough.

"In the same locality, or near the clay deposits, are numerous fissures, or 'swallow-holes,' in the Limestone rock; they carry away the surface water, and are supposed to have outlets near the river Suir, about two miles below. The level of the river at Cahir is 135 feet above the sea, and I should think the clay at Ballymacadam lies from 150 to 200 feet above the river. There is much limestone drift in the neighbourhood, but generally at a lower level than that of the clay.

"The stratification of the clay bed is tolerably perfect, and the dip varies with the angle of the basin; in some cases, as at Ballymacadam Old Castle, the surface of the ground is depressed conformably with the shape of the basin, the beds appearing rather to *line* than fill the pockets in which they occur; but in most of the other cases the surface is smooth and regular, the concavities of the basin being filled with limestone, gravel, and other drift, apparently of local origin.

"The different veins or seams of clay under the gravel, forming the bulk of the contents of the pocket, are numerous but thin; one or two of the seams are very pure, suitable for white earthenware; but they do not occur with any regularity, and therefore could not be worked with profit. Some of the veins are quite white, while others are of a brown, bluish, or grey color. Some borings showed a very thin deposit of nearly black clay, the colour being due to the presence of Lignite and Pyrites—both much decomposed. No solid or hard Lignite was met with, though some of the people on the spot spoke of specimens as large as trees, that had been found where some small workings had been made at Ballymacadam many years ago; much of the clay contained free silica in fine particles; the seams of clay varied considerably in each pocket. Granite, supposed to be the source of the plastic clay, does not appear to occur nearer than the county Wexford, at a distance of fifty or sixty miles."

Subjoined are the details of a boring at Ballymacadam, also furnished me by Mr. Blake, showing the contents of one of the pockets and representing a section, as follows:—

| | | |
|---|---|---|
| 1st. | Clayey Limestone-drift | 27 feet. |
| 2nd. | Soft Lignite | 1 foot. |
| 3rd. | Brown, blue, or white clay, interstratified with a little fine sand and gravel | about 31 feet. |
| 4th. | Bluish sand, of unknown thickness | |
| | | 59 feet. |

*Details of Boring.*

| | |
|---|---|
| Limestone-drift, gravel and sand, mixed with yellow clay | 27 feet. |
| Soft Lignite | 1 foot. |
| Tough brown clay, mixed with fine gravel | 9 feet. |
| Brown clay striped with blue | 2 ,, |
| Brown clay with gravel | 2 ,, |
| Sandy-grey clay | 1 foot. |
| Grey clay striped with blue | 1 ,, |
| Sandy-blue clay | 1 ,, |
| Fine blue clay | 1 ,, |
| Brown clay with fine gravel | 2 feet. |
| Fine blue clay | 1 foot. |
| Coarse brown clay | 1 ,, |
| Blue clay with sandy veins | 10 feet. |
| | 59 feet. |

At a depth of 59 feet, blue sand, containing water, was reached, when the boring was discontinued.

The questions bearing on the foregoing facts that invite consideration, relate

1st. To the probable age of these deposits.

2nd. As to whether they are the remnants of a more extensive formation, that once spread over the whole of the districts in which they occur, or are mere local deposits produced by subaërial action, that never much exceeded their present dimensions.

3rd. Regarding the source of the component materials.

4th. As to the process of the excavation of the pockets and cavities in the Mountain Limestone, in which the deposits are almost invariably preserved.

With reference to age it would be unsafe to assume that these similar deposits in Tipperary, North Wales, and the Midland Counties of England, belong exclusively to the same geological period; and the only fact that can be relied on is their unquestionable infraposition to Boulder-clay drift, which holds good in all the localities I have examined in North Wales and Staffordshire, and seems, also, constant with respect to the occurrence of the deposits of like mineral character in Ireland: their similar position and physical resemblance in all the localities is remarkable. Nearly all the examples occur between the Boulder-clay drift and the Mountain Limestone, and in nearly every case the same beds of peculiar mineral character are associated. The soft chert breccias, white clays, dark laminated clays, white sands, and carbonaceous beds, are recorded from widely separate districts, and the peculiar dark sooty-like substance is common to the Welsh, the Irish, and the Staffordshire deposits.

In connection with their infraposition to the Boulder-clay, and, therefore, the possibility of their Tertiary age, their mineral resemblance to some of the Lower Tertiary beds ought not to be lost sight of, though this fact be insufficient to draw conclusions from without the evidence of fossils.

The evidence bearing on the question of the original extension of the beds beyond their present limits, appears somewhat conflicting: on the one hand, the general limitation to the Mountain Limestone in far removed localities, and the various levels at which the small and isolated patches occur, seem to point to a local, and to a certain extent subaërial agency, the similar mineral character being dependent on an identity of local circumstances and similar sources of component materials. On the other hand, these deposits are not invariably confined to the Mountain Limestone, and in the case of the white clays resting on Lower Silurian rocks, west of Conway, the distance of transport from the nearest Carboniferous Limestone and Millstone Grit seems scarcely compatible with mere subaërial agency.

Again, when occurring on the Mountain Limestone, the deposits invariably occupy deep depressions on its eroded surface, a contour implying the removal previous to their deposition of the whole of the Millstone Grit in each individual locality; but as the sands and chert-beds of the Millstone Grit appear to have largely entered into the composition of the deposit, a certain amount of transport appears indispensable. The Millstone Grit, in many parts of North Wales, is in a very soft and friable condition; but the local débris, resulting from its subaërial decay, does not resemble the deposits under consideration, in which the sorting and separating agency of water appears manifest in the interstratification of various coloured sands with laminated-clays and tough pipe-clays in well-defined beds. This arrangement could not have been produced without the agency of some body of water, though it is probable that the several masses of the deposit may have been accumulated within separate and limited areas.

With reference to the cavities in the Limestone containing the clay- and sand-beds, and the probable process of their excavation, I would refer to a suggestion I made in describing the pockets at Llandudno (Geological Magazine, May, 1865), that they were gradually formed by the slow dissolution of the Limestone, and that this may have taken place *subsequently* to the deposition of the mass of the materials occupying them, after the manner of the excavation of the sand-pipes in the Chalk and Coralline Crag, into which previously existing superincumbent beds appear to have been gradually lowered.

The evidence in support of this view is various; the point that first suggests itself is the difficulty in accounting for the excavation of a deep *cul-de-sac*, complete on all sides, by any ordinary process of either marine or subaërial denudation,—as some force vertically directed seems requisite on any mechanical theory. The effect of ice, which has been adduced to explain the excavation of rock lake-basins, complete on all sides, seems scarcely applicable to the present case, as the walls of the pocket exhibit no evidence of abrasion or striation, but present a smooth mammillated surface, such as would be produced by gradual dissolution, and resembling that of underground cavities in the limestone, which are generally considered to be due to this process.

Another point to be noticed is, the absence of rocky fragments or débris, and the striking dissimilarity of the contents of the cavities to the Glacial beds that overlie them. Had the pockets been excavated by Glacial abrasion, the entire clearing out of all débris from the bottom of a deep *cul-de-sac* would be highly improbable, and, furthermore, had the pockets been at any time opened and exposed, the subaërial accumulation of débris from the sides of the Limestone hills, on which the pockets are frequently placed (as for example at Nant y Gamer, near Llandudno), would soon have filled them up. As a rule, however, the pockets are occupied with the white clays and sands, free from stones and limestone fragments, and resting on these are the Glacial drifts, entirely dissimilar in colour and mineral character, and containing both local and foreign boulders.

A point of analogy with the sand pipes of the Chalk is the tendency to a vertical disposition, or a conformity to the general shape of the pockets of the strata occupying them; instead of the beds lying horizontally or nearly so, as they would have done from direct deposition in the containing cavities, they are in some cases disposed vertically or more generally with a steep inclination, dipping towards the centre; they are also frequently disturbed with singular contortions and full of little faults and slips, which, from the formations being strictly confined within the limits of the cup-shaped cavities, appear, at first sight, difficult of explanation; if, however, the gradual dissolution of the underlying limestone is taken into consideration, the singular arrangement of the beds is at once accounted for. The strata, with a disposition originally more horizontal would, in gradually sinking, conform themselves to the changing outline of the slowly deepening cavity. This sinking and dislocation is evident in nearly the whole of the examples before referred to. Mr. Binney describes the occurrence of an almost vertical mass of pebbly gravel in the midst of a mass of pipe-clay occupying a pocket at Caldon Hill Limestone Quarry; and Mr. Brown, in his paper on the Drifts of the Weaver Hills (see p. 201), states that the white clay and sand deposits below Caldon Low, in the same neighbourhood, betrays its existence by deep sinkings in the surface of the ground. The Welsh deposits, near Llandudno and on Holywell Mountain, appear also to have sunk down since their original deposition, rendered evident by their tendency to a vertical or steeply concave arrangement, and accompanied by the dislocations before referred to. The Irish beds exhibit similar evidences of altered arrangement. Mr. Blake observes that the dip of the stratified clay varies with the angle of the outline of the containing limestone basins, and that the beds seem rather to *line* than fill the pockets. Also that the surface of the ground is sometimes depressed conformably with the shape of the basin. Mr. Wynne, in the descriptive letter-press accompanying quarter sheet, No. 45, S.E. of the Irish Survey, observes, with reference to these beds, that "where the lignite appears at the surface, it seems to have a dip at a high angle southwards." This, I apprehend, must be an inclination from the circumference of one of the pockets. One of the conditions requisite for the gradual dissolution of the limestone—the existence of underground outlets for the discharge of the water, removing the lime in solution, is always present. They are noticed by Mr. Blake and Mr. Wynne, in connection with the limestone pockets in Tipperary; and by Mr. Brown, at the seat of these deposits on the Weaver Hills. In North Wales there is evidence of the existence of underground outlets in the fact that the water freely drains away from the pockets or basins, and Swallow-holes are occasionally visible on parts of the Mountain Limestone range not obscured by the deposit. In the mining operations of the district it is not at all uncommon to break into these cavernous openings in the Mountain Limestone. At Glan Alyn Mine, near Mold, a large cavern occurs at a considerable depth, and discharges a portion of the mine water; and at the Britannia Mine, near Llanarmon, a cave lined with stalactitic deposits was found at a depth of 25 yards, also affording a passage for the water.

Perhaps the most striking fact bearing on this point is the occurrence of great masses of redeposited lime, as Tufa (see GEOLOGICAL MAGAZINE, June, 1866), at the foot of the limestone range in which the pockets occur. Near Caerwys, in Flintshire, in the valley connecting Mold with the Vale of Clwyd, many hundred thousand cubic yards of Tufa have been deposited immediately adjacent to a cavernous channel in the limestone cliff directed to the neighbourhood of the pockets.

A deposit of Tufa has also been noticed near Llangollen, and I am informed by Mr. Beckett, of Wolverhampton, that other masses also occur, somewhat further removed from the Mountain Limestone range: viz., on the eastern side of Wepre Brook, in the parish of Hawarden, in Flintshire, about half a mile below Euloe Castle, where it occupies a considerable breadth of steepish bank, and is remarkably full of calcified ferns and other local plants; Tufa also occurs on the banks of the river Alyn, at Gwersyllt, near Wrexham. It has been already noticed that mixed and interstratified with the sand occupying the cavities, occur beds and patches of a very white and smooth clay, resembling Kaolin in appearance, the origin of which, from the mere mechanical degradation of previously existing beds, seems difficult to account for, as in its purity and whiteness it is unlike anything that could have been derived from the wearing down of the Carboniferous beds. The question suggests itself whether it may not be the insoluble matter contained in the limestone, left behind after the dissolution of the carbonate of lime and iron. The purest limestone contains a small quantity of silica and alumina, that could not be removed in watery solution; and if the pockets have been excavated by the chemical dissolution of the limestone, we should expect to find its insoluble constituents left behind in the pockets.

With the object of ascertaining whether the beds of pure white clay could possibly represent such residue, I procured from Dr. Voelcker the following analysis of the Carboniferous Limestone, forming the walls of the pockets, and of the white clay partly occupying them :

*Analysis of Limestone Wall of Pocket, Nant y Gamer, Llandudno.*

| | | |
|---|---|---|
| Moisture and combined water | 0·95 | Soluble in very dilute Hydrochloric Acid. |
| Oxide of Iron | 0·88 | |
| Alumina | 0·15 | |
| Carbonate of Lime in a little Magnesia... | 95·53 | |
| Oxide of Iron | 0·85 | Insoluble in dilute Hydrochloric Acid, forming 2·49 per cent. of the Limestone. |
| Alumina | 0·26 | |
| Lime | 0·08 | |
| Magnesia and Alkalies (by difference)... | 0·28 | |
| Silica | 1·52 | |
| | 100·00 | |

The carbonate of lime and iron would be the constituents removable in solution by water charged with carbonic acid, and these we find actually redeposited in the neighbourhood in the shape of ochreous Tufa. The remainder would consist principally of silica and alumina, with traces of the other constituents; and with such insoluble residue the following analysis of the white clay closely corresponds :

*Analysis of the White Clay from Pockets in Mountain Limestone, Nant y Gamer, Llandudno.*

| | |
|---|---|
| Moisture and Water of combination | 9·96 |
| Oxide of Iron | 1·84 |
| Alumina | 26·43 |
| Lime | 1·22 |
| Magnesia | 0·82 |
| Alkalies (by difference) | 0·55 |
| Silica | 59·18 |
| | 100·00 |

The proportion of silica is somewhat in excess of that contained by the insoluble residue of the limestone; but as both the clay and the limestone would vary somewhat in their composition, the correspondence is as close as could be expected from the result of a single analysis.

If we suppose this white-clay residue to be gradually thrown off from the sides and bottom of the cavities with the dissolution of the limestone, the sands from the Millstone Grit deposited from above, and the whole contents gradually lowered as the cavities deepen, we should expect just such a result as the arrangement observed at Nant y Gamer, Holywell Mountain, and the Weaver Hills, viz., a kind of rough stratification broken up, bent and faulted, and here and there inverted. The mass being gradually added to, *both from* *below and above*, accompanied by a continual sinking, would assume just that complexity of arrangement the beds display, which, at first sight, appears quite unintelligible, and which, I believe, no other explanation will satisfactorily account for. The probable derivation of these white-clays from the dissolution of the limestone, suggests the question as to whether the beds of pure white impalpable clays, so largely composing the Lower Tertiaries, may not have had a similar origin from the dissolution of the Chalk before being transported and interstratified with other materials.

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## VI.—Discovery of a Hyæna-den, near Laugharne, Carmarthenshire.

By Henry Hicks, Esq., M.D.

THE announcement of the discovery of a Hyæna-den, near Laugharne, may possibly be of some interest to those of your readers who may be inclined to visit the bone caverns of South Wales during the approaching summer. In the autumn of last year J. R. Allen, Esq., of Albert Terrace, Regent's Park, London, was good enough to send me word that, during a few days' stay at Laugharne, he had discovered some fragments of bones in a limestone cavern known as the "Coygan cave;" adding, at the same time, that it was not known in the district that any one had hitherto found bones there, or that it had ever been explored for that purpose.

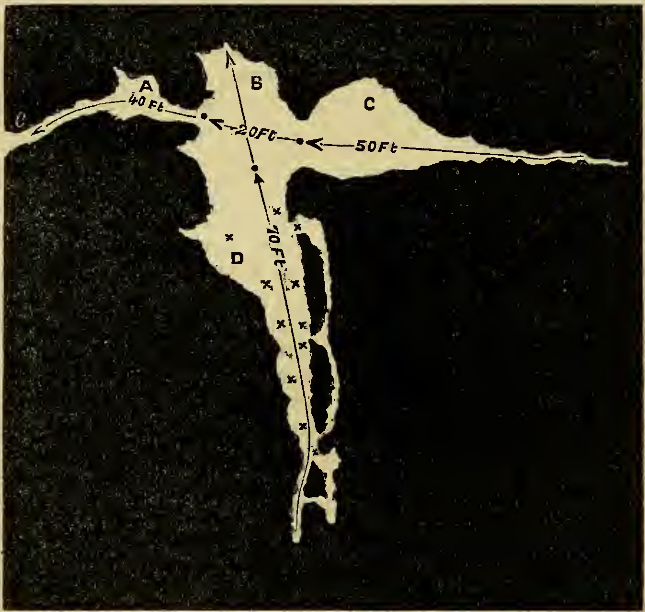
Accordingly, we arranged to meet there soon afterwards, and during our exploration were so fortunate as to obtain numerous fragments of bones, teeth, jaws, etc., and at the same time we were able to satisfy ourselves that it had evidently been at one period a Hyæna-den, until then unexplored. I have since visited the cavern several times, and exhumed a large number of bones belonging to *Hyæna spelæa. Rhinoceros tichorhinus, Elephas primigenius, Equus, Cervus tarandus, Cervus* (small var.). All the bones were forwarded to W. Boyd Dawkins, Esq., F.R.S., for examination, and he has kindly determined the species, and sent me the following list with some notes on our joint collections:—

*Hyæna spelæa*, six jaws with teeth, also separate teeth and bones.
*Rhinoceros tichorinus*, numerous teeth and bones.
*Elephas primigenius*, six teeth (or parts of), portions of tusks and bones.
*Cervus tarandus*, shed antler-guard, etc.
——— (small var.), jaw, etc.
*Equus*, numerous teeth, etc.

He says, "all these remains were derived from a Hyæna-den, and were introduced by those animals in every case. The lower jaws are in every case without angle or coronoid process, and the Rhinoceros humeri, tibiæ, and radii, are gnawed in exactly the same manner as those from Wookey Hole. The teeth, also, of the Hyænas indicate every variety, from the whelp to the adult in the decline of life. A lower jaw belonging to Mr. Hicks shows remarkably the results of the diet of the hyænas on their teeth. The first of the two conical bone-crushers is broken, and the fragments of bone gliding down upon the unarmed gum have caused inflammation of the periosteum. One of the hyæna's last lower molars exhibits the accessory cusp, which is but seldom developed. The remains of the Rhinoceros are most abundant."

The cavern is situated in a Carboniferous limestone hill, called Coygan, about two miles to the south-west of Laugharne. The entrance is about 250 feet above sea-level, and easily accessible.

PLAN OF THE COYGAN CAVE, NEAR LAUGHARNE, CARMARTHENSHIRE.




A. First chamber. B. Central chamber. C. Westerly compartment. D. Northerly compartment. *e.* The entrance. x x. Indicate the spots where the remains were chiefly discovered.

The orifice is low and narrow, about four feet by three. From it a low tortuous channel extends inward for about twenty feet; this is so low in some parts that it becomes difficult to pass in a creeping position. A moderately lofty chamber is then entered, which again leads to another and larger chamber—the principal or central chamber—about twenty feet wide by twelve in height. It then branches off into two compartments, a northerly, and a westerly one; the former extends inward for about seventy feet, and the latter about fifty, when both terminate in rather narrow fissures. The entrance channel, the two chambers, and the westerly compartment, have a very thick flooring of stalagmite, which has not yet been broken through. The northerly compartment, therefore, is the only one which has been searched; this was covered over but thinly and partially, and hence easily worked.

After breaking through this thin coating we came to a reddish earthy soil, with bones imbedded, some of them almost on the surface, others a foot or two deep. It is impossible, as yet, to state what depth of soil occurs here, though evidently it is somewhat considerable; fragments of bone occurred rather plentifully throughout, much more so, however, in some parts than others—heaped as it were in favourite haunts. The bones are all in a good state of preservation, seldom, however, in their natural form, and almost in every instance giving unmistakable indications of having been more or less gnawed. There is no evidence whatever to show that the sea has entered the cavern at any time since it was inhabited by the hyænas, nor have we fluviatile deposits present, nor as yet have we found any traces of its having been a human habitation, like Kent's Hole and others. No worked implements, flint or bone, turned up during our explorations; possibly, however, further diggings near the entrance, or in the chambers, may reveal traces; but up to the present time we have discovered nothing of that nature.

St. David's, *May*, 1867.

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## VII.—On some new Coprolite Workings in the Fens.

By J. F. Walker, B.A., F.G.S., etc.

[Read before the Yorkshire Philosophical Society, May 7th, 1867.]

On the evening before I left Cambridge last term, I was informed by a man who brings me fossils, that some new coprolite diggings had been opened in the Fens. I was unfortunately unable to visit the workings then, but since my return to Cambridge, I have explored them in company with Mr. Moore, of St. Catherine's College. The workings are situate about a mile from Upware, which lies about twelve miles from Cambridge, and seven from Ely.

Upware is known to geologists as the nearest locality of the Coralline Oolite to Cambridge. The bed differs from the "Sandy conglomerate bed," in being less ferruginous, and containing more lime, probably derived from the Coralline Oolite. The nodules are mixed with pebbles, which are picked out by women and children; about a third part is waste. Roller washers are used here as at Sandy. The sections exposed by the workings differ considerably; the best I have seen was on the occasion of my last visit to the pits.

| | | |
|---|---|---|
| 7. Surface, black peaty soil, often containing bones of red deer, horse, etc. | about 1ft. | 6in. |
| 6. Layer of light-coloured Coprolites ... | 1 | 0 |
| 5. Sand (called by the workmen Silt) ... | 1 | 6 |
| 4. Vein of dark-coloured Coprolites ... | 0 | 9 |
| 3. Silt ... | 1 | 6 |
| 2. Vein of dark Coprolites ... | 1 | 0 |
| 1. Clay (not pierced) ... | | |

At another working—

| | | |
|---|---|---|
| Sand ... | 6ft. | 0in. |
| Coprolitic vein ... | 2 | 0 |
| Conglomerate (hard rock) ... | 0 | 4 |
| Light-coloured Sand and Clay ... | | |

The three layers of nodules noticed in the first section often become blended into one, but the top layer differs in the nodules, being of a much lighter color, and I was informed that they were less valuable.

The hard rock (conglomerate), consisting of nodules and pebbles, cemented together chiefly by carbonate of calcium, varies considerably, sometimes being so firm as to be penetrated with difficulty; at other times the coprolites near the clay are easily worked. The Kimmeridge Clay is not pierced, as there is no occasion for a well, the works being near the river. Among the nodules there are found phosphatic shells, as in the bed near Potton. They consist of fragments of Ammonites, (and some of the nodules are marked by impressions of Ammonites( casts of brachiopoda, conchifera and gasteropoda, also remains of large Belemnites and *Gryphæa dilatata*, composed of carbonate of calcium, occur, derived from the Oxford Clay.

I have obtained the remains of most of the fishes and reptiles found at Sandy.

*Sphærodus gigas* Ag.
*Gyrodus*
*Asteracanthus ornatissimus* Ag.
*Pycnodus gigas ?*
*Hybodus* (Spine and *Sphenonchus*).
*Psammodus reticulatus* Ag.
*Edaphodon.*

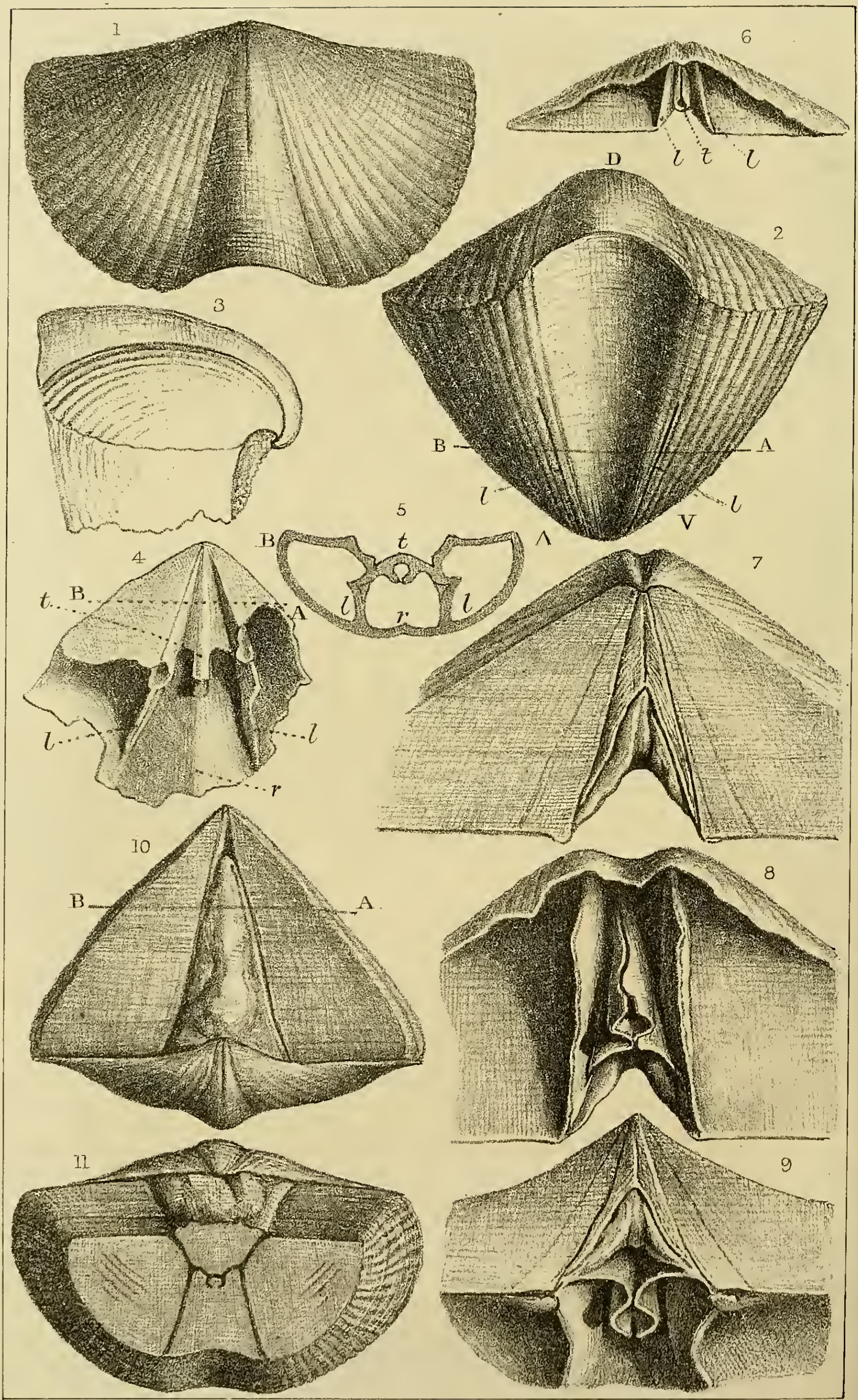
Of reptiles, the remains of *Pliosaurus*, *Ichthyosaurus*, *Plesiosaurus*, *Dakosaurus*, and a tooth of the *Iguanodon*, have been discovered.

The fossils proper to the bed consist of carbonate of calcium, thus differing from the ferruginous shells of the Sandy conglomerate bed. Sometimes masses of these shells are found cemented together, chiefly in the lower part of the deposit. There are found large sponges, bryozoa, serpulæ, etc.; the commonest shell is *Terebratula sella*, of which numbers can be obtained of the workpeople, but on examining the heaps it does not appear to be so plentiful. I have obtained the following species:—

*Belemnites*, sp.
*Scalaria*, sp.
*Cerithium*, sp.
*Turbo*, sp.
*Nerinea*, sp.
*Trochus*, sp.
*Opis neocomiensis*, d'Orb.
*Cardium*, sp.
*Cyprina*, sp.
*Trigonia spinosa*, Park.
*Pecten cottaldianus*, d'Orb.
,, *Carteronianus*, d'Orb.
*Janira neocomiensis*, d'Orb.
*Plicatula Carteroniana*, d'Orb.
,, , sp. ,,
*Ostrea macroptera*, Sby.
*Ostrea*, sp.
*Rh nchonella Gibbsiana*, Sby.
,, *antidichotoma*, Buv.
,, *paucicosta ?* (probably new).
,, *depressa.*
,, *nuciformis*, Sby.
*Terebrirostra neocomiensis*, d'Orb.
*Terebratella oblonga* (small variety).
*Terebratula sella*, Sby.
,, *prælonga*, Sby.
,, *depressa*, Lam.*
,, *hippopus*, d'Orb.
*T.* (*Waldhimia*) *tamarindus*, Sby.
,, *celtica*, Mor.
,, *moutoniana*, d'Orb.
*Bryozoa*, etc.
*Serpulæ.*
*Spongiæ.*

* The largest specimen of *T. depressa ?* I have obtained is 2·8 inches long, 2·5 inches in width, and 1·1 inch in depth.

This bed, and the conglomerate bed near Potton, appear to be of the same age, and probably, also, the Farringdon beds, viz., Lower Greensand, containing large numbers of fossils derived from other formations.




Tho Davidson del & lith. M & N Hanhart imp

SYRINGOTHYRIS, *Winchell*

## VIII.—Perforate and Imperforate Brachiopoda.

By Thomas Davidson, F.R.S., F.G.S., etc.

(PLATE XIV.)

In answer to the observations made by Professor King in the June number of your valuable Magazine, I am quite ready to admit that several very important points in connection with the shell-structure and interior arrangements of the *Spiriferidæ* have still to be determined, and I am always delighted when some new light can be thrown upon the subject.

No one has devoted as much time or shown a greater degree of ability in the careful examination of the shell-structure of the Brachiopoda than Dr. Carpenter has done; and I have no hesitation in reiterating that I cannot doubt the trustworthiness and accuracy of his investigations. Dr. Carpenter has repeatedly shown the absolute necessity of thin sections viewed with adequate microscopic power; and it, therefore, surprises me, that Professor King should so often endeavour to throw discredit on that gentleman's observations, on the strength of surface-markings observed with a "hand-magnifier."

Now, with reference to *Spirifera cuspidata,* Dr. Carpenter assures us that, after having carefully examined by the aid of first-rate instruments the well-preserved shells of several specimens, he found in them a total absence of perforations; but that a deceptive appearance of dots upon certain portions of the surface in some examples may have led to the erroneous supposition that the shell had been pierced throughout by canals. Several statements in an interesting paper by Mr. Meek, published in the Proceedings of the Academy of Natural Sciences of Philadelphia for December, 1865, made Dr. Carpenter desirous of re-investigating the subject; and consequently the shells of several American and British Spirifers, resembling in shape our well-known *Spirifera cuspidata,* were assembled and carefully examined. Dr. Carpenter publishes the results of his investigation in the July number of the Annals and Mag. of Nat. Hist. for the present year.

Some few years ago Professor Winchell discovered in the Carboniferous rocks or "Burlington Limestone" of Burlington, Iowa, a shell undistinguishable in exterior appearance from our British examples of *Spirifera cuspidata,* but which, from presenting certain peculiar interior arrangements, had led him to propose for that and similarly characterized shells the generic denomination of *Syringothyris.*[1] Now, although Professor Winchell has stated that the shell of his genus is fibrous and impunctate in all conditions and under high powers, both Mr. Meek and Dr. Carpenter found very distinct perforations in large portions of the shell of *Syringothyris typa* forwarded to them by Professor Winchell himself.[2]

[1] Proceedings of the Academy of Natural Sciences of Philadelphia, January, 1863.

[2] See Notices of Memoirs, at the end of this article (p. 315), for Mr. F. B. Meek's observations on the shell-structure of *Syringothyris.*

In 1863, as already stated, Professor Winchell describes (but does not figure) his genus as "a shell with an elongated hinge-line. Ventral valve with a mesial sinus, a very broad area, and a narrow triangular fissure closed towards the apex by an external convex pseudo-deltidium; beneath which, and diverging from it, is another transverse plate connecting the vertical dental lamellæ arched above, and beneath giving off a couple of median parallel lamellæ which are incurved so as to nearly join their inferior edges, thus forming a slit-bearing tube, which projects beyond the limits of the plate from which it originates into the interior of the shell. A low median ridge extends from the beak to the anterior part of the valve; dorsal valve depressed, without area, with a distinct mesial fold." But in order that the characters of the genus should be better understood, I have figured in Pl. XIV. five drawings of *Syringothyris typa*, for which I am indebted to Professor Winchell himself. Now, it has been asked by Mr. Meek whether there may not occur at Millecent in Ireland, and elsewhere, two closely similar but really very distinct British types, confounded under the single specific denomination of *Sp. cuspidata*?—that is, one with a punctate structure, and another without it; and the examination of this question by Dr. Carpenter has led him fully to adopt Mr. Meek's conclusion, as I shall presently explain.

Professor Winchell seems not to have been aware that the characters assigned by him to his genus had been already illustrated and defined by Professor L. de Koninck in the Transactions of the Royal Society of Liege for 1859; and, as I made at the time some better and enlarged drawings from the Belgian specimens, I will reproduce them here along with M. de Koninck's original figure (Pl. XIV. Figs. 6–9). These characters were found to exist in a Belgian example of the Carboniferous *Spirifera distans*. Professor Winchell adds: "Some difficulty exists in deciding on the homology of the transverse plate and fissured tube which characterize this genus (*Syringothyris*). In the ventral valve of *Merista*, especially of the type of *Camarium* Hall, an arching lamella arises from the basal portion of each dental plate, and the two unite in the mesial line of the valve, forming a structure which Professor King, before the separation of this genus, had styled the shoe-lifter process—arched in front and attached to the bottom of the valve behind. In *Spirifera granulifera* Hall, a horizontal tranverse plate stretches across the middle of the beak of the ventral valve, connecting the dental lamellæ where nearest approximated by their inward curvatures—a structure which probably represents the pseudo-deltidium of certain *Spiriferæ*, but not of *Cyrtia*. Beneath this plate, the ventral medium septum assumes the form of a tapering cone, resting with its base filling the cavity, and having the anterior part of the upper side marked by a longitudinal groove or slit, while the posterior part sends up a small vertical plate to the transverse plate just mentioned. In *Syringothyris* the tranverse plate equally connects the dental lamellæ where most approximated, and is somewhat arched upwards as in *Merista*, but it does not join the bottom of the valve as in that genus, nor is it connected with the median septum as in *Spirifera granulifera*. Nevertheless, it would seem that the three structures are modifications of the same elements."

But what is the element thus modified? Prof. King suggested that the shoe-lifter process of *Cleiothyris concentrica* is a modified form of the ventral median plate; but the wide separation of its points of origin from the normal position of this plate seems incompatible with such a conclusion; while in *Syringothyris* and *Spirifera granulifera* the median plate exists independently of the apparent homologue of the shoe-lifter. Mr. Billings, whose observations are generally marked by extreme sagacity, regards the shoe-lifter "as an abnormal form of the pseudo-deltidium that occurs in some *Spirifers*." This is the relationship pointed out above; and there seem to exist good morphological reasons for regarding the fistuliferous arching plate of *Syringothyris* as a modified pseudo-deltidium. But to what does the latter structure appertain? In *Merista, Syringothyris*, and certain *Spiriferæ* its relation to the dental plates suggests that it may be an out-growth of those parts. The dental plates are amongst the most heteromorphous structures of the ventral valve. From a normal erect position, they become approximated along the ventral margins in many *Spiriferæ* and other genera, while in *Pentamerus, Orthisina*, and *Camaraphoria*, this approximation results in complete union, and in *Leptæna* in the formation of the saucer-shaped process of the ventral valve. They also vary excessively in longitudinal development. In many *Spiriferæ*, moreover, there is an evident indication of a longitudinal folding of the dental plates, producing on one side or the other a longitudinal laminar process, which, under an extraordinary development, may coalesce with some neighbouring part. While, therefore, the shoe-lifter process of *Merista*, and still more the fistuliferous diaphragm of *Syringothyris*, may be but modifications of the false inner deltidium of *Spirifera granulifera*, the three structures, accidental among Palliobranchs, may be but mere outgrowths of the essential and typical parts known as dental plates."

Such is Professor Winchell's description of his genus *Syringothyris*, and it would be very desirable if any gentlemen who possess good examples of *Sp. cuspidatus* would cut some of them as shown in Fig. 11 of our Plate, so as to see how far they may agree or differ from *Syringothyris*.

I would also refer the reader to some extremely interesting observations upon this subject recently published by Professor J. Hall, in vol. iv. pp. 252-257 of his Palæontology of New York, and from which I will here give the following extract. "If again we look at the characters of *Spirifera alta*, an analogue or representative of *Spirifera cuspidata*, we have many points of similarity with one or more species in the rocks of the west and south-west (America) which are usually referred to a higher position. The high area, and the tranverse concave septum, which is not a true pseudo-deltidium, allies it with *Sp. textus*, in which we find similar features. In *Sp. alta* there has, probably, been an external convex pseudo-deltidium, and between this and the septum closing the fissure, there has been a narrow space. This septum, which is an extension of the dental lamellæ, has been thickened or expanded in the inner side, as shown by casts of the ventral valve, and in several specimens there is a narrow semi-cylindrical depression extending nearly to the beak of the valve. In comparing this with *Sp. textus*, we find similar conditions, or more properly an extension or amplification of the same features. In that species there is a convex arching pseudo-deltidium, though rarely preserved in the specimens; beneath this there is a concave septum, and upon the inner face of this there is a tubular callosity ; or, in other words, the inner laminæ of the septum become fistulose, and enclose a cylindrical or sub-cylindrical space, which extends from the base of the septum to near the apex of the valve. But more usually the laminæ appear to be separated, and, extending inwards, are recurved, their edges sometimes joining to form a tube, but more frequently, perhaps, the margin of each one is recurved upon itself, leaving the tube with a slit along the lower side. In some instances, however, these extensions from the inner face of the septum continue to the bottom of the cavity, and, joining the external shell, leave a quadrangular tube instead of a cylindrical one.

"If, in its full development, the presence of a septum and internal tube be regarded as of generic value, then we have in *Sp. alta* the same appendages in part, or in a partially developed condition, the distinct tube only being wanting. But had we the means of examining the internal characters of the ventral valves of all the species of Spirifers, we should, probably, find graduations from the solid filling of the rostral cavity, with a greater or less extension of shelly matter in the form of a septum, in the fissure occupying a narrow space in its apex, till we reached the development observed in *S. alta* and *S. textus*, etc." It is, therefore, quite evident that much more investigation with reference to the shell-structure of Spirifers, as well as to their interior arrangements, will be required before they can be all definitely divided into groups or genera. After a minute examination of several specimens of *Spirifer*, agreeing in shape with *Sp. cuspidata*, and occurring at Millecent in Ireland, Dr. Carpenter has found that in one example the entire shell was unquestionably imperforate, while in others from the same locality certain parts are unmistakeably perforated, although large patches remain free ; and that in these last named shells, as seen in Fig. 11, the two dental plates or lamellæ are connected by a transverse plate, under which is situated an incomplete tube, similar to the one described by Professor Winchell as peculiar to his genus *Syringothyris*. In the imperforate specimen, on the other hand, he finds the dental lamellæ to be unconnected by any transverse plate, and the tube of *Syringothyris* to be altogether absent.

The next point alluded to by Professor King has reference to the *Cyrtina heteroclita*. It is quite true that in the Annals and Mag. of Nat. Hist. for August, 1846 (not 1864) Professor King did describe the septa and dental plates in this species, and did also announce that the valves were distinctly perforated, and I much regret having inadvertently omitted to state this in my Monograph, and for which omission I gladly apologise; but at the same time it is also right to add that as early as 1841 both Mr. Bouchard and myself were well acquainted with the internal characters of the ventral valve of this species, as well as of *C. Demarlii*, for we had found specimens showing the position of the septum and dental plates in an excellent state of preservation in the Devonian quarries of Ferques in the Boulonnais, and it was from those specimens that the figures given in my Monograph were drawn. I was not, consequently, indebted to Professor King for the information I possessed upon this subject; but am exceedingly glad to learn that he has discovered vestiges of spiral coils in *Cyrtina heteroclita*, as I had not hitherto been so fortunate as to see them in any of the many specimens of the species I had obtained. I may also here repeat that I still adhere to the opinion expressed in my Monograph, namely, that, until sufficient proof to the contrary can be adduced, I must continue to consider *C. carbonaria* and *C. septosa*, as referable to the same group as that typified by *C. heteroclita* and *C. Demarlii*, and that they apparently all possess a perforated shell-structure.

EXPLANATION OF PLATE XIV.

Figs. 1–5. *Syringothyris typa*, from drawings communicated by Professor Winchell. 1. Dorsal valve (cast). 2. D. dorsal, V. ventral valves, *l.* line indicating the length and position of the dental plates. 3. Dorsal and part of the ventral valve seen in profile. 4. Beak of ventral valve partly destroyed; *a.* area, *l.* dental plates or lamellæ, *t.* tube incomplete, *r.* mesial ridge. 5. Section through A.B. The same letters refer to same parts.

Figs. 6–9. *Syringothyris ? distans*, Sow., from the Carboniferous limestone of Visé, in Belgium. 6. Part of the beak of ventral valve, seen from the back, and after Professor L. de Koninck's original figure, published in 1859. 7, 8, 9. My drawings from the same specimen, enlarged. 7. Area and pesudo-deltidium. 8. The same viewed from the opposite side, the shell forming the back of the ventral valve being removed so as to show the shape and position of the dental plates, as well as the position of the transverse plate and tube. 9. The same seen in front; the area and pesudo-deltidium being foreshortened.

Fig. 10. *Syringothyris cuspidata*, or *typa* ? from Millecent, Ireland.

Fig. 11. „ „ from same locality. A transverse section of the beak having been cut through by Dr. Carpenter to show the position of the dental plates, transverse plate, and incomplete tube, as seen in the American specimens of *Syringothyris typa*. In this specimen portions of the shell were perforated, while other parts were free. Indications of the spiral coils may here also be perceived.

## NOTICES OF MEMOIRS.

I.—ON THE PUNCTATE SHELL-STRUCTURE OF *SYRINGOTHYRIS*. By F. B. MEEK, (from *Silliman's American Journal of Science and Arts*, May, 1867, p. 407).

HAVING recently examined Professor Winchell's types of his genus *Syringothyris*, which he was so kind as to loan me, I find them all, with the exception of two silicified specimens (showing no structure), *distinctly punctate.* It is probable that Professor Winchell had happened to examine chippings from specimens not in a condition to show the punctures. I have likewise ascertained, since the publication of my former paper on this subject, that *Spirifer propinquus*, Hall, and *S. Hannibalensis*, Swallow, both nearly like *S. cuspidatus*, have a clearly punctate structure, and hence, probably belong to the group *Syringothyris*.

I have just read a letter from Mr. Davidson, written to Mr. Worthen, in which he quotes, from a letter to him from Dr. Carpenter, a paragraph giving the results of his examinations of specimens of *Syringothyris*, and of the same Irish shell examined by me (and at one time supposed to be *Spirifer cuspidatus*). These chippings were sent over by Mr. Worthen, at Mr. Davidson's request, some little time back. Dr. Carpenter says he finds the *Syringothyris* (that from Floyd Co., Indiana, I suppose), *distinctly punctate*, the punctures being, as I stated, small and scattering. The chippings from the Irish specimen sent over to Mr. Worthen, with the name *S. cuspidatus* attached, Dr. Carpenter also found to be punctured, though the punctures are not so clearly seen as in the other. Chippings of *S. subcuspidatus*, Hall, sent by Mr. Worthen, he says are not in a condition to show the structure.

At the time of writing Dr. Carpenter had evidently not received a package of chippings I had sent him, containing specimens of *S. subcuspidatus*, showing the punctures clearly. He says these examinations of the structure of *Syringothyris* confirm its generic or subgeneric differentiation, established upon other characters, and that the Irish specimen, he believes, belongs to this group. He is still confident, however, that the true *S. cuspidatus* is not a punctate shell, which you will remember I had not supposed to be the case. I never doubted or questioned the accuracy of Dr. Carpenter's conclusions on that point, and there is no microscopist living in whose results I have more confidence than in his.

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## II.—On the Tertiary Volcanic Rocks of the British Islands.

By Archibald Geikie, Esq., F.R.S., F.G.S.

[Abstract from the Proceedings of the Royal Society of Edinburgh, 1866-67, vol. vi. p. 71.]

THIS paper was in continuation of the series of memoirs on the volcanic rocks of Scotland previously read by the author before the Society,[1] and contained the first portion of the results of a survey of the western region, extending from the south of Antrim to the north of Skye. The districts more especially dwelt upon were the islands of Mull, Eigg, and Staffa. After alluding to the writings of previous geologists upon these tracts, more particularly to the discovery by the Duke of Argyll of Tertiary leaves under basalt at Ardtun Head, in Mull, the author remarked, that up to this time the great mass of volcanic rocks in the Western Islands has been usually regarded as of Oolitic age—an opinion in which he himself had shared. His object in the present communication was to show that

[1] See Proceedings, iv. 309, 453, 582, and Transactions, vol. xxii. 633.

as regards Mull and the adjoining islets this opinion was erroneous, that the enormous volcanic accumulations of these islands belonged in reality to the Miocene period, and that, in all likelihood, the long chain of basaltic masses, extending from the north of Ireland along the west coast of Scotland to the Faroe Islands, and beyond these to Iceland, was all erupted during the same wide interval in the Tertiary period.

The nature of the volcanic products was first sketched. It was shown that the two great classes of recent lavas—the basaltic and the trachytic—were well represented among the Western Islands, and that the basaltic series was on the whole the older, since it was found to pass under massive sheets of pale grey and blue claystones, clinkstones, and porphyries belonging to the trachytic group. In addition to these lava-form rocks, masses of coarse volcanic agglomerate occurred, along with beds of tuff and peperino.

The manner in which these various volcanic rocks occur in Mull and Eigg was next described. It was shown that the leaf-beds of Ardtun, which are known by their fossil contents to be of Miocene age, lie near the bottom of the whole volcanic series, and that above them comes a series of trap-beds between 3,000 and 4,000 feet in thickness. Throughout this enormous mass of bedded igneous rock, layers of ash, often abounding in Chalk-flints, are interstratified, and in one part of the cliffs of Inimore of Carsaig a bed of flints twenty-five feet thick lies between the dolerites. Thin lenticular seams or nests of coal likewise occur, but these only occupy small pond-like hollows of the original surface of the trap beds, and are overlaid directly with trap. They are sometimes excellent in quality, and occasionally three feet in thickness; but they rapidly die out in every direction. There is thus no probability that the Tertiary coal of the Western Islands will ever come to be of commercial importance.

Proofs of the long continuance of volcanic action among these islands are afforded by the great thickness of the successive sheets of igneous matter, which in one mountain alone—Ben More—reach a depth of 3,185 feet without revealing either the actual bottom or top of the series. Another and striking piece of evidence on this subject is given by the well-known Scuir of Eigg. That island consists of nearly horizontal sheets of dolerite, like those of Mull, resting unconformably upon Oolitic rocks. After their eruption, they must have been long exposed to the wasting agencies of the atmosphere. A valley was cut out of them, and its bottom was watered by a river, which brought down coarse shingle and sand from the distant Cambrian mountains of the north-west. These changes must have demanded a lengthened lapse of time, yet they took place during an interval in the volcanic history of the island. The igneous forces which had been long dormant broke out anew, and poured several successive *coulées* of vitreous lava down the river-bed. In this way the channel of the stream came to be sealed up. But the same powers of waste which had scooped out that channel continued their operation. The hills which had bounded the valley crumbled away, and the lava-currents that filled the river-bed, being much harder than the surrounding rocks, were enabled in great measure to resist the degradation. Hence the singular result now appears that the former hills have been levelled down into slopes and valleys, while the ancient valley occupies the highest ground in the neighbourhood, and its lava-current stands up as the well known precipitous ridge of the Scuir of Eigg. The gravel and drift-wood of the old river are still to be seen under the rock of the Scuir.

The author then proceeded to point out the possible connection between these Tertiary volcanic rocks and the metamorphism of different parts of the West Highlands. He showed that in Mull, under Ben More, the volcanic rocks themselves give signs of having been subjected to a process of metamorphism, and that they are associated there with masses of syenite, like those of Raasay and Skye. Macculloch pointed out that the syenite of the two latter islands was later than the Secondary rocks of that district; and there now seems to be a strong probability that it will turn out to be of Miocene age. Parts of that syenite are true granite, while the Lias around it has suffered an extensive metamorphism. It will be an important addition to our knowledge of the history of metamorphic action, if the alteration of the Secondary rocks of the Hebrides is eventually shown to be connected with the evolution of volcanic rocks during the Miocene period.

The wide extent to which the British Islands were affected by the Miocene volcanos of the west was then referred to. That extent is not to be measured by the area at present covered with Tertiary volcanic rocks, nor even by the area which these rocks may have originally overspread; but from which subsequent denudation has removed them. From the great volcanic ridge running through Antrim and the Western Islands, thousands of trap-dykes diverge in a south-easterly direction. They become fewer as the distance from that bank increases, yet they extend as far as the coast of Yorkshire. No single dyke, indeed, has been traced across the country from sea to sea; but there can be little doubt that they all belong to one series. They cut through all the formations up to and including the Chalk, and they likewise traverse the older portions of the Tertiary volcanic rocks. They must thus be of Tertiary age, and belong to that series of igneous masses described in the present paper. They do not usually run along lines of fault; on the contrary, they are found to cross faults of fifty fathoms and upwards without being deflected. Their evenness and parallelism show that they must have ascended through fissures prepared for them by subterranean movements. Thus we learn that in Tertiary times the greater part of Scotland, the north of England, and the north of Ireland, were cracked by earthquakes, and that liquid lava rose through the hundreds of parallel rents, perhaps in some cases actually reaching the surface.

The last section of the paper was devoted to an account of the denudation of the Tertiary volcanic rocks. It was shown that wide, deep, and long valleys have been excavated out of the horizontal trap-beds; that these rocks have sometimes been so wasted away that only huge detached pyramids of them are left, as in the case of Ben More, Mull; that the volcanic bank has been worn down into detached islands often miles apart; and that from the fact of so many trap-dykes reaching the surface, even at a distance of more than two hundred miles from the main mass of volcanic rock, the general superficies of the country must have undergone a very extensive amount of denudation since the Miocene period. These changes point to the passing of an enormous lapse of time, and help to teach us that, though in a geological sense, the Miocene age belonged to a recent part of the earth's history, it is nevertheless separated from our own period by an interval too vast to be realised by the mind.

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### III.—Description de la Flore Fossile du premier Étage du Terrain Crétacée du Hainaut, par Eugene Coemans. Bruxelles, 1866.

THIS short but interesting memoir on the fossil flora of the Cretaceous strata of Hainault is well deserving the attention of the student of fossil botany. The remains found at La Louvière consist of many cones, generally well preserved, fragments of wood, pieces of resin, and masses of lignite and small roots, completely carbonized; and their arrangement indicates a tranquil deposit. The striking feature of this flora is that it appears composed almost exclusively of *Coniferæ* and *Cycadeæ*, and like other Cretaceous floras does not possess any species common to other floras of the same period, and differs entirely from that of Aix-la-Chapelle, only thirty leagues distant; not one of the twenty species of *Coniferæ* found there being identical with any of the eight species described from La Louvière,—the flora of Aix-la-Chapelle presenting, according to M. Coemans, a younger aspect, in containing some species of *Sequoia*, and not any Cycad. The recent addition of a Cycad to the British Cretaceous flora is interesting.

M. Coemans considers that the fossil flora of Hainault contains types or intermediate forms which connect certain genera of *Coniferæ*; thus, his *Pinus Corneti* is intermediate to *Abies* and *Cedrus*; the *P. Andrai* connects *Strobus* with *Pinaster*; and the *Pinus Heeri* and *depressa* form a transition from *Cembra* to *Strobus*. At page 17 M. Coemans retains *Zamites macrocephalus* and *Z. ovatus*, both which Mr. Carruthers has shown to belong to *Pinites* (Geol. Mag., Vol. III. p. 536), and are not Cretaceous, but Lower Eocene fossils.—J. M.

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### IV.—Notes on some Triassic Crustacea from Styria. By Professor A. E. Reuss, For. Corr. G. S.

[Proceed. Imp. Geol. Instit., Vienna, January, 15th, 1867.]

*ASPIDOCARIS TRIASSICA*, Reuss, from the inferior Triassic limestone west of Aussee, north-west of Styria, occurs as impressions with fine concentric striæ, not unlike the leaves of *Sagittaria*, with a triangular notch produced by the separation of a rostral portion originally limited by furrows, as in the genera *Peltocaris*, Salt., and *Discinocaris*, Woodw. It must be remarked that all other forms of *Phyllopods*, the actually living genus *Apus* excepted, are Palæozoic. *Aspidocaris*, Reuss, stands next to *Discinocaris*, Woodw.

*Halycine elongata*, Reuss, from the same limestone,—a dorsal carapace badly preserved. The three or four species of the Pœcilopod genus *Halycine* at present known, all belong to the Conchiferous Limestone, or to the Inferior Keuper.

*Cythere fraterna*, Reuss, from the shales of Raibl Carinthia, which also abound in plants, Decapod Crustacea, and fishes. Isolated valves of an Ostracod, nearly related to *Cythere Richteriana*, from the Zechstein, are of some interest as being the earliest remains of this Crustacean stated to occur in the Alpine Trias.—[Count M.]

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## V.—Die Bivalven und die Echinodermen des Braunen Jura von Balin. By Dr. Gustav C. Laube. Wien, 1867.

THESE two papers by Dr. Laube are in part a continuation of the palæontological researches commenced by Professor E. Suess, on the fossils of the Brown Jura of Balin, in Poland. The papers contain descriptions and carefully prepared illustrations of the *Echinoderms* and bivalve shells found in the Lower Oolite of that locality, and are interesting as showing the wide range of some species of the Oolitic fauna. Five species of *Echinoidea*, belonging to the genera *Clypeus*, *Collyrites*, *Echinobrissus*, *Hyboclypus*, and *Holectypus*, are common to Balin and the Lower Oolites of England. Of the *Conchifera* about seventy species from Balin have been identified by Dr. Laube as occurring in the Inferior and Great Oolite and Cornbrash of England. The curious genus *Elignius* of Deslongchamps is represented by two species, and under *Cardiodonta* of Stoliczka, are included certain forms placed by Sowerby and Münster in *Isocardia*. The genera *Tancredia*, *Sowerbya*, and *Gresslya* are also represented.

J. M.

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## VI.—Notes on a New Genus of Fossil Crustacea. By F. B. Meek.

A NEW Crustacean, from the Coal-measures of Illinois, was described in 1865, by Messrs. Meek and Worthen, under the name of *Belinurus Danæ;* it differs, however, in some respects from the characters usually assigned to that genus. Having since seen the paper by Mr. H. Woodward on the Structure of the *Xiphosura* (Quart. Journ. Geol. Soc., Vol. xxiii.), in which that group is now divided into three genera—Mr. Meek has been led to refer his *Belinurus Danæ* to a new genus, holding an intermediate position between *Belinurus* and *Prestwichia*; for this he proposes the name *Euproops,* in allusion to the anterior position of its eyes. This form is at once distinguished from the now restricted genus *Belinurus*, by its anchylosed abdominal segments and the anterior position of its eyes, as well as by the more oval or sub-circular outline of its abdomen. From *Prestwichia,* with which it more nearly agrees in general form, as well as in its anchylosed segments, it differs remarkably in having the area enclosed by its eye-ridge (glabella) comparatively small, and of a quadrangular form, with the eyes situated far forward at its anterior lateral angles.—*Amer. Jour. Science, and Arts, May*, 1867.

## REVIEWS.

I.—Reliquiæ Aquitanicæ: Being contributions to the Archæology and Palæontology of Périgord, and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy, Edited by Professor T. Rupert Jones, F.G.S., etc., etc. (Third Notice.)

In referring again to this important work we have only to state that Part IV. maintains the high character for which the three previous Numbers were distinguished. The six plates now issued are devoted to figures of stones, used as mortars, to flint cores from which flakes have been struck, and to a further series of cleverly-carved Reindeer-horn weapons. The figures of animals, engraved upon some of these remains, possess great merit; especially we would notice the carving of a deer on B. Pl. vii. et viii., fig. 6.

Chapter III. is devoted to a notice of the chief Geological features of the valley of Vezère, and the bordering country, accompanied by a sketch-map and section of that valley.

As suggestive of the origin of flint in the Chalk of the Dept. de la Dordogne, the Editor considers (p. 32) that it is only so much of the Cretaceous stratum silicified.

"The particles of *Polyzoa*, the *Orbitoïdes*, and other organic remains being still in place, and retaining their characteristic structures. Even fish-teeth (*Otodus*) have been altered into flint except a thin external pellicle." "There is also flint showing a further progress of mineralization, in which the constituent organic remains of the limestone have been more and more removed from sight by the increased homogeneity of the pseudo-amorphous silex, as is usually the case with the flint of Northern France and England."

That some flint may have been so formed is possible, but it is equally probable that many, if not all, the flint nodules and bands occurring in the Chalk and even chert, owe their origin to a segregation of silicia, previously held in solution—around some nucleus—such as a silicious sponge, or other organic remain, which almost invariably accompanies these bodies.

We imagine the author would not include in his list of pseudomorphic silicious replacements, the fissures filled with flint in the Chalk as at Pegwell Bay, in Kent, and Rottingdean, near Brighton, and many other localities, which are not unfrequently lines of fault. These veins of flint seem to justify one in attributing their occurrence to the simple infiltration (*without replacement*) of the Silica.

II.—Geological Researches in China, Mongolia, and Japan, during 1862-1865. By Raphael Pumpelly, 4to. pp. 144. 1866. Nine plates. Smithsonian Institution, Washington.

The present memoir contains a full Report of the author's observations, to which we have already alluded in a former Number of this Journal (see Geological Magazine, Vol. III. p. 507.)

The most important chapters are those which relate to (1), The Geology of the Basin of the Yangtze Kiang; (2) The Geology of the Route from the Great Wall to the Siberian Frontier; and (3), On the General Geology of China proper. Mr. Pumpelly gives a hypothetical map of the structure of China, from which it appears that more than two-thirds of the whole area of the country is occupied by Coal-measures, which, yielding both Anthracite and Bituminous coal, have been extensively worked for ages, and appear, from the Plant-remains, to be of Mesozoic date.

The six characteristic plants, figured on Plate ix., resemble those of the European Oolitic Flora, and differ from the Indian and Australian, in the absence of the genera *Phyllotheca* and *Glossopteris*. The names of figs. 4 and 5, on the plate, and also in the text (pp. 122–3) appear to have been reversed.

Chapter IX. contains Notes on the Geology of the Island of Yesso, and Chapter X. is devoted to a list of all the useful minerals found in China, with their localities, and in the Appendix is given analyses of Chinese and Japanese Coals by Mr. J. A. Macdonald, of Yale College.

III.—Barrande's Bohemian Cephalopoda. Cephalopodes Siluriens de la Bohême. Prague et Paris, 1865-1867.

The Text of this great work has now appeared. The two volumes of plates, previously published in 1865, were noticed in the Geological Magazine, Vol. III. p. 32. The present volume contains the description of 447 specific forms, belonging to 16 genera, arranged under the families *Goniatidæ* and *Nautilidæ*, and is only the first part of the studies of M. Barrande on the Silurian *Cephalopoda*, of Bohemia. The second part will include the genus *Orthoceras*, and other straight shells which can be associated with this type, either as sub-genera or distinct genera, such as *Gonioceras, Endoceras, Tretoceras*. M. Barrande reserves for the end of this work his general observations on the study of the Palæozoic *Cephalopoda*, which will no doubt be treated by him in a similar manner to that which has rendered his study of the Silurian Trilobites so exceedingly valuable to Palæontologists.

IV.—Revue de Geologie pour les Années, 1864 et 1865. Par MM. Delesse et De Lapparent. Paris, 1866.

This useful work has now arrived at the fourth volume, and fills up a lacuna much wanted in France, as it comprises a general resumé of the most important works published during the preceding year, so that the series presents us with the history of the progress of Geology since 1860. Its value is enhanced by the methodical arrangement of the subjects, as well as by the classified index, and the present volume is further enriched by memoirs forwarded direct to the Editors, and not previously published. The subjects are arranged under four heads. The first part comprises notices of periodical works on geology, and geological and agricultural maps, agencies at present in operation, both external and internal, and mountain systems. The second part includes the general characters of rocks subdivided under different heads, Meteorites, production of Metamorphism, and the age of Eruptive rocks. The third part treats of Palæontology and the succession and character of fossils found throughout the stratified rocks as derived from the memoirs cited, and the last part embodies the geological researches and descriptions of different countries, arranged geographically, and including some important tables of strata in certain districts. From the selection and conciseness of the subjects, the work will prove eminently useful to the geologist, and highly creditable to the care, judgment, and energy of the editors.—J.M.

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V.—Lectures on Mining.—The reports of the lectures by Professor W. Smyth, on practical mining, are now concluded in the *Mining Journal*, and altogether form a valuable series of papers on some of the guiding principles of the most extensive subjects of mining, and will materially assist the student in systematising the studies he may hereafter take up. In the latter part of the course the following subjects were treated of:—The various methods of working coal, as the pillar and stall, and long-wall workings, and their advantages; the methods in vogue for working seams of unusual thickness; the removal and conveyance of minerals from the workings to the shaft; the raising of minerals, and the difference of use made of shafts, in metalliferous mines and collieries; the use of pumps and their construction; the ventilation of mines, and the various means adopted for distributing air through the workings; and lastly, the different processes used in the dressing and preparation of the ores.—J.M.

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## REPORTS AND PROCEEDINGS.

Odontological Society of London, June 3rd, 1867.—"On the Dental characters of Genera and species, chiefly of Fishes, from the Low Main Seam and Shales of Coal, Northumberland." By Professor Owen, F.R.S., etc., etc.—The author having received, from time to time, sections of coal from the 'Low Main Seam,' or from the shales overlying that seam, (collected and prepared for microscopic examination, by T. Craggs, Esq., of West Cramlington and Gateshead, Northumberland), he found them to consist of portions of jaws and detached teeth, chiefly of minute Fishes, which from their nondescript character, he concluded, after careful study and comparison, to be new to Carboniferous Palæontology.

Professor Owen has proposed for them the following generic and specific appellations:—

Genus I.—*Dittodus*, Owen (διττὸς, twin or double, ὀδούς, tooth).

Species 1.—*Dittodus parallelus*, Owen.

These teeth have the peculiarity of a double crown, rising from a common base; the hard dentine of one crown being continued at the side of the base into the corresponding tissue of the other; thus the two crowns are organically connected together, like the Siamese twins.

Professor Owen considers it highly probable, from the character of the osseous tissue of the portion of jaw preserved with these twin-teeth, that the genus is referable to the Class of Fishes.

Species 2.—*Dittodus divergens*, Owen.

In this species the two crowns are more divergent from their common base; they differ in their shape and proportions (being shorter and broader); and also in structure.

Genus II.—*Mitrodus*, Owen (μίτρα, mitre, ὀδούς, tooth).

Species 1.—*Mitrodus quadricornis*, Owen.

This tooth sends up four subequal conical crowns from the common osteodentinal base, and its name is derived from its resemblance to an ancient mitral diadem.

Genus III.—*Ageleodus*, Owen (ἀγέλη, crowd or cluster, ὀδούς, tooth).

Species 1.—*Ageleodus diadema*, Owen.

In the tooth here described, no fewer than a dozen subequal conical dentinal crowns are developed from a common osteo-dentinal basis.

Genus IV.—*Ganacrodus*, Owen (γάνος, shine, ἄκρος, point, ὀδούς, tooth).

Species 1.—*Ganacrodus hastula*, Owen.

Several of these "enamel-tipped spear-teeth" have been obtained by Mr. Craggs from the shale overlying the "Low Main Seam" of Coal, at West Cramlington. The curious manner in which these teeth are tipped with enamel, at once arrests attention, and the author observes that he had not before met with any similar tooth in the whole range of his odontological researches.

Genus V.—*Ganolodus*, Owen (γάνος, shine, ὅλος, whole, ὀδούς, tooth).

Species 1.—*Ganolodus sicula*, Owen.

These teeth offer points of resemblance to the Sauroid type which are wanting in the previous genus; they are amongst the more common forms met with by Mr. Craggs in his prepared coal-sections.

Genus V.—*Mioganodus*, Owen (μείων, less, γανος, shine, ὀδούς, tooth).

Species 1.—*Mioganodus laniarius*, Owen.

The section of this tooth resembles an incompletely-formed canine of a young mammalian carnivore, save that the enamel of the crown is not present in mammalian proportions and structure.

Genus VI.—*Aganodus,* Owen, (*a,* priv. *γανος,* shine, *ὀδους,* tooth).

Species 1.—*Aganodus apicalis,* Owen.

This genus seems characterised by the absence of the enveloping layer of enamel observable in *Ganolodus,* etc., and there is also a different disposition of the dentinal tubules.

Species 2.—*Aganodus undatus,* Owen.

The form and structure of this tooth differs from that of *Ag. apicalis* in a degree which induced the author to present it under a distinct specific name.

Genus VII.—*Pternodus,* Owen (*πτέρνα,* heel, *ὀδούς,* tooth).

Species 1.—*Pternodus productus,* Owen.

Some of the small teeth, with crowns of unvascular dentine uncoated by ganoine, have the hinder part of the base drawn out like a heel; they differ from the type *Aganodi* in a more gradual basal expanse of the pulp-cavity, and in the absence of the thin platform of hard osteodentine which supports in them the crown of the tooth, and divides it from the ordinary bone of the jaw.

Genus VIII.—*Sagenodus,* Owen (*σἄγήνη,* seine, *ὀδούς,* tooth).

Species 1.—*Sagenodus inequalis,* Owen.

The teeth of this genus offer a type of structure akin to the extinct *Dictyodus* and the existing *Sphyraena,* appearing as tooth-like processes of the jaw, of which they continue the structure with little modification.

Genus IX.—*Characodus* (*χαρὰϵ,* a pointed stake, *ὀδούς,* tooth).

Species 1.—*Characodus confertus,* Owen.

The teeth of this genus are of the Dictyodont type of structure.

Genus X.—*Ochlodus,* Owen (*οχλος,* crowd, *ὀδούς,* tooth).

Specie 1.—*Ochlodus crassus,* Owen.

Close set as are the teeth in parts of the dental series of the last-mentioned genus, they are more crowded in the fragment of the alveolar part of a jaw of this genus for which the author proposes the name *Ochlodus crassus.*

Genus XI.—*Oreodus,* Owen, (*ορευς,* mule, *ὀδούς,* tooth).

Species 1.—*Oreodus robustus,* Owen.

(Probably a species of *Aganodus,* allied to *A. undatus*).

Genus XII.—*Gastrodus,* Owen (*γαστήρ,* belly, *ὀδούς,* tooth).

Species 1.—*Gastrodus præpositus,* Owen.

Of this genus there have been discovered two portions of dentigerous jaw and of detached teeth. All the most complete teeth show a large pulp-cavity, inclosed by a thin wall of unvascular dentine, and in no case does any tissue, like osteodentine, encroach upon the pulp-cavity. In this respect the teeth resemble those of *Dendrerpeton,* and the Frog, and differ from the teeth of most Fishes.

The tissue of the dentine, as well as that of the jaw-bone, bears the same resemblance to those in the *Batrachia* cited.

After carefully and minutely describing the details of the structure of this genus, Professor Owen infers that we have in *Gastrodus* evidence of a minute air-breathing Batrachian, of the age of the lower Coal-measures of Northumberland.

If this inference be correct, the author suggests that it may lead to the determination of the nature of the medium in which these minute fishes, of the size of Minnows or Sticklebacks, lived, apparently associated with *Batrachia*, and now entombed in beds composed of the carbonized remains of land-plants and semi-aquatic vegetation.

With regard to the genera and species here indicated, Professor Owen does not object to the possibility that one or more forms of teeth may have belonged to different parts of the same mouth (e.g. *Mitrodus* and *Dittodus*); the author considers, however, that it will afford most facility to future investigators of these Coal-remains, if they are able definitely to express the nature of the fragment they may have discovered by referring it to one or other of the forms here described.

Professor Owen, in his paper, treats at considerable length of the form and histology of each genus and species recorded, and a series of fifteen elaborately-prepared plates have been drawn by Mr. Tuffen West for its illustration. The whole paper forms one of the unpublished Chapters for a Second Edition of Professor Owen's "Odontography."

Geological Society of London.—I. May 8, 1867.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The following communications were read:—1. "On new specimens of *Eozoön*." By Sir W. E. Logan, LL.D., etc.

Amongst several additional specimens of *Eozoön* which have been obtained during recent explorations of the Canadian Geological Survey, is one which was found last summer by Mr. G. H. Vennor, in the township of Tudor, county of Hastings, Canada West. It occurred on the surface of a layer, three inches in thickness, of dark-grey micaceous limestone, or calc-schist, near the middle of a great zone of similar rock. This Tudor limestone is comparatively unaltered, and, in the specimen obtained from it, the skeleton of the fossil, consisting of white carbonate of lime, is imbedded in the limestone without the presence of serpentine or other silicate, a fact which the author regarded as extremely favourable to the view of the organic origin of *Eozoön*. Sir William Logan also described the nature and relations of the rocks of other localities which have recently yielded *Eozoön*, especially Wentworth, Long Lake, and Côte St. Pierre.

2. "Notes on Fossils recently obtained from the Laurentian rocks of Canada, and on objections to the organic nature of *Eozoön*." By J. W. Dawson, LL.D., F.R.S., F.G.S.

The first specimen described in this paper was the one from Tudor referred to in the previous communication. Its examination had enabled Dr. Dawson to state, that in it the chambers are more continuous, and wider in proportion to the thickness of the septa, than in the specimens found elsewhere, and that the canal-system is more delicate and indistinct. Without additional specimens the author could not decide whether these differences are of specific value, or depend on age, variability, or state of preservation; he therefore referred the specimen provisionally to *Eozoön Canadense*, regarding it as a young individual, broken from its attachment, and imbedded in a sandy calcareous mud. Its discovery afforded him the hope that the comparatively unaltered sediments in which it has been preserved, and which have also yielded worm-burrows, will hereafter still more largely illustrate the Laurentian fauna. After giving short descriptions of new specimens from Madoc, and from Long Lake and Wentworth, Dr. Dawson discussed the objections of Prof. King and Dr. Rowney to the view of the organic nature of *Eozoön*, and stated that those gentlemen had failed to distinguish between the organic and the crystalline forms, as was especially illustrated by their regarding the veins of chrysotile as identical with the tubulated cell-wall of *Eozoön*.

3. "On Subaërial Denudation, and on Cliffs and Escarpments of the Chalk and the Tertiary strata." By W. Whitaker, Esq.. B.A., F.G.S.

From the fact that escarpments differ from cliffs in all their chief features, the author inferred that the two could hardly result from the same action; but that whilst the latter were made by the sea, the former seem to have cut out by subaërial agents.

The chief contrasts between the two kinds of ridges are :—

(1) Escarpments always run along the strike. Cliffs rarely do so.

(2) The bottom of an escarpment is not at one level throughout. That of a sea-cliff is.

(3) At the foot of an escarpment one does not find a breach or other trace of the action of the sea, but often such débris as would be left by a slow and quiet denuding power.

(4) Two escarpments, facing the same way, often run near and parallel to one another for many miles. Not so with cliffs.

(5) The ridge of an escarpment is a nearly even line, and forms the highest ground of the neighbourhood. The top of a cliff is often very uneven and bordered by higher ground.

From an examination of escarpments of the Chalk and of the Tertiary beds, it was shown that though at first sight they might seem like old lines of cliff, yet a little study would destroy the fancied likeness, and it would be found that they are quite unlike cliffs *in the same beds*; for though, from their winding outline, these ranges of hills might remind one of some irregular coast, caused by rocks of different hardness wearing away at different rates, they have little in common with the far more even coast that is formed where there is but one kind of rock.

It was then pointed out that along the present coast, the sea is not the only force engaged in the work of destruction, but that it is largely helped by atmospheric agents (the latter acting from above downwards, to detach and hurl down masses of rock, which the former, acting horizontally below, pounds down and sweeps away); and it was inferred that the joint action of the two kinds of force had a far greater effect than either alone.

In conclusion, it was argued that as deposits of great thickness (such as the Wealden beds) had been made by rivers, it must be admitted that, allowing for waste, still greater masses of rock had been destroyed by streams and by subaërial agents generally. The denuding power of the sea, however, was by no means denied, but it was allowed that as marine deposits much exceed in quantity those of freshwater origin, so the great denudations, the planings-down of vast tracts, of which examples are given by unconformities, have been worked out by the action of the sea; but that, on the other hand, the far smaller denudations, and *comparatively* trifling irregularities of the surface (our hills and valleys) have been worn out by the long continued action of rain, rivers, and ice.

II. May 22, 1867.—J. Carrick Moore, Esq., M.A., F.R.S., Vice-President, in the chair. 1. "On the Bone-caves near Krendi, Zebbug, and Melleha, in the Island of Malta." By Captain T. A. B. Spratt, R.N., C.B., F.R.S., F.G.S.[1]

The Krendi (or Mahlek) Cavern is situated on the south coast of Malta. The flooring consisted of two distinct deposits, the lower being a stratum composed of a hard stalagmitic clay with rounded pebbles, and containing teeth and bones (unworn) of the *Hippopotamus* (*H. Pentlandi*). The upper stratum, also a stalagmitic deposit, contained bones of the *Myoxus Melitensis,* and of birds with some recent land-shells.

The Zebbug Cavern, in the interior of the island, was, when discovered, filled with sandy clay containing subangular fragments of the rock, and bones of at least two species of elephant, comprising a complete set of the teeth and tusks of the pigmy elephant, representing animals in every stage of growth, and part of the tusk of a much larger elephant. No remains of *Hippopotamus* were met with in this cavern; but a few bones of *Myoxus* (2 species), of birds, and of a Chelonian, were discovered in it.

The Melleha Cavern, at the north end of the island, contained a deposit with remains of the teeth and bones of the *Hippopotamus* only, and seemed, therefore, to represent the lower stratum of the Krendi Cavern.

From the fact that the deposits containing remains of the *Hippopotamus* were so distinct from those including the Elephant-remains, Captain Spratt inferred that these two mammals belonged to distinct geological epochs, the elephant being the more recent.

As Malta and Gozo were probably elevated above the sea at the close of the Miocene period, it is very possible that the caverns, formed by the long action of the sea upon its cliffs, may contain the relics of animals of more than one, if not of each subsequent geological period.

In respect to Dr. Leith Adams' discovery of remains of the elephant in scattered *débris* of subangular fragments and red earth, filling fissures and hollows in various parts of Malta, Captain Spratt stated his opinion that the phenomena were produced by a "wave

[1] For an account of the Maltese Bone Caverns, and the Physical Geology of the Island, with Map and Sections, see Geological Magazine for April, 1866, Vol. III. p. 145, Pl. VIII. and IX.

of translation," resulting from a sudden subsidence of the island below the sea at a very recent geological period, of too short a duration, however, to allow of any purely marine deposit being formed.

Captain Spratt discussed the evidence, afforded by soundings, of the former connexion of Malta with Europe and Africa, by land that must have served as a means of migration to the cave-fauna. The submerged lands are indicated by the "Adventure Bank," between Tunis and Sicily; and by the "Medina Bank," a ridge connecting the south-east of Malta with Tripoli. An upheaval of about 200 fathoms would render both banks dry, with the exception of one or two narrow channels, which would not impede the larger animals from passing from one continent to the other at the seasonable times for migration.

2. "On the Lower Lias of the North-east of Ireland." By Ralph Tate, Esq., A.L.S., F.G.S.

The author described the Lias of Ireland as consisting of (1) the Avicula-contorta series, including a well-developed zone of *Avicula contorta* and the White Lias; (2) the Lower Lias, embracing the equivalents to the zone of *Ammonites planorbis*, *A. angulatus*, and *A. Bucklandi* of Great Britian; and a fourth zone (that of *Belemnites acutus*), representing that portion of the Lower Lias superior to the zone of *Ammonites Bucklandi.*

Mr. Tate stated that the principal portion of the Lias belongs to the zone of *Avicula contorta,* and that the greater portion of the Lower Lias is comprised in the zone of *Ammonites angulatus.* The remarkable and isolated mass of metamorphosed Lias at Portrush was referred to the "Planorbis series."

3. "On the fossiliferous development of the zone of *Ammonities angulatus* in Great Britain." By Ralph Tate, Esq., A.L.S., F.G.S.

In this paper the author recorded the discovery of a fauna hitherto imperfectly known in this country, characterizing beds below the Limestone-series of the Lower Lias. It is exceedingly rich in fossils: Cephalopoda are few in number (about 8 species); Gasteropoda are various, numerous and characteristic, there being about 50 species, the majority of which are new to Great Britain; the Corals are abundant and peculiar.

The zone of *Ammonites angulatus* was stated to occur at various places in Ireland; at Marton, Lincolnshire; in Warwickshire; in North Gloucestershire; at Brocastle and Sutton, in Glamorganshire; and in Dorsetshire.

The author further communicated the results of a critical examination of the Sutton stone fossils—which are (1) that the majority of the species are well-known Liassic forms of the continent, and occur in other parts of Great Britain; (2) that they incompletely represent the fauna of the zone of *Ammcnites angulatus*; and (3) that the Sutton Stone is lithologically and palæontologically identical with the "Calcaire de Valogne," the stratigraphical relations of of which have been well determined.

4. "On the Rhætic Beds near Gainsborough." By F. M. Burton, Esq., F.G.S.

Beds of the Rhætic series were stated to occur at Lea, two miles to the south of Gainsborough, and were described as consisting of more or less indurated and highly micaceous sandstones, alternating with black shaly clays, and containing two bone-beds.

The fossils are very abundant, and are those which are usually met with in the "Avicula-contorta" zone of other parts of Great Britain. A fragment of the edentulous portion of the right *ramus* of the lower jaw of a *Pliosaurus* was found in the lowest bed, lying on the blue Keuper Marl. Two interesting additions to the vertebrate fauna of this series are *Trematosaurus Alberti*, and *Lepidotus Giebeli*?

The author pointed out the correlation of these beds with those at Aust Cliff and other well-known localities in England, and their probable connexion with similar deposits in Ireland and on the continent; he concluded by defining the surface-extent of this the most northern English deposit of Rhætic age as yet discovered.

Norwich Geological Society.—Monthly Meeting, April 2, 1867. The Rev. John Gunn, M.A., F.G.S., President, in the chair.

A flint implement, picked up that day at Bramerton, by the Rev. J. Gunn, was laid upon the table, and a communication read, stating that another had been found at South Wootton.

The next subject was introduced by the Rev. S. W. King, M.A., F.G.S., who said that the question as to the proportionate ratio between the existing and extinct species of the Crag was now one of considerable interest, and had been most admirably handled by Sir Charles Lyell and the late Dr. Woodward. One of the most conspicious, as well as interesting, shells belonging to the Norwich Crag was the *Nucula Cobboldiæ*. From a communication lately received from Mr. Gwyn Jeffreys, he learned that *Nucula Cobboldiæ* had been found living in the Japanese seas, near Vancouver's Island. He wrote to Mr. Jeffreys for full particulars, and received a letter from him in which it was stated that the specimens dredged near Vancouver's Island did not differ specifically from *Nucula Cobboldiæ,* and that Mr. Searles Wood confirmed this identification. Now the fact of great interest was the finding of *N. Cobboldiæ* in Japanese seas, so far removed from England, and yet showing that there must have been a marine connection between the two districts. *Leda myalis,* too, which he had found under the Boulder-clay, but above the true Crag at West Runcton, had been found living at the mouth of the St. Lawrence. Mr. King showed a specimen of the *N. Cobboldiæ* from Japan with others from the Norwich Crag. The Rev. O. Fisher, M.A., F.G.S., remarked that they had been told by Mr. Taylor that the Upper Crag was a deep-sea deposit; but it appeared to him the *Mya, Tellina,* and *Cardium* were not deep-sea shells. The Rev. S. W. King said they were littoral shells. Mr. Fisher observed that they were told the assemblage of species showed that the Crag sea had been an area of subsidence, and that important alterations in the fauna had taken place. He scarcely knew what species there were in the bed, proving it to be more northern or arctic than the Norwich Crag, which rested immediately on the Chalk. The Rev. S. W. King said many living shells could now be found upon the verge of low water-mark, but should the shore upon which they rested be depressed slowly and gradually, the area on which those shells were would be increased as they advanced to a higher level. Mr. Bayfield was under the impression that Mr. Taylor said the percentage of specimens found in the upper bed would, perhaps, be a guide as to whether or not they were deposited in a deep sea; for instance, *Astarte borealis* was found in the lower bed, but in still ten times greater numbers in the upper. The Chairman thought but little dependance was to be placed upon shells. If the climate of the Upper Crag were truly represented by the many arctic species found by Mr. Taylor, it was impossible that the Forest Bed could have existed at that time.

Monthly Meeting, May 7.—The following paper was read by Mr. J. E. Taylor, the Hon. Secretary:—"The Upper and Lower Crags in Norfolk." Since I had the honour to read my last paper on this subject before the society, I have from time to time followed it up, and the results I now purpose to lay before this meeting.

That the two Crags—the Upper and Lower—are distinct in their character, I have now no doubt. Mr. Searles V. Wood, jun., has, since I read my last paper, recognised the Upper Crag as identical with the Chillesford bed, not only from its organic remains, but also from the strata which under- and overlie it. In this he is supported by his father on conchological grounds. Mr. G. Maw also, with whom I went over the ground, and who went straight from Norwich to Chillesford to compare the two beds, has identified the Upper Crag with the Chillesford bed.

At the last meeting I was quoted as having stated that the Upper Crag was a *deep sea deposit.* This I never intended to assert. What I first stated was, that the Upper bed bore evidence of *deeper* water deposition than the Lower. I spoke in the comparative, not in the positive, degree.

Taking the mean of the shells belonging to the Lower Crag, I find that those which are rarest belong to the deepest zones. Thus *Pecten tigrinus* may now be dredged from between *thirty* and *forty* fathoms off the coast of Norway. It is exceedingly rare in the Norwich Crag. *Acmea virginea*, and *Bela turricula*, are also instances of deep sea shells which are rare. I have been unable to trace any of the Lower Crag shells whose living representatives have a greater depth than *seven* to *twenty-two* fathoms. This seems to have been the extreme depth of the estuary of the Lower Crag, the great mass of the shells belonging to an average depth of ten fathoms.

To contrast these circumstances with the Upper Crag. In the first place, we do not meet with the slightest trace of freshwater or brackish water shells, many of which are met with in the Lower Crag. The littoral shells are almost *nil*, and even those which are occasionally found, bear evidence of having been greatly waterworn. Some are bored by the little burrowing sponge, *Cliona*. But occasional littoral shells in the Upper bed do not prove a shallow-water origin, any more than occassional deep sea shells in the Lower Crag prove deep sea deposition. "One swallow does not make a summer," and in such circumstances as these, we should be guided by the general facts. Speaking of shallow-water shells in the Upper bed I am reminded of a remark by the late Dr. Woodward, intended as a warning to dredgers. He says, "It is important to distinguish between *dead and living shells,* for almost every species is met with, in the condition of *dead shells,* at depths far greater than those in which it actually lived." The commonest shell in the Upper Crag is *Tellina obliqua;* the nearest living representative of which is the *Tellina proxima*—a shell now living in *thirty* fathom water. Another characteristic species of the Upper Crag, and one which I venture to say is limited to it alone, is the *Modiola modiolus,* a mollusck which lives in *twenty to thirty* fathom water. The *Cyprina Islandica* is occasionally found in the Lower bed, but is more abundant in colonies in the Upper, as at Postwick Grove. *Rhynchonella psittacea* is also usually found in colonies in the Upper Crag, at Postwick Grove and Thorpe. This shell ranges in depth to as much as *one hundred and eighty fathoms,* and is, therefore, *par excellence,* a deep-sea mollusck. At Postwick it has been found in pairs, showing that it must have lived near the spot. It is occasionally found in the Lower Crag, but in single valves and waterworn, as though it had been washed from some distance. The shells which inhabit deeper water, and are Arctic or sub-Arctic in their character, which are peculiar to the Upper Crag, (I have never found them in the Lower), are *Astarte compressa, sulcata,* and *elliptica. Astarte borealis* is sometimes found in the Lower bed, but in nothing like the quantities in which it occurs in the Upper bed at Bramerton and Thorpe. *Lucina borealis* is common to both beds. *Venus fasciata* is common in the Upper bed at Thorpe, and belongs to a genus usually inhabiting a depth of thirty to fifty fathoms. *Cardium Grœnlandicum* is frequently met with in the Upper bed, rarely in the Lower, and then only the largest and strongest specimens. On the other hand, I have met with them of all ages of growth in the Upper bed. This shell is Arctic,and also lives in tolerably deep water.

I have thus particularized the principal shells of the Upper Crag, because they afford the strongest evidence of pure marine deposition, and they also indicate a greater mean depth of water than the shells of the Lower bed.

Since *Nucula Cobboldiæ* is proved to be living, I know of but one shell in the Upper Crag which is really extinct—*Tellina obliqua.* The other eleven, marked as extinct in the Norwich Crag, belong to the Lower bed. There is, on the other hand, a decided greater percentage of species of Arctic or sub-Arctic shells in the Upper bed, three species seeming to be peculiar to it. The proportion also of these Northern shells is much greater in the Upper than in the Lower bed. Here they occur in almost Northern percentage, and appear to have been indigenous.

Between the Upper and Lower beds there usually intervenes a layer of white, false-bedded sand, of varying thickness. The Upper Crag usually lies among a shingle composed of well-rounded flint pebbles. The widely distinct character between the fine sand which forms the matrix of the Lower Crag, and the general pebbly or rubbly nature of the upper deposit, shows that the two strata were deposited under different circumstances. The currents bringing the material must have come from different directions.

It is probable that the Crag at Mundesley and elsewhere in the north-east of Norfolk, may belong to the period of the Upper Crag rather than to the Lower. The fact that several feet of sand intervenes between the Crag and the Chalk, is confirmatory of this idea.

[The Report on the Rev. J. Gunn's paper is postponed till our next Number.]

## CORRESPONDENCE.

### FISH IN THE OLD RED SANDSTONE.

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR,—Precluded, from want of local knowledge, from taking any prominent part in the controversy at present pending as to the relative positions of the Devonian and Old Red Sandstone formations, yet my geological associations are, to so large an extent, connected with the latter formation, that I cannot be otherwise than highly interested in the discussion.

I have now for some years been employing a considerable portion of my leisure hours in collecting and examining our Old Red Sandstone fishes, and, perhaps, on this account feel not a little curious as to the character and state of preservation, etc., of Mr. Pengelly's specimens mentioned in Mr. Salter's communication in your Number of this month (May). I have never seen and it may be long before, if ever, I have an opportunity of examining these; I, therefore, may be allowed, through the medium of your pages, to put a few queries as to their bearing on the subject in dispute.

Then, First: Are these specimens sufficiently distinct to be *undoubtedly* referred to any well-ascertained genus of Old Red Sandstone fishes?

The scales of these fishes are often not a little puzzling; for the same scale may present very different aspects from different surfaces being exposed, while quite distinct scales, belonging to very different fishes, occasionally present surfaces so similar to each other as to be all but undistinguishable. I have now before me a fragment of limestone from Burdiehouse, showing some moderately well preserved *Rhizodus* scales, also a very fine specimen of *Glyptolepis elegans* from Gamrie.—These genera are very distinct, the former belonging to the Lower Carboniferous, the latter to the middle and upper Old Red Sandstone, yet on each of the specimens I can point to a scale which, if detached, and these laid side by side would, by any one, be pronounced specifically identical, so nearly do they resemble each other.

Now, if the *Phyllolepis* from Meadsfoot be only, as stated by Mr.

Salter, "like that genus," *is it of any value whatever in determining the horizon of the Rock in which it was found?*

If difficulty and doubt must exist in determining the affinities of detached scales, much more is this the case with spines. On the fragment of Limestone already referred to, are one or two imperfectly preserved spines which, if found by themselves, would have been thought to belong to a *Diplacanthus*, nearly allied to *D. longispinus*; they undoubtedly differ in form from all the spines of that fish, but not more so than these differ from each other: in short, the spines of Carboniferous Fishes occasionally so nearly resemble those from the Old Red Sandstone that, unless they possess some very marked features, I should think it far from safe to rely on such fragments as good evidence. But supposing the specimens do possess peculiarities, sufficiently marked, for referring them, with certainty, to known genera, is this enough?

Some genera are confined to a comparatively narrow horizon, while others range widely in this respect. The genus *Acanthodes* is found in the lowest beds of the Old Red Sandstone; in its middle division, in the Carboniferous, and in the Permian formations. Even that very peculiar genus *Pterichthys* is found in the middle and upper Old Red Sandstone, and in all probability only terminates its existence in the Lower Carboniferous, and so with many others.

Oddly enough this appears to be the case with the genera to which Mr. Pengelly's specimens are somewhat doubtfully assigned.

Of *Phyllolepis*, Agassiz, the founder of that genus says (V. G. R. p. 67) "Je connais maintenant deux espèces de ce genre, dont l'une provient du vieux grès rouge, *l'anter de la houille*," while *Ctenacanthus* is as much, if not more, a Carboniferous than an Old Red Sandstone genus.

If this genus will not determine the horizon, can these specimens be with certainty assigned to any known species?

In our lowest Forfarshire beds we have *Acanthodes Mitchelli*; in the Murrayshire nodules, and Caithness Flags, *Ac. pusillus*; and in the Caithness Flags also *Ac. Peachi* and *Ac. coriaceus*, all well ascertained species, these formations representing an immensely extended period in time: yet remove their spines from these Fishes, mingle the spines together, and no one could tell the species to which any one of them belonged. The scales, indeed, do vary, but this to so small an extent that it is only in the best preserved specimens, and with the use of highly magnifying powers, that the difference can be detected. The same might be said of the *Acanthodes* from the Coal formation as compared with those of the Old Red Sandstone, only the former being larger fishes have larger scales and spines. This is no doubt an extreme case, but similar, if less striking examples are to be met with in other genera.

Is it, therefore, safe to put any, or at least implicit, reliance on such fragmentary evidence?

I fear with most the verdict would be our Scotch one "Not Proven."—I am, dear sir, very truly yours, JAS. POWRIE.

RESWALLIE, FORFAR, *May* 11*th*, 1867.

## UPPER DEVONIAN IN S. DEVON.

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR,—As my friend Mr. Pengelly asks me a question, having answered mine, it is but courtesy to reply. In speculating on the possibility of explaining the presence of these fish remains in the neighbourhood of Torquay and Looe, I said that the Uppermost Devonian (Upper Old Red) might occur in unconformable patches round the older rocks. We actually have the Upper Devonian at Newton Bushell. Phillips long ago figured the Upper Devonian *Phacops lævis* from thence, and Mr. Pengelly himself explained the way in which, having coiled themselves comfortably for a nap, they were smothered and decapitated in their beds. Newton Bushel is about as near to Torquay as Teignmouth; so, if my friend will not admit the presence of *Clymenia* pebbles at Shaldon to be a proof that the Upper Devonian lies immediately beneath the New Red there, I am sorry for him, but I cannot stop to argue the point. He may take Newton Bushel instead. Only, of course, the neighbourhood of *Upper* Devonian does not prove the neighbourhood of *Uppermost* Devonian,—it only makes it more likely.

My friend certainly told me the fish defences were from Looe Island; it now appears that one of them only came from thence. Will he describe and figure them, and give us the whole of the scattered (not to say buried) information in a tangible form?

Yours truly, J. W. SALTER.

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## DISTRIBUTION OF WHITE SANDS AND CLAYS SUBJACENT TO THE BOULDER-CLAY.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—I shall be much obliged if you will allow me to add a word or two to the excellent paper in your June number, by Mr. Maw, on "The Clays and Sands subjacent to the Boulder-clay." I was able a few months ago to pay a hurried visit to a large pit in these deposits at the foot of the Weaver Hills, I believe the Ribden Pit, and one thing struck me very forcibly which seems to have escaped the notice of Mr. Maw and Mr. Edwin Brown. The mass of the materials seemed to me to be undoubtedly *derived from the Pebble beds of the Bunter, and not from Millstone Grit.* The description written on the spot in my note-book runs thus:—"The deposit consists of unstratified masses of clean mottled sand, incoherent pebble-beds, and little patches of clay, mixed together in the most confused manner. With the exception that the pebbles are all of quartz-rock, instead of flint, the mass is exactly like one of the mixtures of brick-earth ,gravel, and sand, that lie in pipes in the Chalk." In both cases it seems that the underlying limestone has been dissolved by water, and that masses of the rock alone, Lower Tertiaries, or Bunter-beds, have been gradually let down into the hollow, while the insoluble earthy part of the limestone remained behind and furnished the clay.

If this view be correct, the deposits may be of any age later than Bunter times, for there is no reason to believe that the Derbyshire limestone was under water from the end of the New Red Sandstone period till the Glacial epoch, and very likely not even then; and if any outliers of Bunter beds were left upon the Mountain Limestone, similar deposits might be forming at the present day.

I am also far from certain that the Ribden deposits are overlaid by true Boulder-clay; what I saw looked quite as much like the covering, often many feet thick, of local rainwash, which spreads over the hill country thereabouts. Of course, some of this may be of the same date as Boulder beds, some is very likely much older, and it is forming now-a-days after every shower of rain.

Yours obediently. A. H. Green.

Monk Bretton, Barnsley, *June 3rd*, 1867.

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## GRAPTOLITES.

*To the Editor of the* Geological Magazine.

Sir,—Dr. Nicholson's paper in your last number might suitably have closed the correspondence which you have published between us, but I must ask you for permission to add a word or two.

Your correspondent gives up the relation between the capsules and the graptolites, as originally figured by him, to which I objected, and on which he based the whole of his argument for their being ovarian vesicles, and with this consequently that argument as well. But he has, in the paper in your last number, figured several specimens which prove "conclusively that there is an actual organic connection" between the capsule and the zoophyte. What do these specimens show? On the one species, *Graptolithus Sedgwickii*, he finds the "ovarian capsules" borne on the common cœnosarc (Pl. XI. fig. 16) as well as developed from individual polypites! and in the latter case the polypite sometimes is converted into an "ovarian capsule" (fig. 15) the mouth of the hydrotheca narrowing into and being "organically connected" with the capsule, and at other times gives origin to the capsule from the sides of the hydrotheca! (fig. 12-14). The only thing that I know at all comparable to this extraordinary structure is the "ovisac" which is thus so strangely related to the parent, which Dr. Nicholson tells us is a corneous gonophore that becomes a free swimming zooid!

Wm. Carruthers.

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Note.—Prof. Harkness requests that the following corrections may be made in his letter, which appeared in our last Number at p. 286. In the heading to his letter for "*Upper*" read "*Lower* Llandovery," and in the fifth line, for "*about*" read "*above* the position."

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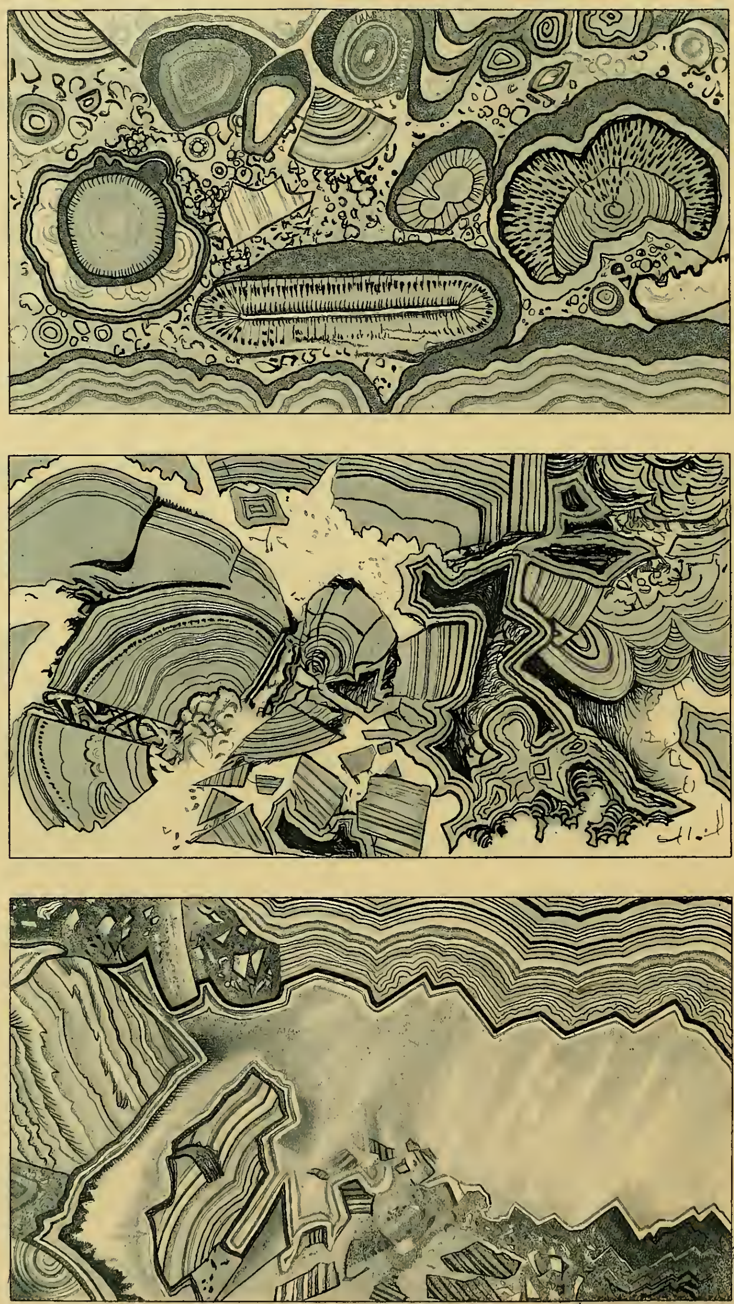


J. Ruskin del^t.                G. Allen inc^t.

BANDED AND BRECCIATED CONCRETIONS.

THE
# GEOLOGICAL MAGAZINE.

No. XXXVIII.—AUGUST, 1867.

## ORIGINAL ARTICLES.

### I.—On Banded and Brecciated Concretions.

By John Ruskin, Esq., F.G.S.,

(PLATE XV.)

AMONG the metamorphic phenomena which seem to me deserving of more attention than they have yet received, I have been especially interested by those existing in the brecciate formations. They are, of course, in the main, two-fold; namely, the changes of fragmentary or rolled-pebble deposits into solid rocks, and of solid rocks, *vice versa*, into brecciate or gravel-like conditions. It is certainly difficult, in some cases, to discern by which of these processes a given breccia has been produced; and it is difficult, in many cases, to explain how certain conditions of breccia can have been produced either way. Even the pudding-stones of simplest aspect (as the common Molasse-nagelfluhe of north Switzerland) present most singular conditions of cleavage and secretion, under metamorphic action; the more altered transitional breccias, such as those of Valorsine, conceal their modes of change in a deep obscurity: but the greatest mystery of all attaches to the alterations of massive limestone which have produced the brecciated, or apparently brecciated, marbles: and to the parallel changes, on a smaller scale, exhibited by brecciated agate and flint.

The transformations of solid into fragmentary rocks may, in the main, be arranged under the five following heads:—

1. Division into fragments by contraction or expansion, and filling of the intervals with a secreted, injected, or infused paste, the degree of change in the relative position of the fragments depending both on their own rate and degree of division, and on the manner of the introduction of the cement.

2. Division into fragments by violence, with subsequent injection or secretion of cement. The walls of most veins supply notable instances of such action, modified by the influence of pure contraction or expansion.

3. Homogeneous segregation, as in oolite and pisolite.

4. Segregation of distinct substances from a homogeneous paste, as of chert out of calcareous beds. My impression is that many so-called siliceous "breccias" are segregations of knotted silex from a semi-siliceous paste; and many so-called brecciated marbles are segregations of proportioned mixtures of iron, alumina, and lime, from an impure calcareous paste.

5. Segregation accompanied by crystalline action, passing into granitic and porphyritic formations.

Of these the fourth mode of change is one of peculiar and varied interest. I have endeavoured to represent three distinct and progressive conditions of it in the plate annexed; but before describing these, let us observe the structure of a piece of common pisolite from the Carlsbad Springs.

It consists of a calcareous paste which arranges itself, as it dries, in imperfect spheres, formed of concentric coats which separate clearly from each other, exposing delicately smooth surfaces of contact: this deposit being formed in layers, alternating with others more or less amorphous. Now it is easy to put beside any specimen of this pisolite, a parallel example of stratified jasper, in which some of the beds arrange themselves in pisolitic concretions, while others remain amorphous. And I believe it will be found that the bands of agate, when most distinct and beautiful, are not successive coats, but pisolitic concretions of amorphous silica.

Of course, however, the two conditions must be often united. In all minerals of chalcedonic or reniform structure, stalactitic additions may be manifestly made at various periods to the original mass, while in the substance of the whole accumulation, a structural separation takes place,—separation (if the substance be siliceous) into bands, spots, dendritic nuclei, and flame-like tracts of colour. But the separation into any of these states is not so simple a matter as might at first be supposed.

On looking more closely at the Carlsbad pisolite, we may discern here and there hemispherical concretions, of which the structure seems not easily to be accounted for;—much less when it takes place to the extent shown in Fig. 1, Plate XV., which represents, about one-third magnified, a piece of concretionary ferruginous limestone, in which I presume that the tendency of the iron-oxide to form reniform concretions has acted in aid of the pisolitic disposition of the calcareous matter. But there is now introduced a feature of notable difference. In common pisolite, the substance is homogeneous; here, every concretion is varied in substance from band to band, as in agates; and more varied still in degree of crystalline or radiant structure; while also *sharp-angled* fragments, traversed in one case by straight bands, are mingled among the spherical concretions: and series of brown bands, of varying thickness, connect, on the upper surfaces only, the irregular concretions together, in a manner not unusual in marbles, but nevertheless (to me) inexplicable.

Next to this specimen, let us take an example of what is usually called "brecciated" malachite (Fig. 2, in the same plate). I think very little attention will show, in ordinary specimens of banded malachite, that the bands are concretionary, not successive; and in the specimen of which the section is represented in the plate, and in all like it, I believe the apparently brecciated structure is concretionary also. This brecciation, it will be observed, results from two distinct processes: the rending asunder of the zoned concretions by unequal contraction, which bends the zones into conditions like the twisted fibres of a tree; and the filling up of the intervals with angular fragments, mixed with an ochreous dust (represented in the plate by the white ground), while the larger concretions of malachite are abruptly terminated only at right angles to the course of their zones, not broken raggedly across: a circumstance to be carefully noted as forbidding the idea of ordinary accidental fracture.

Whether concurrently with, or subsequent to, the brecciation (I believe concurrently), various series of narrow bands have been formed in some parts of the mass, binding the apparent fragments together, and connecting themselves strangely with the unruptured malachite, like the brown bands in example No. 1.

Now, if we compare this condition of the ore of copper with such a form of common brecciated agate as that represented in Plate XV., Fig. 3, it will, I think, be manifest that the laws concerned in the production of this last—though more subtle and decisive in operation, are *essentially* the same as those under which the malachite breccia was formed,—complicated, however, by the energetically crystalline power of the (amethystine) quartz, which exerts itself concurrently with the force of segregation, and compels the zones developed by the latter to follow, through a great part of their course, the angular line of the extremities of the quartz crystals *co-temporaneously formed*, while, in other parts of the stone, a brecciate segregation, exactly similar to that of the malachite, and only the fine ultimate perfectness of the condition of fragmentary separation which is seen incipiently in the pisolite (Fig. 1), interrupts the continuity both of the agate and quartz.

And finally, a narrow band, correspondent to the connecting zones of the malachite, surrounds the brecciated fragments in many places, while in others it loses itself in the general substance of the massive quartz.

I cannot, however, satisfy myself whether, in this last example, some conditions of violent rupture do not mingle with those of agatescent segregation; and I am sincerely desirous to know the opinions of better mineralogists than myself on these points of doubt: and this the more, because in proceeding to real and unquestionable states of brecciate rock, such as the fractured quartz and chalcedony of Cornwall, I cannot discern the line of separation, or fix upon any test by which a fragment truly broken and cemented by a siliceous paste which has modified or partly dissolved its edges, may be distinguished from a secretion contemporaneous with the paste, like the so frequent state of metalliferous ores dispersed in quartz.

Hoping for some help therefore, I will not add anything further in this paper; but if no one else will take up the subject, I shall proceed next month into some further particulars.

EXPLANATION OF PLATE XV.

Fig. 1. Section of a piece of concretionary ferruginous limestone, magnified about one-third.
Fig. 2. Section of a (so-called) "Brecciated" Malachite.
Fig. 3. Section of a Brecciated Agate.

## II.—Notes on some Remains of *Chiton* and *Chitonellus* from the Carboniferous Strata of Yorkshire and the West of Scotland.

By Messrs. James W. Kirkby and John Young.

(PLATE XVI.)

SINCE the occurrence of Chitons, in the Mountain Limestone of Settle, was noticed by one of us, in 1862,[1] other remains have been found in the same rock, as well as in the Carboniferous Limestone and shales of Scotland. The former were discovered, as before, by Mr. J. H. Burrow, of Settle, who has kindly placed them in our hands for description.

Both suites of remains are, as is usual with fossils belonging to this group of mollusca, in the state of isolated plates. Those from Yorkshire are from the Lower Scar Limestone, where they are found associated with great numbers of other fossils, such as *Orthoceras Goldfussianum*, De Kon.; *Goniatites striatus*, Phillips; *Spirifera cuspidata*, *Rhynchonella angulata*, etc., etc. Those from the West of Scotland are from the calcareous shales of the Lower and Upper Limestone series of Craigenglen, Campsie; Williamwood, near Cathcart, Renfrewshire; Braidwood, near Carluke; and Robroystone, N.E. of Glasgow; and they, like the Yorkshire specimens, occur associated with many other marine fossils.

The Scotch specimens do not appear to have been much worn or corroded before they were imbedded in the rock materials. The Yorkshire plates, on the contrary, are nearly all more or less injured in respect to surface. They are likewise thick-shelled compared with the Scotch species, and seem to have been adapted, as well as subjected, to the wear and tear of a rock-bound coast.

*Description of Specimens from Yorkshire:*—

1. *Chiton Burrowianus*, Kirkby, 1862. [Quart. Journ. Geol. Soc. vol. xviii. p. 234, figs. 1 and 2.] Plate XVI. Figs. 14 and 15.

This species was described from two plates, a posterior and an intermediate one. Other two have been found by Mr. Burrow, which are likewise posterior and intermediate. The last found posterior is larger than the first, being an inch in width and five-eighths in length. It is much worn and does not show any additional feature. The intermediate plate has apparently belonged to a smaller individual and is not quite perfect.

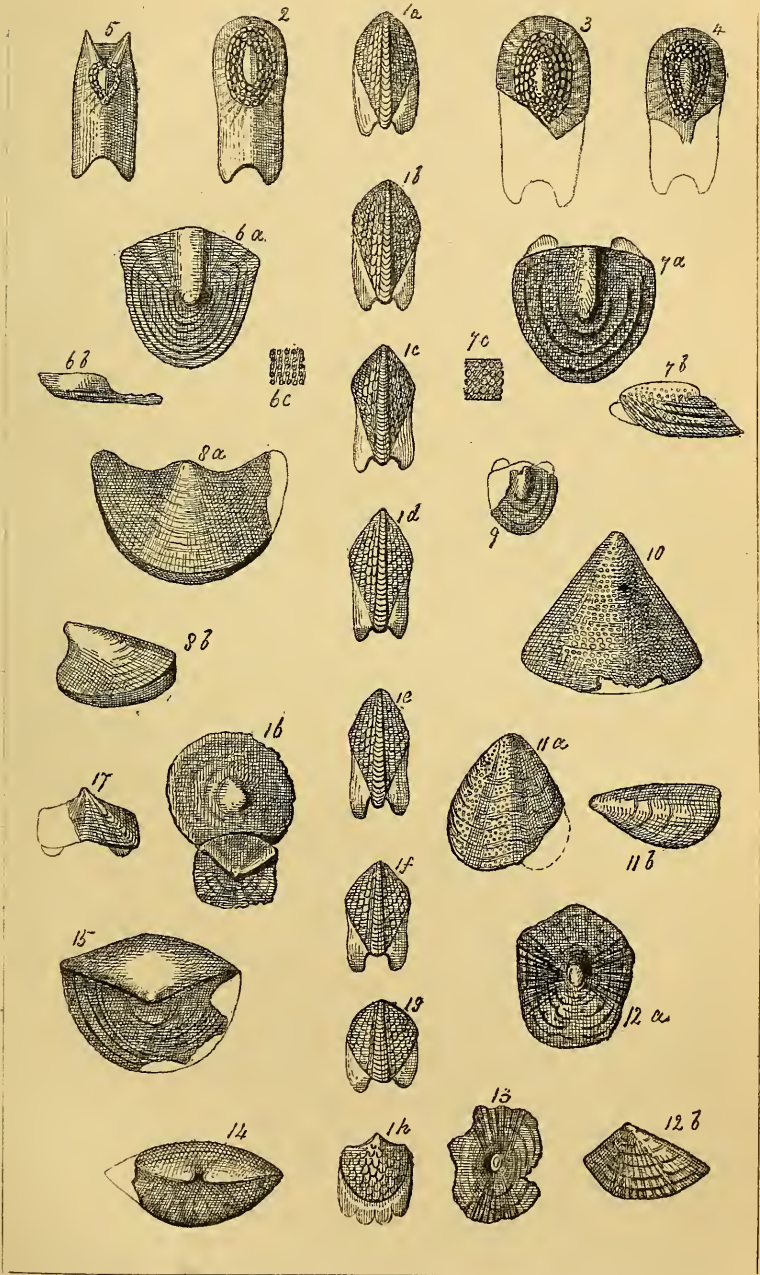
2. *Chiton coloratus*, Kirkby, 1862. [Quart. Journ. Geol. Soc. vol. xviii. p. 234, figs. 3, 4, 5, 6.] Plate XVI. Figs. 8*a*, 8*b*.

Several imperfectly preserved posterior plates occur. Also an anterior plate, which is very thick-shelled, and which has a worn surface that retains traces of granulation. The anterior margin forms rather more than a semi-circle; the posterior is concave on each side of the apex, and projects backwards to join the anterior margin. Length three-eighths of an inch; width half an inch; height three-sixteenths of an inch.

3. *Chiton Loftusianus*, King, 1848. [Catalogue of Org. Rem. Perm. Foss. p. 12.] Plate XVI. Fig. 17.

In a former paper,[2] by one of us, an intermediate plate of a *Chiton* is figured that greatly resembles those of *C. Loftusianus*, King, of the Magnesian Limestone. Its resemblance to that species was pointed out, though it was not identified with it.

[1] Quart. Journ. Geol. Soc. vol. xviii. p. 233. [2] Ibid. p. 236.




G. R. De Wilde, fecit. Hailes & Co., Imp.

RECENT & CARBONIFEROUS CHITONIDÆ.

Another plate of the same kind occurs among Mr. Burrow's recent discoveries, and we venture to identify both it and the former one with the last-named species.

4. *Chiton* (?) *cordatus*, Kirkby, 1859. [Quart. Journ. Geol. Soc., vol. xv. p. 616, pl. xvi., figs. 24, 27, 54.] Plate XVI. Figs. 10*a*, *b*, 11*a*, *b*.

An intermediate plate, and, I believe, an anterior one, occur among the Yorkshire specimens. Both are larger than the Permian specimens from which the species was described.

The intermediate plate is almost cordate in shape, being comparatively broad, rounded, and centrally sinuated anteriorly, and extremely narrow and acuminate posteriorly,—the anterior, lateral, and posterior margins blending insensibly together. The median line is slightly arched; the lateral areas occupy less than two-thirds of the plate-surface, and are separated from the dorsal area by a slight sulcus. The surface is finely granulated; length, half an inch, and the same in breadth.

The anterior plate is semi-cone shaped; is over half an inch wide, three-eighths of an inch high, and a quarter of an inch long. It is thick-shelled, and has the surface covered with rather coarse, oval granulations, regularly arranged in concentric lines.

Both these plates closely resemble the type specimens of *C. cordatus*, except in the granulated surface of the anterior plate, which differs both from the intermediate plate we describe here and from the Permian specimens. It may possibly belong to another species, but as it comes so close to *C. cordatus* in other characters, we place it along with that species for the time being.

5. *Chitonellus* (?) *subantiquus*, sp. nov. Plate XVI. Figs. 12*a*, *b*, 13.

We describe two patelliform plates under this genus, as we consider them to be plates of *Chitonellus*, though as the marginal processes of insertion are not exposed, our opinion as to their generic position can scarcely be free from doubt. They evidently belong either to that genus or to one of the groups of *Patelliform Gasteropoda*, though we believe to the former. Indeed, one plate so nearly approaches the Permian species *C. antiquus*, Howse (see fig. 17, pl. xvi. Quart. Journ. Geol. Soc.), as to render its separation from it a matter of difficulty. The following is a brief description of the most perfect plate, which we take to be an intermediate one.

Conical, sub-pentagonal in marginal outline, apex recurved and placed rather behind the centre of the plate. Several fine ribs radiate from the apex down each side, and others appear to have originally existed in front and behind, but are not now visible on this specimen, owing to the imperfect preservation of the shell in these parts. Surface marked with strong lines of growth; length rather under three-eighths of an inch; breadth rather over two-eighths of an inch.

*Description of Scotch Specimens*:—

1. *Chiton humilis*, Kirkby, 1865. [Trans. Geol. Soc., Glasgow, vol. ii. p. 14, pl. i., fig. 1.] Plate XVI. Figs. 6*a*, *b*, *c*.

This species was discovered two years ago and described in the Transactions of the Geological Society of Glasgow. The only perfect plate found is a posterior one, which we re-figure. It occurs in calcareous shale in the Robroystone beds N.E. of Glasgow.

2. *Chiton sp.* Plate XVI. Figs. 7*a*, *b*, *c*, 9.

Mr. Jas. Armstrong and Mr. Jas. Bennie, of Glasgow, have found three posterior plates in the Carboniferous Limestone Shale of Williamwood, near Cathcart, in Renfrewshire, which differs from the preceding species. They are relatively broader, more pointed in front, and more sharply angulate, and with coarser surface granulations than the equivalent plate of *C. humilis*. They are about one-fifth of an inch wide, and the same or a little less in breadth, and show well-developed processes of insertion.

These plates approach nearest to *Chiton Burrowianus* of any Chiton known to us; but they do not come near enough to allow them to be identified with that species. We leave them for the present unnamed.

3. *Chitonellus Youngianus*, Kirkby, 1865. [Trans. Geol. Soc., Glasgow, vol. ii. p. 14, pl. i., fig. 2.] Plate XVI. Figs. 2, 3, 4.

Since the discovery of a single plate of this species in 1865, portions of two others have been found. These we figure along with the first.

The plates discovered appear to be intermediate ones. The one that is perfect is nine-thirty-seconds of an inch long and four-thirty-seconds of an inch broad. It is ovately oblong in outline, with an anterior sinus, and is sharply ridged along the median line from the apex forwards. The apex is placed about one-fifth from the anterior margin. The exposed portion of the plate, or that which was uncovered by the mantle, is slightly raised, anteriorly, ovate in shape, and with a pustulous surface; the inserted portion of the plate is marked with coarse, radiating striæ, except in front.

The other two plates are both imperfect in the anterior inserted portion; but so far as they are preserved, they both agree precisely with the one described. They were found in the marine shales of Craigenglen. Another perfect plate appears to have been found by the late Mr. Alex. Cowan of Campsie, but has been lost.

All the plates have been found in the marine shales of Craigenglen, Campsie.

4. *Chitonellus subquadratus*, sp. nov. Plate XVI. Fig. 5.

We designate by the above name another plate that has also occurred in the Craigenglen shales, and which cannot be referred to *C. Youngianus*. It may be described as subquadrate in outline, with both anterior and posterior margins forked, but with the former more so than the latter, and with the anterior portion of the plates rather narrower than the other. It is ridged or angular along the median line from the apex forwards; and from near the apex posteriorly two declining angular ridges diverge and run into two sharp projections that are formed by the junction of the latero-posterior margins. The exposed portion of the plate is very small compared with the portion that was buried in the animal, being not more than a fifth or sixth part; it is heart-shaped, with the pointed extremity in front; it is slightly elevated above the rest of the plate, and granulated about the margin. Numerous delicate striæ fringe this heart-shaped area on the surface of the inserted portion of the plate. Length, quarter of an inch; breadth, one-eighth of an inch.

Besides the species which we have already enumerated from Scotland, Mr. John Hunter, of Braidwood, near Carluke, has obtained from the main limestone of that place one or two small plates of a species of Chiton, which we have been unable to determine correctly, owing to their imperfect preservation.

Mr. James Thomson, of Glasgow, has also a Chiton plate in his collection, from Carboniferous shale on the banks of the Anan, near Strathanan. His specimen, so far as we remember, agrees very closely in form and ornamentation with the *Chiton gemmatus* of De Koninck.

It is not unlikely, when the affinities of the palæozoic *Chitonidæ* can be carefully investigated, that the generic nomenclature adopted at present will require revision and alteration. Some of the species described would almost appear to possess points of more than specific difference from all the known recent types of *Chiton*, so that it may ultimately be found requisite to establish new genera for their reception. It is well, however, not to be too hasty in the formation of new types; for our knowledge of the palæozoic species is nearly in every case imperfect, and in some instances the conclusions drawn from the facts known may be erroneous.

We give figures of the eight plates of the recent *Chitonellus striatus*, Lam., to illustrate the nearer approach of the fossils we describe as *Chitonelli* to that genus than to *Chiton*. From these it will be seen that in *Chitonellus* the plates are longer than broad, while in *Chiton* just the contrary holds; also that the plates are not formed to imbricate on each other as in *Chiton*, but to be fixed isolatedly, though firmly, in the mantle; and, lastly, that much more of the plate is inserted in or covered by the mantle of the mollusc. In these respects the fossil species to which we allude certainly approach nearer to *Chitonellus* than to *Chiton.*

EXPLANATION OF PLATE XVI.

Figs. 1*a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*. *Chitonellus striatus*, Lamarck. Recent, from the coast of New Holland. The plates are detached from the mantle; fig. 1*a* being the anterior, and 1*h* the posterior. Magnified three times.

Figs. 2, 3, 4. *Chitonellus Youngianus*, Kirkby. Intermediate plates. Magnified three times. From Craigenglen, Campsie.

Fig. 5. *Chitontellus subquadratus*, sp. nov. Intermediate plate. Magnified three times. Craigenglen, Campsie.

Figs. 6*a*, *b*, *c*. *Chiton humilus*, Kirkby. Posterior plate, magnified; *b* lateral view; portion of granulated surface highly magnified. Robroystone.

Figs. 7*a*, *b*, *c*, 9. *Chiton sp.* Posterior plates; 7*b* lateral view; 7*c* portion of surface highly magnified. Williamwood, near Cathcart.

Figs. 8*a*, *b*. *Chiton coloratus*, Kirkby. Anterior plate, magnified; *b* lateral view. Settle.

Figs. 10, 11*a*, *b*. *Chiton* (?) *cordatus*, Kirkby. 10, anterior plate; 11*a*, intermediate plate; *b* lateral view of same. Magnified. Settle.

Figs. 12*a*, *b*, 13. *Chitonellus subantiquus*, sp. nov. Intermediate plates; 12*b*, lateral view. Magnified. Settle.

Figs. 14, 15. *Chiton Burrowianus*, Kirkby. Posterior plates, one (14) being distorted by pressure. Settle.

Fig. 16. *Chiton*, sp. indet. Settle.

Fig. 17. *Chiton Loftusianus*, King. Intermediate plate. Settle.

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## III.—Kitchen-Middens on the Great Ormeshead.

By the Rev. T. G. Bonney, M.A., F.G.S.

I CAME accidently upon the deposits which are the subject of this brief notice, the afternoon before I left Llandudno last April. Want of time prevented my making more than a hasty examination of them, but I think that they will repay any one who happens to be visiting Llandudno this summer, and will devote a day or two to them.

After passing the Dean of Christchurch's house, a gate leads on to the shore of Conway Bay (Pen-morfa on the Ordnance Map.) A high steep talus covered with thin turf, here separates the fine limestone cliffs of the Ormeshead from the shore, the lower part of which has been eaten away by the waves, so that a cliff has been formed, which soon rises to a height of some twenty feet; the lower tier of limestone soon emerges from the shingle and slopes upwards, still separated from the upper cliff by the drift-covered talus. The deposits of which I have to speak occur between the above-named gate and the place where the lower limestone makes its appearance. Directly after passing through the gate, we find a thin seam of *Mytilus edulis* with *Balanus balanoides* attached to the shells, and a sort of bed, or pocket, of *Mytili* 1½ feet below it. These perhaps may not be the remains of a Midden, but of a mussel-bed corresponding with those along the same shore about a mile to the south.

The cliff rises rapidly, and about four or five yards further on to the N.W., we have a tolerably clear face with the following section:

(1) Soil with angular fragments of limestone, 1½ ft.
(2) A very thin seam of shells mostly *Littorina littorea.*
(3) Dark soil, about six inches.

(4) Thin seam of shells, mostly *Patella vulgata*, with dark soil.
(5) Dark soil, about eight inches.
(6) Greyer soil, with thin seam of *Patella* near top, and of *Mytilus* near bottom, about six inches.
(7) Gravel of angular fragments of limestone, with a few shells of *Mytilus* in lower part, three inches.
(8) Reddish clay, with angular fragments of limestone and rolled trap pebbles, about two feet.
Red sand without pebbles, yellower in upper parts, about three feet.
(9) Talus of clay, &c., about four feet.
(10) Shore, sloping some two or three feet to high-water mark.

In (2) I found *Littorina littorea*, *Patella vulgata*, and *Mytilus edulis*, with some grains of a friable red earth resembling burnt clay; and a bed a few feet to the west,—probably the same—yielded not only *Patella*, but also a valve of *Cardium edule*, and some larger fragments of this burnt clay, one of which was about the size of a walnut.

From 6, besides the shells named, I collected *Littorina littorea Cardium edule*, a fragment of bone, and the mid-dorsal vertebra of an ox, differing from that of the common ox in having one large perforation for arteries in the neural arch.

The face of the cliff for about ten yards further shows a somewhat similar section, but the different deposits cannot be traced with certainty for more than a few feet. From beds in a position corresponding (nearly) with (4) I collected *Littorina littorea*, *Patella vulgata*, *Mytilus edulis*, and the following bones :—Left tibia of small deer, probably roebuck; fragment of femur of bird; fragment like a bird's bone in form and medullary cavity, and as large as the tibia of a swan; teeth of lamb or young roebuck.

We then find a very interesting section exposed :—

(1) Surface soil with angular fragments of limestone, 1½ feet.
(2) Shells, 1¼ feet.
(3) Soil with limestone fragments, one foot.
(4) Shells, chiefly *Patella vulgata*.
(5) Sandy deposit, about 2½ feet.
(6) Reddish clay, with many limestone fragments, some many cubic feet in contents.

(2) Is simply a mass of shells, almost, if not wholly, *Littorina littorea* and *Patella vulgata;* it extends for some six or seven yards further to the north-west, though it runs rather thinner, and one can trace it for some fifteen yards beyond by a scanty seam of shells which rises with the ground—owing to the thickening of (6)—to a height of from twenty to twenty-five feet above the shore. With the shells I found two pieces of bone, which, according to Mr. H. Seeley, whom I have to thank for determining the bones herein mentioned, are "very young and have the proportion of the maxillary and lower jaw in the lamb, but may be the roebuck, with which I have no means of comparing it."

(4). The shells in this bed shew more marks of age than any of the others. I found also *Littorina littorea* and "the metacarpal of a small deer, probably the roebuck."

## IV.—Notes on Glen-car Valley, Sligo.

By A. B. Wynne, F.G.S., etc.

A RECENT visit to the picturesque lake-valley of Glen-car, about seven miles N.N.E. of Sligo, has afforded an opportunity for reconsidering the method by which the fine precipices enclosing it were formed.

Viewed at a shorter distance the appearance of an anticlinal curve intersected by the cliff, referred to and illustrated in the January Number of this Magazine (Vol. IV. Pl. I. Fig. 5, p. 5), was found to have been in this instance deceptive. The limestone strata are more nearly horizontal than otherwise, while the appearance of an open curve—see right side of figure referred to above—is given by three parallel land-slips along the face of the cliff, letting down large masses, so as to form the benches shown in the figure, and were doubtless caused by fissures like those in Fig. 4 of the same plate.

The cliffs do not overhang, and the profile of a portion of the mountain as sketched from the lake,[1] looking towards the mouth of the glen (see Sketch, Fig. 1) does not show traces of former undercuttings by sea-breakers to have been the cause of these land-slips.

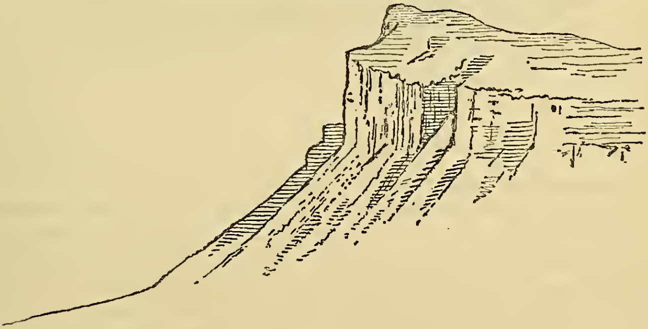

Fig. 1.—Profile of cliff, looking towards the mouth of Glen-car; sketched from the Lake.

Several of these great slips occur in this locality. At a place called the Protestants' Rocks, on the south or opposite side of the glen, an immense flake or mass, many yards in length and height, has slipped down from and now inclines towards the face of the cliff, resting upon the talus at its foot; and, though much weathered, still shows the hollow of a ravine above, by which it was crossed before the settlement took place (see Sketch, Fig. 2).

Between the group of mountains in which this glen lies, and Sligo bay to the west, are several long rising grounds running east and

[1] Two small islets, one at either end of the lake, are said to be "crannoges," or old lake habitations. The evidence upon which this statement was made, is supposed to have been obtained many years ago, when the lake was lowered by large excavations and alterations in the bed of the Drumcliff river, which forms its outlet; but these have since then silted up so much that the lake is now said to maintain nearly its old higher level, and the islets present merely the appearance of heaps of stones.

west, either formed of, or deeply covered by heavy limestone drift, supposed to be the débris of materials eroded from their glens by glacial action. However this may be, the large accumulations which remain in this shape can form but a very small portion of the great sheets of limestone and Coal-measures which once overspread and have been denuded off the face of the country, and of which the mountains themselves are only remnants.

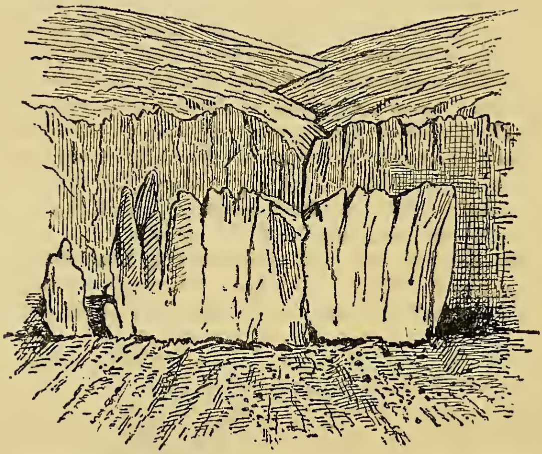

Fig. 2.—Land-slip at the Protestants' Rocks, on the south side of Glen-car, Sligo.

The whole aspect of Glen-car forcibly impresses upon an observer the active and powerful agency exerted by atmospheric denudation. It may be plainly seen how the cliffs are gradually receding, yet still preserve their bold character. Naked portions of the mountain tops are covered by small pieces of disintegrating rock; the precipices crumbling away together with rain-washed fragments from above, dress the steep slopes immediately beneath with shingle, the downward motion of which frequently appears to be too rapid for vegetation to cling to; and these shingly slopes are cut through by the small runnels and more rapid mountain torrents.

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## V.—On the Break between the Upper and Lower Silurian Rocks of the Lake District, as seen between Kirkby Lonsdale and Malham, near Settle.

By T. Mc K. Hughes, M.A., F.G.S.

The Rocks included under this head are those already described by Professor Phillips, in his paper "On a Group of Slate Rocks in Yorkshire, between the rivers Lune and Wharfe, etc." (Trans. Geol. Soc., 2nd Series, III. 1). Also by Professor Sedgwick, in his paper "On the Lower Palæozoic Rocks at the base of the Carboniferous Chain, between Ravenstonedale and Ribblesdale" (Quart. Journ. Geol. Soc. VIII. p. 35).

Professor Sedgwick, in a letter dated 1846, published in Wordsworth's Guide to the Lakes, makes the Coniston Flags the base of the upper group; but later, in his letter published in 1853, page 242, he says that the determination of the fossils by Messrs. Salter and McCoy, and the agreement in mineralogical character of the Coniston Grits with the May Hill Sandstone, led him to draw the line at the base of the grits, and this classification was followed in his synopsis.

Professor Harkness and Mr. Nicholson, in a paper read before the Geological Society in May, 1866, say that the Wenlock and Llandovery Rocks are unrepresented in the Lake Country, and they refer the Coniston Flags and Coniston Grits to the Upper Caradoc.

When that paper was read, I stated to the Society my reason for believing that there had been some mistake in the collection of the fossils from the Coniston Flags, and that the fossils, from the presence of which the flags were referred to the lower group, had not come from the beds containing *Cardiola interrupta*, and the numerous large *Orthoceratites*.

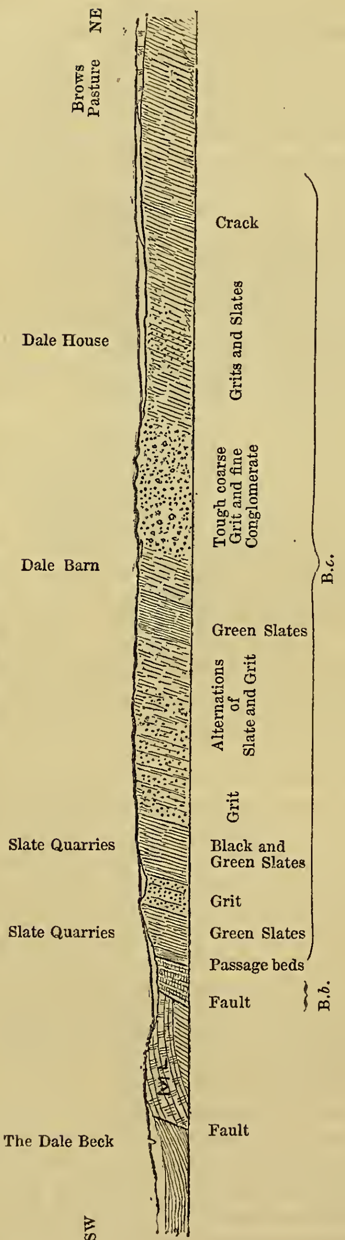
In an unpublished letter, written about that date, Mr. Salter said that he felt sure there were two sets of flags, the one belonging to the upper and the other to the lower group; and informs me that he had expressed that opinion on various occasions previously.

The detailed manner in which we are instructed to map the country has enabled me to work out the order of succession of the Silurian rocks along the borders of Yorkshire and Westmoreland, and, I think, to fix the position and nature of the break between the upper and lower group. The result I arrive at is that, "On the evidence, both of mineral structure and of fossils, we are compelled to separate the Coniston Flags from the Coniston Limestone and Calcareous Slates, placing the former at the base of the Upper Silurian series of the Lake district." [1]

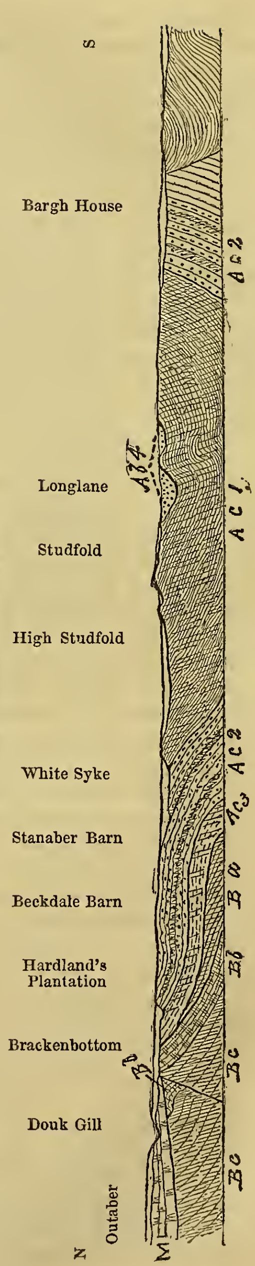
The first Section which accompanies this paper is drawn north-east and south-west along the valley running down from Chapel-le-Dale to Ingleton, and shows the junction of the Green Slates (B.*c*.), with the Coniston Limestone (B.*b*.). The beds seen at the north end of the valley are a series of greenish gritty sandstones and slates, which are succeeded by a thick set of coarse grits and conglomerates. Going still south, we cross alternations of greenish slates and tough gritty sandstones for about a mile, when we arrive at the first large quarry, in which a blackish and green slate has been extensively worked. These darker slates are separated from the lighter green and olive slates of the next quarry by alternations of greenish grit and slate.

This appears to be an ascending section all down the valley. The beds dip at an angle of from 70 to 90 in a south-west direction, and the ascending series varies in lithological character so much that there is nothing to suggest that the beds have been anywhere repeated. On the other hand, there are several large gaps where the section is obscured by drift, and where there might be sharp folds or faults. Faults, where the strata are so highly inclined would have to be very large to produce much effect on the measured

[1] Sedgwick, 1846, *loc. cit.*




SECTION I.—INGLETON.
*Scale—twelve inches to a mile.*




SECTION II.—HORTON IN RIBBLESDALE.
*Scale—twelve inches to a mile.*

thickness of the beds. Also they must have taken place previous to the deposition of the Carboniferous Rocks, as the great Scar Limestone is seen up both sides of the valley, lying with an almost horizontal line of junction upon the upturned edges of the Silurian Rocks. If we have here an unbroken ascending series there must be more than 10,000 feet of green slates seen in this valley; but for the reasons above stated the measurement must be received with caution.

These green slates pass up into a thin bedded shivery slate, often breaking up when weathered into small wafer-like fragments. These in turn pass up into more sandy slate, with calcareous bands forming the base of the Coniston Limestone. The limestone has here yielded only some obscure traces of fossils, being considerably altered by its proximity to one of the Great Craven faults. There would appear, therefore, to be a passage from the green slates to the overlying Coniston Limestone, as we find that not only does the dip of the two formations agree exactly, but that there are beds intermediate in lithological character between them. The two formations are seen holding their relative positions in several small sections to the east of those last mentioned; but nowhere else in this neighbourhood is the junction seen.

The next section, No. II., is drawn due north and south, down the east side of Ribblesdale, near Horton. The green slates are seen in the bed of the stream called Douk Gill, which runs out from a "keld"[1] on the east of the village. They dip at a high angle in a southerly direction, and pass up into calcareous slates, full of characteristic Lower Silurian fossils. These are the lower part of the Coniston Limestone, and about 150 yards down the stream they begin to turn up again, so that what we have here of the Coniston Limestone has been preserved in a synclinal, broken at its west end by a fault noticed by Professor Sedgwick (Journ. Geol. Soc., viii. p. 49), which cuts off the Coniston Limestone, bringing the green slates again to the surface. The Lower Silurian rocks are not seen again on this side of the valley, the country where they might be expected being entirely obscured by Drift.

Along the road north of Hardland's Plantation, and south-west from that to Hardland's Barn, there is a tough grit, succeeded by flags exposed in the quarry in Hardland's Plantation. These may be seen undulating gently in many places west of Beckdale Barn, and north-west of Redding Barn. They are of no great thickness, and are soon succeeded by more grits, which are seen along the road north-west of Dove Cote, and also sticking out in ice-worn bosses here and there to the south of Stanaber Barn. These grits and flags are the lower grits (A.*c.* 2) with their subordinate flags, which are therefore the equivalent of those west of Crag Hill Barn.

Near Stanaber Barn the grits pass up, through alternations of flags

[1] "Keld" is the term applied to the large springs so common in limestone districts, where the water collected in the pot-holes and crevices of the rock runs out a full stream from a cave below. Prof. Sedgwick informs me that a similar word ("Kelda," I think) is used to denote a similar phenomenon in Iceland.

and roughly cleaved sandstone or grit, into the Coniston Flags (A.*c.* 1). These flags stand out here and there all over the hill, and are well exposed in large quarries at Studfold.

At the south end of Studfold Low Pasture they pass under more tough grits (A.*b.* 4), similar in lithological character to those above described (A.*c.* 2). They are well seen near the guide-post, and elsewhere in Long Lane. The flags turn up again south of the guide-post; but another patch of the grit is preserved in a second small synclinal, and seen in the next stream. These grits (A.*b.* 4) are the highest beds to be seen in this district. I think they are the same as the grits at the south end of Casterton Fell, where they also have yielded no fossils, and rest on similar flags with Orthoceratites and Graptolites.

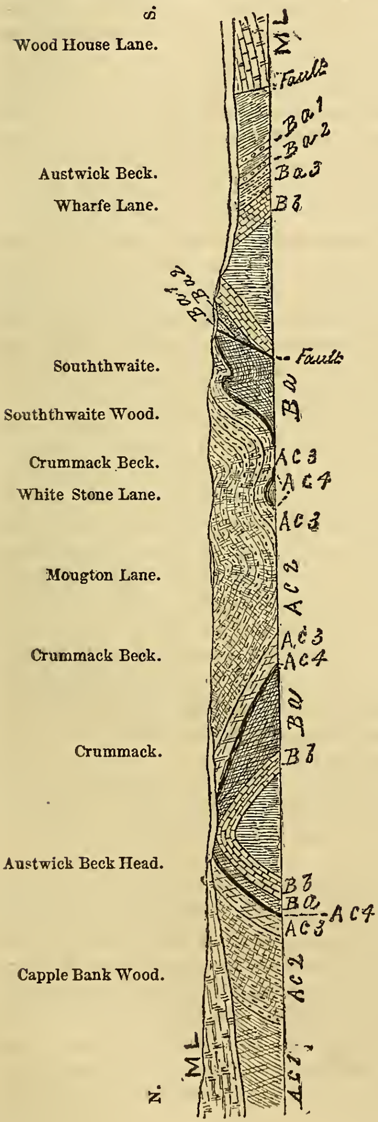
I have already described that section in this Magazine, Vol. III. p. 206; (*a*) of that section will be the equivalent of A.*c.* 1 of this. and (*b*) of A.*b.* 4.

On the west side of the valley a similar section can be made out, The green slates (B.*c.*) are seen in the Ribble, between New Inn and Horton; also near Pettythorn Barn and Beecroft Hall; and consist of the usual alternations of greenish grit, sandstone and slate. The beds are much twisted, and the section obscured by Drift, for the next half mile to the south, where an anticlinal running east south-east and west north-west, brings up the Coniston Limestone near Crag Hill. At Crag Hill the lowest beds consist of sandy or slaty concretionary limestone, with plenty of fossils. The concretions are generally very tough, but sometimes weather into a dark brown earth, showing remains of corals and other fossils. Occasionally this earthy matrix gets washed away, leaving the fossils beautifully preserved. The beds of limestone are thicker and less earthy as we ascend, and at the top we find a bed of a peculiar grey, tough, crystalline limestone. It is exceedingly difficult to see fossils in this, except on the weathered surface. I found only two or three species of *Favosites*. The junction of this bed and that immediately above it, is nowhere exposed; but it is seen to be succeeded by soft slates (A.*c.* 3), which pass up into a tough, grey, gritty sandstone. This is probably the base of A.*c.* 2, and, with one roll, continues with a southerly dip as far as Arco Wood. Near Crag Hill Barn there is a subordinate bed of flags, probably on the same horizon as that in Hardland's Plantation.

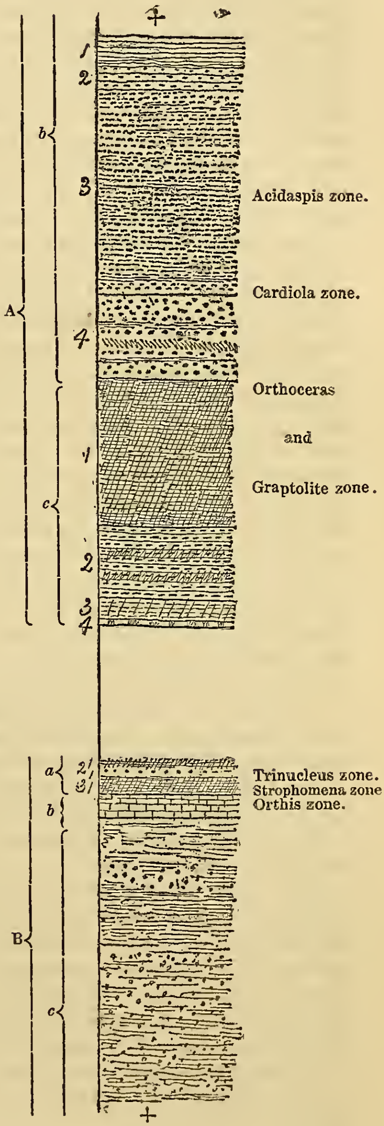
A little north of Arco the grits pass under the Coniston Flags proper, A.*c.* 1. The Arco Wood quarries are in the lower part of the flags; the Comb's quarry flags are much higher, but they all form one indivisible set. The flags turn up again on the south side of Comb's Quarry, and, with a north north-easterly dip of from 27° to 75°, form bare ridges, bursting through the soil here and there. The principal of these may be followed east south-east, by Dry Rigg Quarries, across the Ribble, and west north-west, under Moughton Scar, into the next valley, behind the small village called Wharfe. Section III. is drawn due north up this valley, but further west than the flags (A.*c.* 1) extend. The grits (A.*c.* 2) also turn up again

SECTION III.—CRUMMACK.

*Scale—12 inches to a mile.*




VERTICAL SECTION IV.



from under the flags. The junction crosses the road about half a mile east south-east of Newfield House, and may be followed in a west north-west direction into the next valley, where the boundary line may be traced round to Studrigg Scar; the grits coming up from below the flags on the south, west, and north. South of Swarth Moor the grits are repeated by a fault parallel to the Craven Faults, but older than the Carboniferous rocks under which it passes. Owing to this fault, which is a broken anticlinal with a downthrow on the north, the base of the grits (A.*c.* 2) is not seen until we get to the Crummack Valley. They are thrown against a lower part of themselves as far as Lower Bark House Barn, on the west of which they come against (B.*a.*) the slates, grits, and ash-like beds above the Coniston Limestone; then against the Coniston Limestone itself. As this fault has a little more west in it than the strike of the beds on the north side, lower beds abut against it as we proceed westward; and so the base of the grits comes against the fault near the road between Austwick and Wharfe, and can be traced from that point, through Wharfe, across Crummack Beck, south of Souththwaite Wood, across Crummack Lane, near the Limekilns, till it disappears under the Scar of Mountain Limestone. As the grits turn up again on the north, the base line may be traced across the Beck, some way south of Crummack, and up to Moughton Scar; but this line is much obscured by Drift. Under Moughton Scar the slates (A.*c.* 3) are seen here and there, and lower down one small boss of Coniston Limestone, just enough to prove that it comes there.

Some of the subordinate flags of (A.*c.* 2) may be seen north of Far End Houses, where we have a bed about 60 feet thick. Some flaggy beds, probably at a lower horizon, occur in the grits north of White Stone Wood, then curving round with the rest of the beds, may be traced to about 100 yards west of Moughton Lane. A still lower set occurs in Souththwaite Wood, and is, probably, about the horizon of the flags of Hardland's Plantation and Crag Hill Barn. In several places along the east edge of the valley, under the limestone cliff, flags occur, alternating with the grit.

The slates (A.*c.* 3) may be seen rolling about at small angles all down the stream, from the base of the grits in Souththwaite Wood to within 100 yards of Wharfe Mill Dam, where they are cut off by the fault above mentioned.

About fifty yards west of the stream we come to the base of the slates (A.*c.* 4) which is here a very coarse irregular conglomerate. This may be traced for about a quarter of a mile west-north-west, fragments of the broken ridge occurring along the fields south of Souththwaite. A similar conglomerate is seen at Austwick Beck Head, dipping north-north-east under some slates, and these again under the grits and flags of Capple Bank, which I take to be A.*c.* 2.

At Austwick Beck Head the conglomerate rests on an irregular cleaved mudstone, of which there is very little seen, and that much weathered.

Below Souththwaite the conglomerate rests on a series of slates, with subordinate more gritty bands (B.*a.* 2) which pass into rocks very like what have sometimes been called ash-beds. Some of these beds cross Crummach Lane just north of Norber Brow. One is seen in the stream close to the Dam House Bridge. The series rolls over, and several such beds are seen dipping to the south, near Jop Ridding, Woodend, Staindale, etc. Below them the slates become more flaggy (B.*b*. 3); have often long bands of concretions packed parallel to the cleavage, so as to make it very difficult in small sections to make out the bedding. They are well seen on Norber Brow and under the Limestone cliff of Norber, in both of which localities I found several specimens of *Trinucleus*. These beds pass down into Coniston Limestone, which may be seen near Wharfe Mill Dam, up Wharfe Gill Dyke, etc.

Thus it will be seen that the flags of Horton, in Ribblesdale, lie in a synclinal, the axis of which slopes to the east-south-east; and so in the Crummack valley, we have only the lower part of the flags (A.*c*. 1) preserved in the hollow of the grits (A.*c*. 2), while, in the Horton valley, we have the whole of the flags, and at its east end even part of the grits above the flags (A.*b*. 4), preserved in their then deeper trough.

Two anticlinals, also with their axes sloping to the east-south-east, bring up the lower group (B) on the north and south of this synclinal.

Along the northern anticlinal, the grit A.*c*. 2 (which is a more marked bed than A.*c*. 3), is close upon the Coniston Limestone B.*b*.; along the southern anticlinal it is separated from the limestone by a very considerable thickness of slates and shales, etc., with Lower Silurian fossils.

Thus A appears to rest upon different beds of the underlying group B.

Also the base of A is sometimes a conglomerate made up of fragments of the older series B.

That is to say A rests unconformably upon B.

Such are the stratigraphical relations of the rocks in the district under notice. From these data I have constructed a Vertical Section (IV.), to which I shall refer by index letters and numbers, in offering a few remarks upon the lithological character and palæontology.

I have avoided giving names to the subdivisions, as I feel that names derived from locality can probably be more conveniently found in the typical region to the north and west, and that names from characteristic fossils are not likely to hold good over large areas, as all A, with which I have chiefly to do, is so undoubtedly one group, that where similar conditions of sea bottom recurred, we must expect to find that the same creatures were there or thereabouts, ready to migrate and re-migrate to suitable areas. Probably, also, most of the divisions will fit in with local names, already used by Professor Sedgwick, such as Ireleth Slates, Brathay Flags, etc.

When the fossils, collected by Mr. Gibbs and myself, have been arranged and determined by Mr. Etheridge, I hope to offer larger and more trustworthy lists.

B.*c*. *Green Slates.*—These are the green slates and porphyry of

Professor Sedgwick. I have dropped the word porphyry, as I have not in this district found any part of them which could be so called. The specimen which I saw in the Kendal Museum also, from further north, seems only a grit, though certainly altered a little. I have not been able to detect any fossils in these beds, unless some obscure black marks which I found in the slates due west of Twisleton Manor House, should turn out to be traces of Fucoids or Graptolites. Professor Harkness has, however, shown that their equivalents further north are of Caradoc age, and the passage from the Coniston limestone into them near Ingleton would seem to bear out this view.

B.*b.* *Coniston Limestone.*—A dark blue, close grained, more or less calcareous slate and shale, passing into a hard blue grey crystalline limestone. I have nowhere got the top and bottom of this bed in one section, so I can offer no estimate of its thickness; nor am I prepared to say that it is the very same bed that occurs at the different places from which I have collected fossils, and not rather limestone bands on slightly different horizons of the same series. Fossils are abundant. Speaking generally, the same species occur everywhere, though in some localities they are more numerously represented than in others. Besides the localities referred to in the description of the cross sections, this formation is well exposed and highly fossiliferous in the upper part of Helm Gill, and above Gawthorp near Dent; also in Sarly Beck, north-east of Sedbergh.

The following are some of the fossils:—

*Halysites catenularia.*
*Heliolites.*
*Petraia æquisulcata.*
*Favosites fibrosa.*
*F.* 2 other sp.
*Encrinites.*
*Cystideans.*
*A Phyllopod crustacean.*
*Calymene Blumenbachii* (var *brevi-capitata*).
*Cheirurus bimucronatus.*
*Cybele verrucosa.*
*Illænus.*
*Lichas.*
*Phacops conophthalmus.*
*P.* sp.
*Remopleurides.*
*Atrypa marginalis.*
*Leptæna quinquecostata.*
*L. sericea.*
*L. transversalis.*
*L.* small sp.
*Lingula*, 2 sp. ?
*Orthis Actoniæ.*
*O. biforata.*
*O. calligramma.*
*O. elegantula.*
*O. flabellulum.*
*O. porcata.*
*O. vespertilio.*
*O.* sp.
*Strophomena depressa.*
*Murchisonia ?*
*Lituites ?*
*Orthoceras.*

B.*a.* Strongly cleaved slates. Near Souththwaite the difference between them and the slates (A.*c.* 3), above may be well examined—the latter being less altered, and showing the direction of the bedding better. In the upper part the altered grits like Ash-beds (B.*a.* 2) occur, below which, but some way above the limestone, the Flaggy Slates (B.*a.* 3) with packed concretions occur. In the upper part of B.*a.* 3 fragments of *Trinucleus* become tolerably abundant. So also in coming down Helm Gill we have a geologically ascending section, and in the beds near the bottom, and therefore highest in the series, we find *Trinucleus*, while fossils are scarce through the beds immediately below. Also in coming south-west from Sarly

Beck we have an ascending series, and just above the limestone find shales in which *Strophomena alternata* is the characteristic fossil; and much higher up, on the south-west side of Rawthay Bridge, shales in which *Trinucleus* is abundant.

Limestones always form a convenient dividing band, both from their pointing to some physical change, and from their marked lithological character. Therefore, although B.*a*. passes down into B.*b*., we may take an arbitrary line for the base of B.*a*., and we shall find that a change has set in somewhere thereabouts.

In B.*a*. I have found—

| | | | |
|---|---|---|---|
| *Petraia subduplicata*, var. *crenulata*. | | *O. calligramma*—large close ribbed var. | |
| *Encrinites*. | | *O*. sp. | |
| *Phacops apiculatus ?*<br>*Phacops*, sp. (*obtusi-caudatus ?*)<br>*Trinucleus concentricus*. | Chiefly in the upper part. | *Strophomena depressa*.<br>*S. alternata*.<br>*S*. sp. | Abundant in the lower part. |
| *Orthis biforata*. | | *Orthoceras*, etc., etc. | |

A.*c*. 4. This bed is seldom exposed. Probaby it does not everywhere exist as a conglomerate, and, moreover, in the other parts of this district which I have had an opportunity of examining, I have never found the upper group near the lower, except where I have plenty of independent evidence of its being brought on by a fault. It is, however, well seen in a few places in the Crummack Valley, where it is a very coarse irregular conglomerate, made up of rolled and angular fragments, which appear to be derived from the grits and fine conglomerates of the green slates; from the Coniston Limestone series—some pieces are very like a bed seen in B.*a*. close by;—bits of quartz and slates of various texture, etc. The greatest thickness I could measure was about ten feet. The only fossils I found were *Favosites alveolaris*? *F. fibrosa*. It may be that the breccia-like limestone above the Coniston Limestone at Crag Hill is the equivalent of this conglomerate. I have nowhere seen a limestone of that character in the Coniston Limestone, where it has been covered by beds undoubtedly belonging to the lower group B.; also, the only fossils I found in it were the same corals I found in the conglomerate; but this is a point to be worked out.

A.*c*. 3. Slates very uniform in character throughout. Generally a soft mudstone splitting by cleavage and joints into small rhomboidal pieces. Faint lines often indicate the bedding. I have not as yet found any fossils in these beds. The thickness is probably several hundred feet. They pass up through a roughly cleaved sandy slate into—

A.*c*. 2. Tough grits, or greywacké,[1] with subordinate beds of flags. These have as yet yielded no fossils. They are about one thousand feet thick, and always, in this district, succeed the slates (A.*c*. 3) with a very uniform character and thickness.

A.*c*. 1. Flags with subordinate thin beds of grit. These are the

[1] The word "greywacké" as defined by Mr. Forbes (p. 229, *sup*. foot-note) would be a very useful term in this country. We want a name for the tough Silurian rocks which seem to be something between a grit, or sandstone and quartzite.—See Geol. Mag., Vol. III. p. 206, foot-note.

Coniston Flags proper, in which are the great quarries. Where the bedding and cleavage nearly coincide they form good flags, where the cleavage makes a considerable angle with the bedding they split along the cleavage; but the lines of bedding are well marked across, and the stone breaks into irregular slabs of hardly any value except as "troughs" for walling.

The thickness of these beds is about two thousand feet. Fossils, with the exception of Orthoceratites and Graptolites, are very scarce. I, however found the following; quite enough to connect them with the beds above, instead of with those below:—

| | |
|---|---|
| *Favosites fibrosa.* | *Lituites giganteus.* |
| *Actinocrinus pulcher.* | *Orthoceras primævum.* |
| *Graptolites Ludensis.* | *O. subundulatum.* |
| *G.* sp. | *O.* sp. (*ventricosum ?*) |
| *Pterinea tenuistriata ?* | *Worm tracks*, etc. |
| *Cardiola interrupta.* | |

A.*b.* 4. Tough grit or greywacké, with a few subordinate flaggy, or slaty beds. These are the highest beds seen in the Horton district. I have estimated their thickness at about twelve hundred feet on Casterton Fell. I have found no fossils in them there, or in the Horton district; but fossils rarely occur in rock of that character. Near Cautley Spout, north-east of Sedbergh, I found a large *Lituites* in a tough grit, which I must refer to the top of this, or the bottom of the overlying set (A.*b.* 3). Also, at Helmside, near Dent, there are some flaggy beds, near the top of what I take to be this grit which have yielded the following:—

| | |
|---|---|
| *Cliona.* | *Pterinea tenuistriata.* |
| *Spirorbis Lewisii.* | *Cardiola interrupta.* |
| *Ceratiocaris Murchisoni* (See Geol. Mag. Vol. III. p. 203). | *Orthoceras Ludense.* |
| *C. robustus.* | *O. bullatum.* |
| *Graptolites Ludensis.* | *O. angulatum.* |
| *G.* sp. | *O.* 3 other sp. |

A.*b.* 3. These are the sandy slates of Casterton, Middleton, and Howgill Fells — more than 3000 feet thick. Having already described them in the first mentioned locality, I will now only give a list of fossils, to show that as a group they are the same as those which occur down to the bottom of the Flags.

| | |
|---|---|
| *Petraia.* | *Graptolites.* |
| *Encrinites.* | *Pterinea tenuistriata.* |
| *Ceratiocaris Murchisoni.* | *Cardiola interrupta.* |
| *C. robustus.* | *Lituites.* |
| *Acidaspis.* n. sp. Salter. | *Orthoceras*, 2 sp. |
| *Phacops*, sp. | |

Thus it appears that all (A.) is one series, characterized by such fossils as *Cardiola interrupta*, that it rests unconformably on a lower series (B.), characterized by such fossils as *Orthis Actoniæ* and *Trinucleus*.

I gather from Prof. Sedgwick, whose kind help on all occasions I take this opportunity of acknowledging, that A.*c.* 1 to A.*c.* 4, are what he included under "Coniston Flags," and I would therefore merely wish to return to the classification which he published in 1846, and make the flags so defined the base of the Upper Silurian Series.

## REPORTS AND PROCEEDINGS.

### THE CHEMISTRY OF THE PRIMEVAL EARTH.

A LECTURE BY DR. T. STERRY HUNT, F.R.S., F.G.S., DELIVERED AT THE ROYAL INSTITUTION, LONDON, ON FRIDAY EVENING, MAY 31ST, 1867.[1]

MR. PRESIDENT, LADIES, AND GENTLEMEN,—The subject of my lecture this evening, as has been announced, is the Chemistry of the Primeval Earth. The natural history of the earth, to which we give the name of "Geology," is necessarily a very complex science, including, as it does, the concrete sciences of Mineralogy, of Botany, and of Zoology, and the abstract sciences of Chemistry and of physics, not to speak of others. These sciences, and especially chemistry and physics, have a very important relation with regard to the whole process of development of our earth, and have, from the very first time, exercised a most important relation with regard to all its changes. And we have lately learned, from more extensive study, that these chemical laws apply not only to terrestrial, but to extra-terrestrial matter. Recent investigations show us in fact, as might have been presumed, that all the other bodies of our solar system, and bodies even of other systems, revolving around other suns, have essentially the same chemical composition as our own planet. The spectroscope, that marvellous instrument in the hands of modern investigators, has thrown a light upon the composition of the farthest bodies of the universe, and has made clear many points which the telescope had not been able clearly to decipher. It has shown us, as it were, matter in all its different stages, and has enabled us to trace the great processes of the condensation and the formation, so to speak, of worlds. It is, as you are aware, long since Herschel speculated upon the nebulous matter which seemed to be diffused in different parts of space. Some of these nebulæ Lord Rosse and others were able, with their great telescopes, to resolve, and to show that they were really composed of stars; and thence there came a doubt whether there were really such masses of nebulous matter diffused as had been hitherto maintained, but the spectroscope has placed that beyond a doubt, and has enabled us to see in the bodies in the heavens above, not only planets like our own earth shining by reflected light, and other bodies like the sun, consisting of luminous and apparently solid particles, but also others still—true nebulous masses, that is to say, luminous gaseous matter,—these three forms representing, as we may suppose, three distinct phases of the consolidation or the condensation of the first primal matter from which our earth, as well as all the other bodies of the solar system, would seem to have originated.

This nebulous matter we conclude to be intensely heated—so intensely heated as to be completely gaseous, and, in fact, to owe this gaseous form to its intensely elevated temperature; being, however, comparatively feebly luminous when we contrast it with the solid

[1] Being a full report taken down verbatim in shorthand, and now printed for the first time.

matter which appears in the flames of burning gas and in most other terrestrial flames, or compared even with the light which has emanated from the sun itself.

But still further, the spectroscope has enabled us to discern in the matter of the sun, and, to a certain extent, in the matter of the fixed stars—which, as you are well aware, are other suns, the centres of other systems—for the most part the same elements with those which make up our own earth.

You have probably already had explained to you in this place—and it would be foreign to my object to-night to speak of it—the mode in which these investigations have been conducted; but of the great conclusion you are aware, that the commonest elements, the sodium, the iron, the magnesium, and most of the other commonest elements of the crust of the earth also enter into the composition of the sun, and enter into the composition, moreover, of the fixed stars—that is to say, of other suns. And here it is singular how modern science has realized the gentle intuition of the poet. Long since we heard a poet singing, who told us that he

"Saw alike in stars and flowers a part
Of the self-same universal being
That is throbbing in his mind and heart;"

and this, which seemed little more than a poet's fancy, has been realized in the most prosaic way by modern investigation, which shows us from the examination of the light of the sun and of the stars, the very elements which enter into the composition of our own earth—which actually enter into the composition of our own bodies.

Still farther, we know the sun is intensely heated. Calculations have been made as to the amount of heat and of light which have radiated from the sun, and of the temperature of the surface of the sun. The figures which are required to represent that heat are so immense that it is really difficult for the mind to conceive of the intense elevation of temperature which exists in that body. And modern chemical investigation has thrown a curious light, it seems to me, upon the nature of the action which is going on at the sun's surface, and upon the source of the luminosity of that body. We all know that heat is favourable to chemical combination,—that, under ordinary conditions in the laboratory, if we wish to effect a combination of two bodies, we expose them to heat; but it has been found that a higher degree of heat reverses all these affinities, or most of them. Many of the metals—the "noble metals," as we call them, like gold and silver—are capable of forming combinations with oxygen, for instance, but at a higher temperature the oxygen goes off and the metal is regenerated. A similar thing was shown many years ago by Mr. Grove, with regard to water. The elements of water, oxygen and hydrogen, brought together at the elevated temperature of the electric spark, unite to form water; but at a still higher temperature the compound is again broken up into its two elements, so that if you have these elements at a very high temperature, cold would actually produce the effect of combination. A certain point, either of heat or cold, would really produce a similar result—the combination of these elements; and thus, literally, to use Milton's line, "frost would be found to perform the effect of fire." Now, it seems from still later investigations by Deville and by others, that this great law of indifference of bodies when intensely heated is a universal law, and that this principle, which Deville calls "dissociation," probably extends to all matter. All the substances that we know would probably, at a sufficiently high temperature, be dissociated: that is to say, the various elements which make up the earth—which make up any body—when in this state of intense ignition would be uncombined, and, moreover, would all be capable of being reduced to the state of vapor—to the state of gas; and this we must conceive to be the real condition of the matter which forms the sun.

Now what must be the process going on at the surface of such an immense mass of matter, intensely heated, but by the very fact that it is gaseous, but feebly luminous? You are well aware that a hydrogen flame without any solid matter in it, though giving a very high temperature, emits almost no light whatever. At the surface of this enormous globe, the sun, a process of cooling would be going on; and there such bodies as at the still very high temperature were capable of uniting—to form oxides, let us say—would be precipitated, and would form a sort of mass or cloud suspended in the still dissociated vapours, and would then give off light and become intensely luminous, as such solid particles necessarily are, and would thus give rise to a brilliant light, and would also radiate the sun's heat. Hence we suppose that at the surface of the sun, and at the surface only, there is this process of condensation going on. This hypothesis, lately put forward, has, I am aware, been opposed; but it does not seem to me that the arguments which have been brought against it are valid, and I cannot but think, from the present state of our knowledge, that it affords us something like a correct idea of the nature of the action which is going on at the sun's surface.

But you will ask what all this has to do with our earth? Very much, and for this reason: the almost universally accepted hypothesis with regard to the origin of our solar system, not to speak of other systems, is that the different bodies of our system—the sun and the planets which compose it—have been evolved out of a common nebulous mass.

Now, whether we admit that nebulous mass in rotating to have thrown off successive bands, which bands have been broken up and agglomerated into worlds, or whether, with Chacornac and some others, we suppose that in the midst of this great nebulous mass a process of concretion went on by which an enormous ball of vaporous matter resolved itself somewhat as you may see, a white cloudy mass, at times breaking up and resolving into smaller masses of clouds,—I say, whether you adopt one or the other notion with regard to the breaking up of this great nebulous mass, and the formation from it of sun and of planets, you come to the conclusion that our earth must at one time have been a portion of such a nebulous mass as is the sun at the present day: in other words, it must at one time have been a gaseous mass; it must at one time have been a mass so intensely heated, that this process of consolidation was only going on at the surface. It was once a self-luminous body, such as the sun is at the present day, but being very much smaller, the process of cooling has gone on with a very much greater rapidity.

Now there comes up another question,—whether, in this process of concretion, or agglomeration, or separation, which has gone on n this nebulous mass, all the masses—all the subordinate masses—have the same composition,—whether this great mass of vapor was homogeneous or not. That we cannot certainly decide, but from our present knowledge it would seem extremely probable that it was so.

But let us consider this cooling to go on, and, as in the case of the sun, a condensation taking place at the surface. This mist-like matter, as it became solid or liquid, having a certain weight, would fall down toward the centre of the sun, or of the planet which was then like the sun, and undergo the process of heating again, From the constant contraction going on in this mass, the process of losing heat, and of gradual condensation, would be going on until you arrived at the point of liquefaction, that is to say, at the point where there were certain compounds which could exist without decomposition even at the centre, in other words, until you had cooled it below the decomposing, the dissociating point of certain compounds. Let us suppose that certain of the metals are capable of combining with oxygen and forming compounds so condensed and so fixed that they resist the decomposing action; then, and then only, would commence the formation of a liquid nucleus. That once begun, a process of condensation would go on until in each one of these planets—in our earth for example—you would have eventually a great liquid globe, an igneous fluid mass, surrounded by intensely heated vapours.

Now as to the composition of this mass. Whether it would be homogeneous or not becomes a question. I think it extremely probable that in such a mixture as this you would have toward the centre a progressive condensation and accumulation of matters denser than at the surface. This idea has been a favourite one with many who have speculated upon the density of the earth, for you are well aware that the earth, weighed as a whole, has a specific gravity of something over five,—five three-tenths, as was determined by Maskelyne,—that being, in fact, about twice the density of the superficial parts. Hence, I think it extremely probable that we have at the centre metallic or metalloid masses of elements, grouped in different proportions from any that we have at the surface, and in that way we have explained the great density of the earth considered as a whole.

But next with regard to this central mass. Would it remain fluid, or would it become solidified? And here I am aware of a notion very widely entertained and very generally taught in our text-books on geology, that the earth's centre is a liquid mass, and has only a crust of from fifteen to twenty or twenty-five miles in thickness, a crystalline solid rock which bears us upon its surface.

This notion is supported to a great extent by fallacious reasoning. It is said that in the cooling of such a fused mass solidification would naturally commence at the surface; and people have reasoned in that way from a fact which is common to the observation of all of us—the freezing over of our lakes and vessels of water during the winter season. We find that the ice forms at the surface of the water, while the mass below remains liquid; but modern investigation has shown us that water is an exception, differing in this respect from almost all other substances; and that while ice is lighter than the water upon which it forms and upon which it certainly floats, the solid congealed material of almost all metals, and of all rocks, slags, and such fused substances as might be supposed to form this condensed mass of the globe, is very much heavier than the liquid. Without going into the details of these experiments, which have been very carefully made and verified by numerous investigators, we may say in a few words that the process of cooling in a mass like this would be just like the cooling of a great bath of metal or of sulphur; in other words, the condensation or congelation would commence at the centre and extend outward toward the surface, so that the temperature of the centre would therefore be the temperature of congelation. Matters, too, congealing at the surface and going down towards the centre, even if they met a somewhat higher temperature below, would not be exposed to melting, for the beautiful investigations of Messrs. Hopkins and Fairbairn have shown that in such cases pressure actually increases the act of fusion, so that the pressure at the surface actually favours the solidification of the mass, and the temperature at the centre would be actually the temperature of congelation, which is said to increase with the pressure. It has been assumed that this increase was indefinite, so that it was easy in that way to imagine a heat of intense whiteness at a few miles only from the surface; but you will at once perceive that if these matters had cooled to the solidifying point at the surface and then gone down towards the bottom, it is only the congealing point at the surface which will represent the maximum temperature of the centre of the earth.

Now comes a very curious question: what is the composition of this fused mass,—or, rather, what is the composition of the largest stratum which remains at the surface?—for, as I might show you, did time permit, there is no reason to believe that any portion of this great fused mass, with the exception of the very surface, has ever taken any part in the subsequent changes which have gone on in the earth's crust. In other words, we must find in the first few metals of that solid crust, and in the gases and vapors that surround it, the source of all the materials which now make up the solid stratified crust of the earth, the waters of the ocean, and the atmosphere above us. Let us imagine all these materials to be brought together and fused. Suppose all the elements of the visible earth that we know to melt with fervent heat, the chemist, by a knowledge gained in his laboratory, will easily understand the nature of the reactions. All the carbon which is in the form of coal would be burned and converted into carbonic acid. All the siliceous matters which make up the earth's crust, the quartz and the sandstones, would act upon the carbonates of lime and expel all the carbonic acid. The waters of the sea, volatilized, would leave a residue of salt and of gypsum behind them; and these materials again acted upon by the excess of siliceous matters in the crust, in the presence of water, would expel all the chlorine in the form of hydrochloric acid. All the sulphur would be diffused in the atmosphere in the form of sulphurous acid; and eventually all the lime, the magnesia, the soda, the potash, and the metallic bases would be combined with alumina and silica in a great fluid magma whose composition would be, perhaps, more like the slag of some of our iron furnaces in its composition than anything else we know; and the slow cooling of them would probably develop various crystalline compounds. The cooling of such a mass at length would render it somewhat viscid; and then, as I mentioned, inasmuch as the solid rock is always denser than the liquid, you would have irregular shrinkings and corrugations of the surface, so that the first cool surface of the globe would be a scoriaceous slaggy mass, as I conceive,—with exceedingly irregular outlines of hill and valley, —a curiously depressed and corrugated surface,—perhaps such a surface as the moon presents to us through a telescope,—perhaps such a surface as we observe on a mass of fused silver after it has come out of the furnace and is giving off the gases which it has absorbed,—and it is very probable that gases may be absorbed during the cooling of this scoriaceous mass.

But then let us ask what is the composition of that atmosphere. In that atmosphere we should have the whole of the carbon in the form of carbonic acid; the whole of the chlorine in the form of hydrochloric acid; the sulphur as sulphurous acid; and we should, moreover, have nitrogen and probably an excess of oxygen. This great accumulation of gases, and of hydrogen in the form of watery vapor, would give rise to an atmosphere of enormous density. The atmospheric column at that time must probably have weighed upon the earth's surface with a weight seven times that of our atmosphere at the present day, and the cooling of this crust would have then gone on very, very slowly. Heat would radiate with extreme difficulty from this mass, and ages would take place probably before the cooling came on to such a point as to admit of condensation. But just let us conceive that under this high column, this great pressure, condensation of water would take place at a very much higher temperature than it does under our present atmospheric column. That water might remain in a liquid state on the earth's surface at temperatures, perhaps, of 300 or 400 degrees;—this would depend upon the unknown height of this great barometrical column, of which we have not sufficient data to determine the exact weight. Then this first water coming down, moistening the surface of this crust, would be intensely impregnated with acids, especially hydrochloric acid. We all know from chemical investigation that this rocky slaggy mass would be readily attacked on the surface by these acids. Indeed, the action would probably be very energetic, and would go on until the whole of the affinity of the acid was saturated at the expense of the lime, magnesia, and soda, and other metallic bases which form a portion of this crystalline scoriaceous mass—this primary slaggy surface. The silica separated at this high temperature, if we may judge from the investigations of chemists, would take the crystalline form, and you would thus have, naturally, great deposits at the surface of the earth of silica, probably in the form of crystalline or granular quartz; and you would thus have a separation of quartz on the one hand, and on the other hand you would have the waters of the primeval ocean intensely impregnated with chlorides and sulphates of all the bases which were at first combined with this quartz—with this siliceous matter. This process is a submarine one; that is to say, it would take place only in the depressions of the earth's surface where these waters accumulated. And it would be a very rapid process. The action would very soon be exhausted, because the affinities of these acids—hydrochloric acid, and sulphurous acid, and perhaps sulphuric acid —formed at that temperature would soon be satisfied. Then comes another and a slower process, which would be effected upon the exposed portions of the crust by the carbonic acid in the atmosphere, combined with the moisture there present,—a process of slow decay and transformation of all these silicates which are thus exposed; and that is a process similar to that which is now going on at the surface of the earth by which our hardest granites and gniesses, hard felspathic and pyroxenic rocks, are broken down and converted into clay—a process which even makes the granites of Cornwall crumble into Kaolin. In the elimination from these felspathic rocks of the alkali which they contain—the lime, magnesia, and soda—there would be a separation of silica and alumina in the form of clay, which remains insoluble at the surface of the earth, and the formation of carbonates of soda, of lime, and of magnesia, these carbonates being formed at the expense of the carbonic acid in the atmosphere, which is absorbed by these bases at the moment they are liberated;—and these, through the condensing waters or rains which are falling upon the surfaces exposed to subaërial action, are carried down into the sea, where their first act would be to precipitate aluminous matters,—to precipitate at that high temperature all the denser metals, and, finally, to give us a sea which would consist only of lime, magnesia and soda.

Now, that process is still going on—has been continued down to our present time, and it is one which is constantly operative at the surface of the planet,—slowly, very slowly, at the present day, it is true, because the amount of carbonic acid in the atmosphere is now very much less than it was at this former time.

Thus you see the result of this subaërial decomposition of these rocks gives rise to clay; but the carbonate of soda going down into the sea decomposes the lime-salts in the sea: and precipitates carbonate of lime,—in other words, limestone. First, the action gives rise to solid quartz-silica; secondly, to the formation of clay;

and thirdly, to the formation of carbonate of lime or limestone; and in these three elements you have, as it were, the alphabet of all our stratified or water-formed sedimentary rocks. Sand (broken up quartz), clay, and lime, in various proportions, either in their simple mechanical mixture or, secondly, combined by chemical action, make up the whole of the rocks with which we have to deal,—of course including iron and some other metals which intervene, to a very secondary degree however.

Thus I have endeavoured, so far, to show you how these processes naturally going on, give rise to the elements which make up these stratified and sedimentary rocks. It belongs to physical geology to explain the breaking down of these sediments and their mechanical distribution, and the subsequent origin of the different varieties of rocks; and we can only indicate the general chemical law which has thus presided.

But here you see not only the origin of these three great classes of minerals which make up the rocks, but you see the origin of the saltness of the sea. That is a question which has very much puzzled and perplexed many who have written upon the subject,—whence the sea derived its salt. It has been said by some writers that the source of the salt was to be found in the land, because salt was recognized as an element in the rocks; and some even went so far as to contend that the origin of this salt was to be found in igneous action. They imagined in the centre of the earth a source from which all its materials were extruded, and rock-salt among them; but a very careful series of investigations upon the composition of ancient waters, the mineral waters, which are nothing less than the fossil sea-waters locked up in the ancient rocks, have shown that there has been a slow progressive change in the constitution of the ocean, and that by means of the action of carbonate of soda, derived from the decay of the solid rocks, there have been separated the whole of the carbonates of lime, which make up the calcareous strata—the marbles and the various limestones which we find on the earth's surface. It is not unusual to say that these limestones are the result of organic action, because we find them to a great extent made up of shells, of corals, and of the remains of calcareous animals. That is very true, but these animals can only appropriate the carbonate of lime which they find ready formed at their hands; and that carbonate of lime has been formed from the salts of the sea by reason of this peculiar decomposition which I have just now explained.

But this takes us a step farther; for if the rocks are decomposed by virtue of the carbonic acid of the air, there has been a great separation of carbonic acid from the atmosphere. You will recollect that we supposed that at first the whole of the carbon which has since gone into the solid crust of the earth was diffused in our atmosphere, thus giving a composition very different from that which we have at the present time. Now, we all know that this carbonic acid in large proportion is unfavourable to the development of the higher forms of life; and we see, therefore, in this slow chemical process by which the carbonic acid has been separated from the air, the agency which has progressively purified our atmosphere, and has fitted it for the support of the higher forms of animal life, so that every clod of clay represents a very instructive series of processes. That clod of clay tells us of the decomposition of an old felspathic or granitic rock as it were—of the separation from it of carbonate of soda,—of the decomposition of the salts of lime in the sea water,—of the formation, therefore, of an equivalent of carbonate of lime,—of the formation of common salt,—and of the separation from the atmosphere of an equivalent of carbonic acid; and thus the great law of equilibrium binds together the composition of the solid crust of the earth, of the waters, and of the air.

We have thus considered two great sets of action. Principally, however, I should say we have considered the action from without—the action of acids and gases and vapors upon the solid crust of the earth. But you will ask, is there no action from within? Geologists have been prone to assign the action of the central fire as the source of almost all the changes which take place at the surface of the earth; and shall we exclude that from our scheme? No, certainly not; but I dare say that when I spoke of this solid crust of the earth, the question was asked by many in their own minds whether that first-formed crust was not identical with granite. It is a very common notion that granite forms the substratum of the earth—that it was the rock upon which all other rocks were built.

Now, in the first place, I would remark that we have not evidence anywhere of an exposed portion of that crust of the earth. In fact, by the very conditions of the problem, as I have put them forward, we would conceive a complete decomposition, a complete destruction, of all that crust either by submarine or subaërial agency,—the breaking of it down into clay or into other elements of that kind, so that everywhere the primitive crust of the earth is buried beneath its own ruins. But if we may be permitted to imagine the composition of that primitive crust—to reconstruct it, so to speak, as I have just now done—you will see that its composition would have excluded altogether free silica,—would have excluded quartz, and that this very quartz, which is one of the constituent elements of granite, is only the result of a secondary chemical process which I have just explained to you; so that, in fact, the granites and the gniesses and all these rocks which at the earth's surface now appear in a disruptive extruded form are, in fact, older rocks decomposed by water—the results of the metamorphism of the older rocks themselves deposited from water.

One point (and I beg pardon for having omitted it just now) with regard to the composition of this earlier atmosphere. Unfitted as it was for the higher forms of life, still from the comparatively large amount of carbonic acid present, it would seem to have been peculiarly fitted for the development of luxuriant vegetation; and it was long since pointed out by Brongniart that we might suppose a marvellous luxuriance of vegetation in earlier periods of the earth which gave rise to enormous beds of coal and other fossil fuel; for we should judge that this abundance of carbonic acid favoured a wonderful development of vegetation, and, at the same time, the elimination of the carbon in the shape of coal, helped powerfully to purify the air at that time.

But there is another little question which comes up with regard to the vegetation of these early times. We find, not only under the tropics, but over the whole of the British Islands, and even within the Arctic circle, a wonderful vegetation. Ferns and palms, such as are now found growing only within the tropics, once grew within the Arctic circle, and, indeed, very near the Poles. A very curious and beautiful explanation of that has recently been presented by the experiments of Dr. Tyndall, which I believe have been first made public in this very Royal Institution. He observes with regard to carbonic acid, and many other gases of that kind, that their relations to radiant heat, and notably to obscure heat, were such that a very small proportion—a few hundredths—of that carbonic acid diffused through the atmosphere would be quite sufficient to prevent, almost entirely, the radiation of obscure heat from the earth's surface; so that an atmosphere constituted, as I have shown, from chemical grounds, the atmosphere of these early times must have been constituted, would permit the solar heat to pass through our atmosphere, but would prevent its escape by radiation after it had once heated the surface of the earth, and would thus immensely augment the temperature of the lower strata of the atmosphere, producing an effect precisely as if we had covered the whole earth with an immense dome of glass,—had transformed it into a great Orchid-house,—and had thus established, from the equator to the poles, a moist, warm, equable climate, which would permit, even within the limits of the polar circle, a luxuriant vegetation.

This wonderful explanation of one of the most obscure problems of geology, comes from the investigation of the relation of different gases to radiant heat.

I might go on still farther—(the subject tempts me)—and speak of another curious class of phenomena that went on at the earth's surface in these earlier times, and with regard to which the atmosphere of that period played a very conspicuous part—the formation of Magnesian limestone, or Dolomite. You all know how over great parts of England the Mesozoic rocks are made up in great proportions of carbonate of lime combined with magnesia. Wherever you have gypsum beds you have a large quantity of this dolomite. The formation of this substance has been a very obscure problem. I have found, however, that by certain reactions in which carbonate of lime intervened with the salts of the sea—reactions hitherto unsuspected—it was possible to explain the formation not only of gypsum, but of dolomite, but with one exception: I found that the carbonic acid, which was an indispensible condition in the success of that experiment, was constantly going off by diffusion. My experiments were constantly interrupted by the spontaneous evolution of the gas. I remembered, however, that we must admit that in the earlier times we had an atmosphere with several hundredths of carbonic acid: the whole phenomena of limestone require it; and, in fact, the whole chemical conditions for this hypothesis which I am explaining to you require it. Let us see what will be the effect of preparing an artificial atmosphere. If we endeavour to reconstitute such an atmosphere as must have involved this globe at the time these rocks were being deposited, let us see whether we cannot get the conditions for the formation of these rocks. In an apparatus fitted for the purpose I surrounded the required materials with such an atmosphere as existed in the coal-period, and I found that under that artificial atmosphere, providing the conditions for evaporation, the whole series of phenomena went on perfectly, and there was no difficulty in producing carbonate of magnesia and gypsum; and, in fact, I had here another confirmation of the notion of the highly carbonated condition of the atmosphere in palæozoic and mesozoic times. That theory is confirmed by climate, by vegetation, and by the singular series of reactions which have hitherto been a perplexity to chemical geologists.

But we have hitherto been considering, as I said before, only superficial actions—actions in which gases and vapors and matters diffused in the atmosphere are operating to produce the slow decay, crumbling down, denudation, and disintegration of the solid crust so that the first inequalities of the earth's surface would be rapidly effaced; and the result of all this would be, to reduce the whole surface of the earth to a dead level were it not that there is below a counteracting force, and that that counteracting force is no other than the central heat, that central heat operating directly upon these buried sediments, giving to the lower strata a softness and plasticity so that they give way under the superincumbent pressure of accumulated masses of sand, and of clay and of gravel. These slowly send the other matters down until they came within the sphere of the central heat, and thus they indirectly produce those effects which have been by most writers attributed to direct outbursts of the central fire. The generally received opinion is, as you are aware, that volcanoes and igneous eruptions have their seat in this great fluid bath, upon which floats the thin crust upon which we live; but in the great density of these solidifying cooling rocks I have already demonstrated a chemical reason for repudiating that doctrine.

It would be foreign to my object to-night to enter into a discussion of the physical, mathematical, and astronomical reasons, which have been given against that doctrine, and which go powerfully to support this practical reasoning. I may appeal, however, to the labours of the late Mr. Hopkins, of Cambridge, who, by his admirable combination of mathematical and geological science, contributed so much to the advancement of geology. He was able, by very careful calculation upon the precession of the equinoxes and upon the phenomena of mutation, to conclude that the earth, if not solid to the core, must be almost solid; and Professor Thompson, from the theory of the tides, and Archdeacon Pratt, of Calcutta, have also arrived at conclusions which support completely those arrived at from purely chemical data, namely, the essential solidity of the great mass of the earth, and, consequently, of the independence of volcanic phenomena of any supposed theory of a fluid nucleus within. Yet it is not the less true that we have in volcanic phenomena a condition of things which recals sufficiently the state which must have existed at the very commencement of solidification upon our planet;—that we have still evolved molten rocks, which are very like what I suppose this first scoriaceous crust of the earth must have been;—that we have evolved from these volcanoes different gases and vapours such as must have floated over the surface of the first formed and first solidified planet; and they come in as beautiful explanations of what I was endeavouring to explain—the composition of this crust, for they are really the result of the melting together of the successive interstratified and intermingled layers of the earth's crust, and may represent,over very considerable areas, the mean composition of the stratified rocks. When these become depressed, so that they come within the action of the central heat passing upward by radiation, then takes place the fusion, the melting together of the limestones, of the clay, of the salt, of the gypsum, and of the gault together with the sand, and there are produced these fused scoriaceous masses which we call lavas; and, at the same time, are liberated enormous masses of elastic fluids and gases which produce all the phenomena of volcanic eruption. However, in certain cases where there is no disengagement of gases you have simply the crystallization of the rocks—the conversion of them into what we call granites, or gneisses, or mica-slates, and other varieties of crystalline rocks which form so often our great mountain chains. And we have, morever, in the movements dependent upon this crystallization, depression in one part and upheaval in another. We have those movements which preserve the irregularity of the surface of the earth, which prevent it from being entirely depressed beneath the level of the sea and converted into one vast ocean. And here we see coming up the old vexed question of the Neptunists and the Plutonists. There are persons still living who recollect the controversy which raged at the close of the last and the beginning of the present century, and which in Germany and Edinburgh raged with such virulence that the opposing parties were almost broken up socially. You had the school of Werner or the *Neptunists* on the one hand, and the school of Hutton or the *Plutonists* on the other. The one endeavoured to create the earth entirely by water, and the other as entirely by fire. In the light of modern chemistry, I think we may now safely conclude, that the origin of the earth was first an igneous mass,—that fire came in and did its work until a cooling took place sufficient to allow of the precipitation of water, and from that time the mechanical action of water, and the chemical action of water, and of acids and gases, were the principal means in modifying the rocks at the surface of the earth, and it was only when these became thickly accumulated, and depressed below a certain level, that they came again within the domain of Pluto, where the igneous actions were again commenced, which produced those igneous rocks which were confidently appealed to by the Plutonists as the proof of their hypothesis. Thus you see both hypotheses justified by the latest investigations in chemistry and geology.

In this sketch which I have endeavoured to present to you of the way in which chemical forces have operated upon the surface of our planet, I may seem, to some of you who are familiar with chemical processes, to have drawn somewhat upon my imagination; and yet I conceive that there is not a principle here adduced which is not supported by the most rigorous chemical investigation. If we once admit this nebular hypothesis, which I think we can scarcely fail to admit in the light which telescopic and spectroscopic investigations have now thrown upon the sun and the other bodies of the great universe around us,—if we admit that,—if we admit the laws I have explained of association by cooling, and the ordinary play of chemical affinities that must come in, in the case of cooling bodies, we can scarcely doubt that the reactions that come into play have been essentially such as I have explained to have taken place in the essential order in which I have enumerated them.

I should have been very glad, if the time permitted—but it does not—to enter still farther into the discussion of many secondary points which arise here,—the whole theory of metalliferous deposits, of metallic veins, of mineral springs, of thermal waters, and of gaseous emanations from the earth,—and to show that all of these flow as natural, and necessary, and logical consequences of the scheme of chemical geology which I have put forward briefly tonight. I hope, however, that in these few remarks I shall have made these principal points so plain that you may see that chemistry has already been able to do something to elucidate the history of our planet, and that a chemical consideration of this kind is not altogether out of place in the hall of the Royal Institution, which the labours of such eminent men as a Davy, a Faraday, and a Frankland have made, as it were, a classic temple and a fane of science.

Geological Society of London.—June 5, 1867.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The following communications were read:—

1. "The Alps and the Himalayas: a Geological Comparison." By Henry B. Medlicott, Esq., A.B., F.G.S.

Current opinions on Alpine geology were first fully discussed by the author, especially as regards the abnormal nature of the actual boundary of the Molasse with the rocks of the higher Alps, including the explanation usually given of this phenomenon, and of the contortion of the inner zone of Molasse, namely the direct upheaval of the main mountain-mass. Mr. Medlicott then described some of the sections exposed on the south flank of the Himalayas, and suggested a parallelism between them and those exhibited in the Alps. The clays, sands, and conglomerates of the Sivaliks are very like those of the Molasse; and in both regions the coarser deposits prevail towards the top. In the Himalayas also the younger Tertiary deposits almost invariably dip towards the mountain range which they fringe, the plane of contact inclining in the same direction, and thus producing actual, though not parallel, superposition of the older rocks. All the arguments which have been used to prove prodigious faulting in the case of the Alps would therefore, the author stated, be quite as applicable to that of the Himalayas. But, as regards the latter range, Mr. Medlicott brought forward evidence which appeared to him sufficient to prove that the present contact of the Sivalik formation with those mountains is the original one, modified only by pressure, without relative vertical displacement; and that the *sinking* of the mountain-mass is the proximate cause of the contortions of the Tertiary strata. He then endeavoured to show that this explanation is equally applicable to the Alps, especially as it seems also to account for collateral phenomena which appear difficult of explanation consistently with the ordinary hypothesis; and he concluded by discussing the current theories of the formation of lake-basins, in relation to the more immediate subject of his paper.

2. "On some striking instances of the Terminal Curvature of Slaty Laminæ in West Somerset." By D. Mackintosh, Esq., F.G.S.

Whilst engaged in investigating the nature and extent of oceanic and atmospheric denudation, and the origin of superficial accumulations in the West of England, the author observed, on the nearly level floor of one of the valleys which indent the Quantock Hills, the laminæ of Devonian (Carboniferous?) Slate, very regularly and distinctly bent backwards towards the south.

Sections near Wiveliscombe exhibited some interesting instances of the curvature of the laminæ, the line of demarcation between the commencement of the curving back and the undisturbed mass of slate below, being remarkably distinct and straight when looking along the strike of the cleavage; but upon looking at right angles to the strike, the surface formed by the edges of the laminæ beneath, though as distinctly marked, is very uneven.

At Raleigh's Cross other instances of the curvature are seen. The most important fact in connection with the sections was thus stated,—the bending and curving back over extensive areas has taken place on perfectly level ground with a declivity instead of an elevation on the side whence the movement must have come.

An exaggerated continuation of the general curving back is seen at Gupworthy, which at first sight appeared to be part of a denuded anticlinal fold. Instances, much less decided, have also been exposed in a cutting of the Exeter and South Devon Railway near Plymouth, and near Torquay.

In all parts of Devon, West Somerset, and Cornwall, if not in all districts were the slates are *flexible*, and where the cleavage laminæ dip at a considerable angle to the south, or where they are vertical, with an approximately east and west strike, similar appearances might be discovered, irrespective of the outline and inclination of the ground.

In the author's opinion the curving back of the slaty laminæ in this district must have been produced by a great weight of solid matter propelled in a southerly direction.

NORWICH GEOLOGICAL SOCIETY.—THE ORDER OF SUCCESSION OF THE PRE-GLACIAL, GLACIAL, AND POST-GLACIAL STRATA IN THE COAST SECTIONS OF NORFOLK AND SUFFOLK, (with especial reference to a section at Happisburgh, in Norfolk, and Corton, in Suffolk). By the Rev. JOHN GUNN, F.G.S.—Mr. George Maw, in an article "On the relative ages of the coast Boulder-clay of the Eastern Counties, and that of the higher ground,"[1] expresses his belief that there is no evidence of direct superposition of the high-level Boulder-clay upon that of the coast. "If," says Mr. Maw, "the higher clay were more recent than the lower, surely some cases would occur in which direct superposition was evident. But there is no coast section exhibiting the sequence of the high-level directly over the low-level clay, with the intervening sand bed." This statement excited surprise, because the author had repeatedly seen instances of such superposition in the cliffs of Corton and Horton, near Gorleston, in Suffolk; and because the late Mr. Trimmer, in a paper in the Quarterly Journal of the Geological Society, June 17, 1857, corroborated his observations. Additional evidence has been afforded by the recent fall of part of the cliffs at Happisburgh. An upper and a lower Boulder-clay, with stratified sands and clays intervening, have been exposed about a quarter of a mile north of the Preventive Service Station, beginning where the cliffs rise to an eminence of 50 feet, and extending three-quarters of a mile to where they are denuded to a lower level near Ostend.

The following is the section :—

| | | Feet. |
|---|---|---|
| No. 1 | The Warp ... ... ... ... ... ... | 4 |
| 2 | Post-glacial sand, clay, and gravel ... ... ... | 14 |
| 3 | Upper Boulder-clay ... ... ... ... ... | 10 |
| 4 | Middle drift ... ... ... ... }<br>Stratified clay and sand ... ... } | 8 |
| 5 | Lower Boulder-clay ... ... ... ... ... | 9 |
| 6 | Laminated series ... ... ... ... ... | 4 |
| 7 | Forest bed on the beach | |
| | | 49 |

This section corresponds with that at Corton, and as they represent the several strata in their normal and undisturbed condition, the study of them may serve as a key to their highly disturbed and contorted state near Cromer.

With respect to (No. 2) the Post-glacial sand, clays, and gravel, from their position immediately above the upper Boulder-clay, they might be expected to yield the remains of the *Elephas primigenius;* and such is the case. Mr. Gunn had obtained a good upper molar from this same bed in the parish of Witton, about two miles inland. The teeth and bones fall from these upper Pre-glacial beds upon the beach, and become intermixed with those derived from the forest bed, and their occurrence led the late Dr. Falconer to infer that the *E. primigenius* was a denizen of the forest bed.

Mr. Gunn gave a general account of the Glacial Beds and the Laminated Beds, and then made some observations on Mr. Taylor's recent researches on the Crag Fossils.

[1] See GEOL. MAG. Vol. IV. March, 1867, p. 97.

Admitting fully the correctness of Mr. Taylor's observations with respect to the increasingly Arctic character of the shells found in the Upper Crag at Bramerton, Thorpe, Horstead, Weybourne, and other places, and also with respect to the increasing depth of the sea in which they were deposited, he stated that a question arose as to the position and sequence of stratification of the Forest Bed, so rich in Mammalian remains. On the one hand, the abundance of the Mastodon in the true Norwich Mammaliferous Crag forbids us to imagine that the Forest Bed, in which no remains of the Mastodon have been detected, could have preceded that Norwich crag. On the other hand, the Arctic character of the shells in the Upper bed forbids us equally to believe that it could have succeeded that deposit, and yet all these several beds have hitherto been massed together under the name of Norwich Crag. This difficulty in assigning its true position and place to the Forest Bed is greatly augmented by the increase of depths of water in which the upper bed of shells has been deposited. Either the Forest Bed must have preceded the Mammaliferous Norwich Crag, which abounded with the Mastodon, or else there must have been oscillations of level of land and water, and change of climate, to admit of a forest flourishing for ages, as appears from the profusion and variety of Mammalian remains. The only alternative seems to be to dissociate the Mastodon Crag, which is confined to the layer of large stones upon the Chalk, altogether from the upper beds of Crag-shells, and to place the Forest Bed next in order above the Mastodon Crag, and the upper beds of Crag-shells in the marine part of the laminated beds.

In justice to Mr. Searles Wood, jun., he mentioned that that gentleman concurred in placing the Chillesford Crag and also the upper Weybourne Crag in more recent beds than the Mammaliferous Norwich Crag; as recent as the Lower Drift, but Mr. Wood appears to place the drift at an earlier period than Mr. Gunn did, and to include the laminated beds and the Forest Bed in it, so that the difference between their views was more nominal than real.

He had some doubts as to where to draw the line between the true Mammaliferous or Mastodon Crag and the Upper bed; but he was certain the Forest Bed could not have come after the Upper Crag unless there was a change of climate or of level. He had no doubt that the Chalk hills, upon which the Mastodon lived, remained exposed as a land-surface, for a long period, and in this opinion he was supported by Dr. and Mr. H. Woodward. The Forest Bed was a most important stratum, as it made us acquainted with the fauna and flora of an ancient terrestrial epoch of considerable duration.

The Rev. J. Crompton, M.A., read a paper on Lake Dwellings, as described by Herodotus, (Lib. V. c. 16).

Cotteswold Naturalists' Field-club.—At the annual meeting of this Club, Sir W. V. Guise, Bart., in the chair, about thirty members assembled. Sir William Guise was unanimously re-elected as President. The re-election of Dr. Paine, as Honorary Secretary, was also proposed and carried.

The financial statement was passed, and some dissatisfaction was expressed that members should allow their subscriptions to be in arrear.

Sir W. Guise then proceeded to read the annual address, which was principally a *resumè* of the field meetings and proceedings of the past year. Allusion was made to a letter received by the President from Mr. C. Moore, of Bath, on the much-mooted question of the Infra-liassic beds of the West of England, and which had induced the members to select Dunraven as one of their places of meeting (on August 21st). During the disscussion which ensued, Dr. Wright objected strongly to the term "Infra-lias," and Mr. Etheridge took exception to that part of Mr. Moore's paper which referred to the range of *Gryphœa incurva*, at Brocastle, but especially at Southerndown, which he believed, after examining the specimens, were not *G. incurva,* the true type of which occurs in the *Bucklandi* beds above, and in those immediately succceeding the Liassic beds in the Southerndown section. The occurrence also of *Plicatula intusstriata* in the zone of "*A. angulatus*" should be expected; for although an abundant and typical shell in the Rhætic beds below (everywhere in England and on the Continent), still the persistency with which deep-sea species were found to live on, —especially the *Ostræadœ,*—would excite no wonder that so few were found in common even in one formation. The Brocastle and Dunraven areas are fraught with the greatest difficulty, both on physical and palæontological grounds. Much has yet to be done in this area, and the Cotteswold Club are right in preparing to make this spot the scene of one of their visits, to explore for themselves, and look into the vexed question of the occurrence of "Muschelkalk" species in the so-called "Infra-lias" beds of the West of England and Wales.

A paper by Professor Buckman was then read, on Roofing Tiles of Roman date, which were discovered during some excavations at Bradford Abbas.

At the request of the President and some of the members present, the Rev. Mr. Symonds read a paper on the celebrated address delivered by Dr. Hooker, at the British Association Meeting at Nottingham, and the opinions of that distinguished botanist on the "Theory of the Origin of Species," by Mr. Darwin.

Dr. Wright said that, although a consistent opponent to Darwin's theory on the "Origin of Species," he rejoiced that the days were passed when the *odium theologicum* was applied to scientific investigations. He then entered into his reasons for opposing the theory on palæontological grounds, and gave an eloquent description of the persistence of living species of corals in the Western Ocean, where existing coral reefs were ascertained, by the careful investigation of Agassiz, to be more than *seventy thousand* years old. How then did it happen, that during all that lengthened period the species remained unchanged.

Mr. Etheridge did not think Palæontology alone would solve this intricate question: so many links were broken, so much of past life lost, never to be restored. He believed that Mr. Darwin and Dr. Hooker were right in their mode of investigation, and that the records of Insular and Arctic floras, combined with the aid given by fossils, may yet solve the problem which so interests every scientific man, since the publication of Mr. Darwin's work, and the results arrived at by Dr. Hooker.

Montreal Natural History Society.—The last meeting of this body for the session of 1866-67, was held at its rooms on April 29th. Principal Dawson read a paper "On Insects from the Carboniferous and Devonian Formations." Up to last year no remains of insects had been found in the Coal-fields of Nova Scotia, except a single head and small portions of a large insect found in the excrement of a reptile, which, along with other animal remains, were found in the trunk of a tree at the Joggins. This specimen seemed to indicate that the coal reptiles were insectivorous creatures. Last year Mr. James Barnes was fortunate enough to find the wing of an insect, in a bed of shale at Glace Bay, Cape Breton. Mr. Scudder, an eminent entomologist at Boston, considers that it belongs to the *Ephemera* group, and that is is a Neuropterous insect closely allied to the day and shad flies. The insect appears to have been of large size and it seems not improbable that this species may have haunted the swamps of the period, and have been preyed upon by Carboniferous fishes. Wings of four species of insects have been found by Mr. C. F. Hartt, in the plant-bearing Devonian shales, of St. John, New Brunswick. These are of considerable interest to the geologist, as being the oldest fossil insects known; the antiquity and exact date of the beds from which they are procured being unquestionable. These insects also belong to the Neuroptera, and seemed allied to the *Ephemera*. Like many other insects, they appear to have had a mechanical apparatus on their wing for producing sound, the structure of which was explained in detail. They appear to be a connecting link between the Neuroptera and Orthoptera.—*Montreal Gazette,* May 1, 1867.

## CORRESPONDENCE.

### DRIFT OF THE EASTERN COUNTIES.

*To the Editor of the* Geological Magazine.

Sir,—There are one or two facts which I think are serious objections to the view Mr. Maw has taken as to the age of the Cromer beds. The first is, that there does not exist along the Norfolk coast any such *continuous* margin of comparatively low ground as his paper would seem to imply. On the contrary, some portions of the cliffs are, I believe, as high as any part of the watershed of East Norfolk, and, as a rule, higher.

For example, at Trimmingham, one of the highest points of the coast and of the county, the spire of the Cathedral at Norwich, standing in the valley there but a few feet above the level of the sea, and more than twenty miles from it in a direct line, is visible across a comparatively low country. I am not aware of any point inland, equally distant, from which it can be in the same manner seen. Other similar cases could be given. A reference to the Ordnance maps will show that the only line of hills which presents the appearance of an old coast line, at a higher level than the cliffs, is that which runs due west from Cromer; but this is distinctly intersected by the present coast line at the Lighthouse Hill, and certainly, the beds under discussion do not show there any signs of disappearing. From this point to Hasbro' the country very often slopes inland from the cliffs, and in a southerly direction is comparatively flat.

The rapid and unceasing encroachment of the sea along the Norfolk coast should also be remembered. Mr. Gunn gives an instance where ninety yards of the cliff have been swept away in thirty-five years; and I do not know any reason why this may not have been going on at a more or less rapid rate, perhaps from the very commencement of the present period. It will be thus seen that the present coast-line is a purely accidental one, and cut across what may have been once almost the centre of the county.

A very satisfactory reason can be given for the absence of the Boulder-clay (upper drift) from the coast section between Hasbro' and Weybourne; and that is, it has been completely denuded from the northern part of the county, as shown in Mr. Wood's map.

I am not aware of a single outline existing north of a line joining Hasbro', North Walsham, and Holt. I ought to say that Mr. Gunn thinks the Upper Drift does appear in the cliff at Hasbro'. I am sorry that I am unable to agree with him in this, but if it does occur there, it settles the question.

I am, yours truly,

F. W. Harmer.

Heigham Grove, Norwich,
*June* 4, 1867.

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*To the Editor of the* Geological Magazine.

Sir,—All I need say in reference to Mr. Maw's remarks is, to suggest that he give some sections drawn from his supposed high level Boulder-clay to that on the coast. I do not mean a hypothetical section like that at page 98, of vol. iv., but actual sections drawn to not less than half the horizontal scale of the Ordnance map (half-inch to the mile), and showing all the places marked on that map along the line taken. To have any value at all, such sections should show every bed, from the Crag upwards, that may come to the surface *en route*. Of these sections, two at least would be required: one from Norwich to some part of the coast section between Hasboro' and Weybourne; and another from Norwich to the Boulder-clay of Pakefield and Corton cliffs.

I hope that Mr. Taylor may succeed in obtaining recognizable specimens of shells from the Middle Glacial beds, so as to afford the means of comparison with those obtained from Macclesfield; for although I have examined hundreds of sections in this formation, from Leicester to Chelmsford, and from Buckingham to the East Coast, I never until lately succeeded in obtaining a reliable shell. I recently, however, found two perfect specimens of *Ostrea edulis* in the Middle Glacial gravel, above the Brick-clay, in the disused brick-field at Stevenage. Any one having local opportunity would do good service by hunting this locality before the field is levelled and closed up, which is now being done.

As *O. edulis* is not an arctic shell, and occurs as far south as Gibraltar, its presence, as far as it goes, accords with the other characters of this formation in shewing that the Middle Glacial was not an arctic deposit.

Yours faithfully,

SEARLES V. WOOD, JUN.

BRENTWOOD, ESSEX, *June* 7, 1867.

P.S.—The obscure specimens of shell obtained from Saxlingham, Mr. Taylor will, I think, find belong, not to the Middle Glacial, but to the Chillesford beds (*i.e.* his Upper Crag), which are present there in a feeble form resting on the Chalk. Those obtained by him from Sprowston I presume are from the Middle Glacial sands, as the Upper Drift does not occur, to the best of my knowledge, at, or within, some four or five miles of that place. Perhaps, however, he may refer to some small outlier that Mr. Harmer and I have missed, or, possibly "Upper" may be a misprint in his letter for "Lower."

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## ON THE NATURE OF EOZOON.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—Having been engaged for some time on a paper on classification, with especial reference to the Mollusca, I had already in the introductory part of it written the greater part of what follows when I read in the GEOLOGICAL MAGAZINE an abstract of a memoir by Dr. Dawson on *Eozoön*. As it may be some time before my paper just referred to is ready for publication, I send you this part of it at once.

It will doubtless be some time before the true relations of *Eozoön Canadense* are finally settled. But before Mr. Hancock's paper on "Boring Sponges"[1] appeared, I was decidedly of opinion that the *Eozoön* had nearer relations with the Sponges than with the Foraminifera. That paper has quite confirmed me in this view; for Mr. Hancock shows the great similarity which exists between the disposition of the cells and sarcode in *Cliona* and *Orbitoides*. The latter genus was chosen by Dr. Carpenter for comparison with *Eozoön* to show the foraminiferal nature of the latter, and Mr. Hancock might fairly have carried on his comparison to *Eozoön*. Any one who compares the figures accompanying Dr. Carpenter's memoir on *Eozoön* in the Quarterly Journal of the Geological Society with Mr. Hancock's diagram of *Cliona*, will not fail to be struck by the similarity. Doubtless the *Eozoön* is allied to *Rhizopoda* as well as to the

[1] Ann. and Mag. Nat. Hist., 3rd ser. vol. xix. p. 229.

Sponges. And this is precisely what we might expect in so ancient a form. For it is well known that the more ancient forms often blend the characteristics of types, or as Dana expresses it, they are "comprehensive types." In this way *Eozoön* may, to some extent, comprehend the characters of *Rhizopoda* and *Spongiadæ.* Without committing myself, however, to all the generalizations, frequently extremely hazardous, of the celebrated American geologist, I may remark that all this is perfectly compatible with the doctrine of descent with modification, and that that hypothesis is the only one yet propounded which satisfactorily explains these alliances.

I find myself completely borne out in my views on the nature of *Eozoön* by the discovery by Principal Dawson of siliceous spicules in the cells of that organism. It is true, that able palæontologist attributes these spicules to a sponge which has filled the cells of *Eozoön* subsequently to the death of the latter. But I think, in view of the resemblance between the structure of *Eozoön* and that of the boring sponges, that the hypothesis of Dr. Dawson is wholly unnecessary, and that there is no difficulty in attributing the spicules to the *Eozoön* itself.—I am, Sir, your obedient servant,

R. Lechmere Guppy.

Port-of-Spain, Trinidad,
*3rd June*, 1867.

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## SHELLS ON THE GREAT ORMESHEAD.

*To the Editor of the* Geological Magazine.

Dear Sir,—In the paper on "*Glacial Action near Llandudno,*" in the July number of the Magazine, Mr. Bonney (page 290) notices the occurrence, in the surface deposit at Gwydfyd, on the Great Ormeshead, of quantities of shells. It is worthy of remark that there are none but those of eatable species,—*Patella vulgata, Littorina littorea, Mytilus edulis, Ostrea,* and *Tapes.* I obtained examples here in November, 1864, when their extreme profusion, and the way in which they occurred, convinced me that they had been brought there by the hand of man. I find from a section I made at the time, from the pier at Llandudno to the top of the Ormeshead, that the shell bed occurred at a height of 380 feet above the sea. The accumulations of the subaërial loam which covers it would seem to imply very great antiquity in relation to the human period; but it is evidently quite a different deposit to the Boulder-clay that occurs on the coast at the bottom of the valley, here limited to a range of about 170 feet above the sea (it terminates close to the lowest fence).

Similar clay with transported boulders forms a terrace of about the same height on the south side of the Head, and attains a somewhat greater elevation on the flanks of the Little Ormeshead.

Whilst suggesting that the Gwydfyd shell-bed is of artificial origin, I do not wish to call in question the evidence Mr. Bonney brings forward in proof of Glacial action, as drift with transported and striated boulders is abundant in the neighbourhood, especially on the east side of Orme's Bay. There is also a good section containing shells about midway between the Bay and Bryn Gosol, not far from the turnpike-road. Whilst referring to this district, Mr. Mackintosh's paper suggests my pointing out an example of a higher coast level, as indicated by Pholas-borings. A friend informs me that he has seen these markings high up on the mountain to the west of Conway, but I have no record of their exact altitude.

Referring to Mr. Green's letter, I would remark that the Llandudno district affords clear evidence of the superposition of Glacial drift on the white sands or clays resting on the Carboniferous Limestone; though, it must be admitted, this is not so obvious in Staffordshire. Regarding the source of materials, the broken chert beds that are near Llandudno associated with these deposits, seem to indicate a derivation from the Millstone Grit which, along the north coast of Wales, contains extensive beds of chert. The Bunter beds in North Wales are so invariably red that I scarcely think it probable they can have supplied any materials for the white beds underlying the Boulder-clay drift in that district.

George Maw.

Benthall Hall, Broseley,
*July 2nd*, 1867.

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## SOME REMARKS ON THE REPORT OF PROFESSOR OWEN'S PAPER ON FISH REMAINS FOUND IN THE NORTHUMBERLAND COAL-FIELD.[1]

*To the Editor of the* Geological Magazine.

Sir,—I beg to be allowed to make a few remarks on the Report which appeared in the July number of the Geological Magazine of Professor Owen's paper, "On the Dental characters of Genera and species, chiefly of fishes, from the Low Main Seam and shales of coal, Northumberland," (read before the Odontological Society on the 3rd of June last).

I have been engaged for many years in collecting fish and other remains from the Northumberland Coal-field, and have obtained a vast number of specimens, both entire and fragmentary, from the shale in connection with the Low Main Seam at Newsham, West Cramlington, and other places. Mr. T. Craggs, who was cognizant of my operations, gathered, a short time ago, a few specimens of fish-remains, principally teeth, from the same localities; and sent prepared microscopical sections of some of them to Professor Owen, who has, from these materials, described twelve or thirteen new genera, several of which I believe to be founded upon remains previously described, while others are, apparently, the result of an examination of the varied sections of the same forms.

I believe there are no remains noticed in Professor Owen's list, so far as the concise account in the Report enables me to judge, of which there are not numerous specimens in my collection; and as I have had the advantage of examining these under varied conditions—not merely of sections—I am in a position to speak with some degree of

[1] See Geol. Mag., July, p. 323.

confidence on the subject, having made numerous sections of them in well-determined planes. The specimens submitted for examination appear to have been all very minute examples of their respective kinds, or Prof. Owen would not, I feel sure, have asserted that these "minute fishes" were "of the size of minnows or sticklebacks." Most of these remains have belonged to fishes of no inconsiderable size, some of them, I believe, to the largest fishes of the Coal-measures. The following genera, proposed by Professor Owen, seem to require particular notice :—

Genus I. *Dittodus.*—This is undoubtedly *Diplodus* of Agassiz, and is not a tooth but a dermal spinous tubercle.—I have in my collection vast numbers of such, some detached, others in connection with a thin layer of granular matter, which there can scarcely be any doubt is the skin of some fish. One of these patches in my possession is fifteen inches long and about seven wide. On this the tubercles are comparatively few, and are scattered far apart from each other. But on another patch, measuring fifty-six inches square, they are very numerous, and are crowded together without any apparent order.

These tubercles are analogous to the spinous dermal tubercles found on some of the Rays, only in the Ray there is but one spine, while in that under consideration there are usually three, sometimes two, and rarely only one; when three are present, one is always much smaller than the other two, and rises from the common bony base behind them and opposite to the space between them. So that in making a section to exhibit the two principal spines it is almost impossible to preserve the small posterior one; consequently it happens that only the two large spines are seen united at the base—"the two crowns" as Professor Owen expresses it, being "organically connected together, like the Siamese-twins."

*Diplodus* varies very much in size, being occasionally quite microscopic, and not unfrequently measuring nearly three-quarters of an inch in length. It also varies considerably in character, the spines, or 'crowns' being frequently long, nearly parallel, and comparatively slender; occasionally they are found diverging, short, stiff, and much bent; numerous specimens occur having characters intermediate to the two extreme forms; there can, therefore, be no doubt that *Dittodus parallelus* and *D. divergens* are mere varieties, the one of the other.

Genus II. *Mitrodus.*—This, I believe, will also prove to be a dermal tubercle. There are occasionally found in the Low Main shale thin layers or patches almost entirely composed of minute compressed bodies, having rising up from their upper or free margin from two to seven conical denticles, which answer very correctly to the account given of this form. I possess such a patch measuring 20 inches long and 13 inches wide. It is spread over with vast multitudes of these tubercular bodies, which are crowded together in a confused manner. Detached specimens of the tubercles also occur.

These tuberculated patches are usually associated with the spines and other remains of *Gyracanthus*, and are most probably the skin of that fish. Thus it would appear that *Mitrodus*, instead of belonging to a fish of the size of a minnow, is most likely part of one of the largest, if not the very largest, fish of the Coal-measures. *Dittodus* too—as the size of the dermal patches proves—was an animal of no mean dimensions.

Genus III. *Ageleodus*.—This is the *Ctenoptychius* of Agassiz. It occurs of various sizes, and is sometimes minute; but it is frequently upwards of three-tenths of an inch wide, and is usually found detached, though sometimes two are placed end to end; this form has also much the appearance of being a dermal tubercle rather than a tooth. It is much compressed, and the spines, or "dental crowns," which vary in number from six to sixteen, give to the upper margin a saw-like denticulation. The bony base, giving support to the denticulated portion is, of considerable extent, and has all the appearance of the basal limb of a dermal tubercle.

Genus IV. *Ganacrodus*.—Teeth tipped with enamel are very common in the shale of the Low Main Seam; they vary greatly in size, though not in other respects, but when seen in section they seem to differ considerably. Their apparent curvature depends entirely on the plane of the section, and the point becomes more or less obtuse as this is further from, or nearer to, the axis of the tooth. The apparent extent and form of the enamel-tip also varies much in accordance with the section. Some specimens are entirely coated with a thin film of enamel; in others, traces of it only can be observed; and in some again, it seems entirely wanting, owing apparently to the state of preservation of the specimen.

I have little hesitation in saying that all these teeth tipped with enamel found in the shale overlying the coal of the Low Main Seam at the localities before-mentioned, belong to *Palæoniscus*—the teeth of which genus are always thus tipped with enamel, as I have satisfied myself by sections of several jaws, with the teeth attached, taken from well authenticated specimens.

That *Palæoniscus* occurs abundantly in this shale I have ample proofs, having taken from it well preserved individuals of this genus, besides numerous fragmentary specimens. The teeth of *Amblypterus* and *Pygopterus* are likewise tipped with enamel, but the latter genus has not yet been found in the localities named. *Amblypterus* is very rare: the tooth of *Pygopterus* is extremely characteristic, and is readily distinguished by the obtuseness of the terminal enamel.

The teeth of *Palæoniscus* vary much in size in the same individual, some being quite microscopic, others comparatively very large. The minute ones are exceedingly numerous, and much crowded; the larger are few in number, and considerably apart from each other.

Genus V. *Ganalodus*.—There are two of this number. Genus 5, *Mioganodus*, and Genus 6, *Aganodus*, are probably all founded on teeth belonging to either *Palæoniscus* or *Amblypterus*, both of which genera occur in the shale connected with the Low Main.

Genus VII. *Pternodus*.—When a single spine of *Diplodus* is observed in lateral section, it has a heeled appearance, and in other respects agrees with the characters of this genus, so far as they are given in the Report. The variety of *Diplodus* with a single spine also exhibits the same peculiar feature.

The characters of the four other genera, described in the paper, are too concisely given in the Report to enable me to form any decided opinion respecting them, though I venture to think that more than one are apparently only varieties of previously described forms.

THOMAS ATTHEY.

GASFORTH, NEWCASTLE-ON-TYNE,
*July* 15, 1867.

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## THE WEAVER CLAYS.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—When I paid my first visit to the Ribden Fire-clay Pit several years ago, I formed pretty much the same opinion as that now held by Mr. Green, viz., that the deposit consisted of local washings from surrounding strata, gathered into a wide fissure. I have since then, however, made many journeys to the district, and I have convinced myself, from a leisurely examination of *all* the openings which have been made in search of "clay," that the deposit is a very extensive one, and *truly of marine origin.* The beds extend over an area of nearly two miles in length, with a width varying from a quarter of a mile to a mile and a half.

Mr. Green is in error in attributing the parentage of the sands and clays to the Bunter. The greater portion of the deposit has certainly been derived from the Millstone grit strata that still prevail so largely to the westward of Weaver. Immense blocks of grit, of different degrees of hardness and coarseness, are thickly embedded in the sands at Caldon Low, and they are to be seen in every state of degradation, from the hard unperished stone to incoherent sand, that merely shows where the blocks previously existed, by a slight difference of tint from that of the sand of the matrix. A very small percentage only of the sands of the deposit have been derived from the Bunter.

The sands in some parts of the deposit are as white as the best Alum Bay sand. They are so free from iron that, at my recommendation, they have been tried lately for glassmaking, and they have been found to answer very well. Bunter sand could scarcely, under any circumstances, have been washed sufficiently free from iron to stand this manufacturing test.

With regard to the "Boulder-clay Drift," I must state it to be my firm conviction that the red bed which overlies the "Weaver Clays," in some parts to the thickness of from twelve to fifteen feet, does really belong to that formation. It lies in many places where it could not have been deposited by subaërial action; it contains rounded and subangular masses of stone of many formations, and it has itself been subjected to after-denudation. It is also of similar character to the red clay that is seen to fill the fissures in Caldon Low, at a height of twelve hundred feet; and to be piled on the floor of Thor's Cave, at about nine hundred and fifty feet above the sea-level.

I do not understand Mr. Green's hesitation to admit that the sea covered the Derbyshire Limestone Hills at the Glacial epoch, for I read in the valuable Ordnance Memoir of the country round Stockport, Macclesfield, Congleton, and Leek, by Messrs. Hall and Green, and with the paragraph itself bearing the initials A. H. G., that "In an outlying patch of sand and gravel about three miles from Macclesfield, on the Buxton road, at a height of about twelve hundred feet above the sea, Mr. Prestwich found shells; and Mr. Sainter tells me that he has collected there *Turritella*, *Cardium edule*, and others." Now the point on the Axe Edge range here indicated is only about sixteen miles from Weaver, and the highest tops of the Weaver range are not more than about twelve hundred and twenty feet above the sea; the Weaver Clays and the Boulder Drift, the subjects of the present communication, lying at from one thousand to one thousand and fifty feet.

We have not yet found shells in the drifts of the neighbourhood; but we have every other proof that can be desired of their marine origin.

The chief geological interest that attaches to the "Weaver Clay" deposit is, that it proves a submersion of this part of the country at some period between the Triassic and the Boulder-clay epochs, at which latter period our hills were undoubtedly again sunk beneath the sea. I am, Sir, Yours faithfully,

Edwin Brown.

Burton-upon-Trent.
12*th July*, 1867.

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## THE LOB-WORM EPOCH.

*To the Editor of the* Geological Magazine.

Sir,—Mr. Baily (Figures of Characteristic British Fossils, p. 12) tells us that the only remains of animals in the Cambrian rocks (the oldest fossiliferous British strata) are those of worms; and (p. 3) that these worms were "allied to the recent lob-worm." It is true that he remarks (p.12) that "it has been argued, and with reason, that this apparent paucity of organic remains may have arisen from the nature of the deposit . . . and that there may have been a more varied assemblage of life during *this epoch* . . . as this, however, is necessarily conjectural, much importance cannot be attached to it." Now is the negative argument not also "conjectural?" and is it not a most absurd conjecture that because in certain marine strata, in a certain *place* in England, signs of no life are found save that of worms, that in the "epoch" or *time* when those strata were formed no animals existed on the terraqueous globe save worms? Is this not "conjectural?" and most absurdly conjectural? Continents from the denudation of which the Cambrian strata were formed must have existed for countless millions of years. And were these continents, and the land, and the water, of the whole terraqueous globe uninhabited, except by marine lob-worms? This is a curious *conjecture.* And it is founded on the most ridiculous confusion between *space* and *time*, between *place* and *period*, as I have argued throughout "Rain and Rivers."

Mr. Baily will not, I am sure, think that I intend to attack him. I attack the received doctrine which Mr. Baily supports; and I must confess that I am the twelfth juryman who complained of his eleven obstinate compeers.—I have the honor to be, Sir,

Your most obedient, and most obliged,
George Greenwood, Colonel.

Brookwood Park, Alresford,
19*th July*, 1867.

## OBITUARY.

William John Hamilton, F.R.S., G.S., etc.—It is with sincere regret that we have to record the loss which the science of geology, very many personal friends, its cultivators, and, above all, the Geological Society of London, has sustained by the premature decease of Mr. William Hamilton, a loss which can be but very imperfectly replaced, owing to his long official connexion with that Society, and his accurate knowledge of its affairs. Mr. Hamilton became a member of the Geological Society in 1831, and in the following year was elected one of its honorary secretaries, which office, or else that of Foreign Secretary, he continued to occupy almost uninterruptedly till 1854, when he was elected its President. Mr. Hamilton's first contribution to geology dates back to 1835, from observations made in the previous year, and relates to the proofs of recent elevation of the land, which he had observed on the coast of Fifeshire. About this time, and, as is generally understood, at the suggestion of the present Sir R. Murchison, Mr. Hamilton formed the plan of an extended foreign tour for the purpose of studying the phenomena of physical geography and geology; through him also he became acquainted with the late Mr. Hugh Strickland, which resulted in their becoming fellow travellers; the partnership was a judicious combination, and Mr. Hamilton constantly acknowledges the value of Mr. Strickland's great knowledge in various branches of natural history.

The limits of such a notice as the present preclude even a summary of Mr. Hamilton's travels. They were commenced in the summer of 1835. Beginning with the extinct volcanic districts and old lacustrine areas of the Mont Dor and the Vivarais, as preparatory to visiting those of Asia Minor, they thence passed by the North of Italy, Trieste, Corfu, Patras, Corinth, Athens. They reached Smyrna by the end of October, having visited much that was of interest on their way. Mr. Strickland was called back to England in the early part of 1836, after which Mr. Hamilton continued his travels alone, but some papers, the results of their joint observations, were communicated to the Geological Society.

The summer of 1836 was spent in the country to the south of the Black Sea, returning to Smyrna by November. He then accepted the offer of Mr. J. Brooke (now Rajah Brooke) of a cruise in the "Royalist," along the coasts of Ionia and Caria to Rhodes. This occupied till February, 1837, when, starting again from Smyrna, he visited for the second time the Katakecaumene, of which he gave an account, which was published in the transactions of the Society, as also another memoir on the Eastern portion of Asia Minor. The objects of Mr. Hamilton's travels were not, however, exclusively geological. The results were given in two volumes, as "Researches in Asia Minor: Pontus and Armenia, their Antiquities and Geology," to which reference must be made before a just estimate can be formed as to Mr. Hamilton's qualifications as an enterprising and accomplished traveller. The objects proposed were successfully carried out, and so far as he himself was concerned, the Eastern tour served to realize what as yet was undeveloped, gave him habits of observation, and of applying the varied education he had received, created a power of clear narration, and finally assigned to him a high position among modern English travellers. He possessed all the qualities which go to form a good traveller; he was unselfish, always adapting himself readily to circumstances, and a good companion; moreover, he was an accomplished linguist. Spanish, French, Italian, and German were as familiar to him as his own language.

Mr. Hamilton was elected President of the Geological Society for the second time in 1865. His later contributions to Geology were on Tuscany, and the best account that has yet been given of the Eocene basin of Mainz was the result of his examination, and of the large collection of the fossils he formed there in 1852. For some years he had devoted much time and expense to recent conchology, under a sense of the dependence of the history of the "Tertiary period" of geologists, on a knowledge of existing forms of shells, and their geographical distribution, with which objects in view he had already formed a very large collection. It was in the hope that he might some day turn this knowledge to the service of geology that he joined in the excursions which several of his fellow members of the Geological Society made into the districts of the Faluns of Touraine, and of the crag of Antwerp.

Mr. Hamilton was an active Fellow of the Royal Geographical Society—he was elected president for the years 1848 and 1849, and has served on the Council for many years. He contributed the article, "Geography" to the Admiralty Manual of Scientific Inquiry, edited by Sir John Herschel.

Mr. William Hamilton was the eldest son of Mr. Hamilton, sometime British Minister at Naples, and author of Ægyptiaca; was born in 1805, educated first at the Charter House, and subsequently at the University of Gottingen. At the outset of his career he served in the foreign Diplomatic Service at Madrid, Paris, and Florence. He was *prècis* writer at the Foreign Office under Lord Aberdeen, and resigned it on his election for Yarmouth. Mr. Hamilton was twice married; his second wife, who survives, was the Hon. Helena Dillon, youngest daughter of Viscount Dillon.—R. G-A.

THE
# GEOLOGICAL MAGAZINE.

No. XXXIX.—SEPTEMBER, 1867.

## ORIGINAL ARTICLES.

### I.—On Some Remains of Palæozoic Insects recently discovered in Nova Scotia and New Brunswick.

By J. W. Dawson, LL.D., F.R.S., F.G.S.,
Principal of McGill's College, Montreal, Canada.

(PLATE XVII., FIGS. 1–5.)

In connection with the preparation of the second edition of "Acadian Geology," I have obtained, from friends who have been engaged in geological investigations in Nova Scotia and New Brunswick, some interesting illustrations of the entomology of the Carboniferous and Devonian Periods, which I have thought it might be useful to publish in advance of the appearance of my work.

1. *Carboniferous Insects.*—The existence of insects in the Carboniferous period has long been known. The Coal-formations of England and of Westphalia afforded the earliest specimens; and, more recently, some interesting species have been found in the Western States.[1] They belong to the orders *Neuroptera* (shad-flies, etc.), the *Orthoptera* (grasshoppers, crickets, etc.), and *Coleoptera* (beetles, etc.).

In the Coal-field of Nova Scotia, notwithstanding its great richness in fossil remains of plants, insects had not occurred up to last year, except in a single instance—the head and some other fragments of a large insect, probably Neuropterous, found by me in the coprolite or fossil excrement of a reptile enclosed in the trunk of an erect Sigillaria at the Joggins, along with other animal remains. This specimen was interesting, chiefly as proving that the small reptiles of the Coal-period were insectivorous, and it was noticed in this connection in my "Airbreathers of the Coal-period." Last year, however, Mr. James Barnes, of Halifax, was so fortunate as to find the beautiful wing represented on Plate XVII., Fig. 1, in a bed of shale, at Little Glace Bay, Cape Breton. The original engraving was taken from a photograph kindly sent to me by Rev. D. Honeyman, F.G.S. It will be observed that in consequence, probably, of the mutual attraction of loose objects floating about in water, a fragment of a frond of a fern, *Alethopteris lonchitidis*, lies partly over the wing, obscuring its outline, and bearing testimony to its Carboniferous date. The wing has been examined by Mr. Samuel H. Scudder, of Boston, who has made such specimens his special study, and who refers it to the

[1] See Lyell's Elements, and Dana's Manual, for references.

group of *Ephemerina* (day-flies, shad-flies) among the Neuroptera, and has named it *Haplophlebium Barnesii.* It must have been a very large insect—seven inches in expanse of wing—and, therefore, much exceeding any living species of this group. When we consider that the larvæ of such creatures inhabit the water, and delight in muddy bottoms rich in vegetable matter, we can easily understand that the swamps and creeks of Carboniferous Acadia, with its probable mild and equable climate, must have been especially favourable to such creatures, and we can imagine the larvæ of these gigantic Ephemeras swarming on the deep black mud of the ponds in these swamps, and furnishing a great part of the food of the fishes inhabiting them, while the perfect insects, emerging from the waters to enjoy their brief space of aerial life, would flit in millions over the quiet pools and through the dense thickets of the Coal-swamps. Mr. Scudder describes the species as follows:—

*Haplophlebium Barnesii,* Scudder (Plate XVII. Fig. 1).—This is probably one of the *Ephemerina,* though it differs very much from any with which I am acquainted. The neuration is exceedingly simple, and the intercostal spaces appear to be completely filled with minute reticulations without any cross-veins. The narrowness of the wing is very peculiar for an *Ephemeron.* The form of the wing and its reticulation remind me of the *Odonata,* but the mode of venation is very different; yet there is apparently a cross-vein between the first and second veins in the photograph (not rendered in the cut) which, extending down to the third vein, occurs just where the "nodus" is found in *Odonata,* and if present would, unquestionably, remove this insecct to a new synthetic family between *Odonata* and *Ephemerina.* I cannot judge satisfactorily whether it is an upper or an under wing. The insect measured fully seven inches in expanse of wings—much larger than any living species of *Ephemerina.*

2. *Devonian Insects.*—The only known remains of insects of this age are the wings of four species found by Mr. C. F. Hartt, in the plant-bearing Devonian Shales of St. John, New Brunswick. The figures now given of these remains, taken from drawings made by Mr. Scudder, though they represent fragmentary specimens only, are of the highest interest, as the most ancient remains of insects known to us, and contemporary with the oldest known land flora; their age being probably about that of the Hamilton or Chemung formations of New York.

Their geological date is unquestionable, since they are found in beds richly stored with species of Devonian plants, and unconformably underlying the oldest portion of the Carboniferous series. These beds are fully described in a paper by Mr. Matthew, in the "Quarterly Journal of the Geological Society of London," and also in Professor Bailey's "Report on the Geology of Southern New Brunswick" — "Appendix A, on the Devonian Plant locality of Lancaster, by Mr. C. F. Hartt."

These insects, it will be observed, are of older date than the Carboniferous species previously noticed, and they bore the same relations to the land and the water of the Devonian which the former did to those of the Carboniferous period. They were all Neuropterous insects, and allied to the Ephemeras. It is interesting, however, to observe that, like many other ancient animals, they show a remarkable union of characters now found in distinct orders of insects; or constitute *synthetic* types, as they have been termed. Nothing of this kind is more curious than the apparent existence of a stridulating or musical apparatus like that of the cricket, in an insect otherwise allied to the *Neuroptera*. This structure also, if rightly interpreted by Mr. Scudder, introduces us to the sounds of the Devonian woods, bringing before our imagination the trill and hum of insect life that enlivened the solitudes of these strange old forests. Mr. Scudder has kindly furnished descriptions of these insects as follows:—

*Platephemera antiqua,* Scudder (Plate XVII. Fig. 2).—The direction of the principal nervures in this insect convinces me that it belongs to the *Ephemerina,* though I have never seen in living *Ephemerina* so much reticulation in the anal area as exists here—so, too, the mode in which the intercalary nervules arise is somewhat peculiar. It is a gigantic species, for it must have measured five inches in expanse of wings—the fragment is a portion of an upper wing.

*Homothetus fossilis,* Scudder (Plate XVII. Fig. 3).—At first sight the neuration of the wings of this insect seem to agree sufficiently with the *Sialina* to warrant our placing it in that family; but it is very interesting to find, in addition to minor peculiarities, that near the base of the wing, between the two middle veins, there is a heavy cross-vein from which new prominent veins take their rise; this is characteristic of the *Odonata,* and of that family only. We have, therefore a new family representing a synthetic type which combines the features of structure now found in the *Odonata* and *Sialina,* very distant members of the *Neuroptera.* The fragment is sufficiently preserved to show the direction, extent, and mode of branching of nearly every principal nervure. It is evidently a portion of an upper wing; the insect measured not far from three and a half inches in expanse of wings.

*Lithentomum Harttii,* Scudder (Plate XVII., Fig. 4).—This was the first specimen discovered by Mr. C. F. Hartt. I have therefore named it after him. Apparently it does not belong to any family of Neuroptera represented among living forms. It agrees more closely with the family *Hemeristina,* which I founded upon a fossil insect discovered in Illinois, than it does with any other; but it is quite distinct from that, both in the mode of division of the nervures and in the peculiar cross-veining. The fragment which Mr. Hartt discovered is very imperfect; but, fortunately, preserves the most important part of the wing. I am inclined to think that it was a lower wing. The insect probably measured three and a half inches in expanse of wing.

*Xenoneura antiquorum,* Scudder (Plate XVII., Fig. 5).—Although in this fragment we see only the basal half or third of a wing, the peculiar mode of venation shows that the insect cannot belong to any known family of *Neuroptera* living or fossil; yet it is evidently a Neuropterous insect. In addition to its other peculiarities there is one of striking importance, viz., the development of veinlets, at the base of the wing, forming portions of concentric rings. I have endeavoured in vain to explain these away as something foreign to the wings, accidentally introduced upon the stone, and I know of nothing to which it can be compared but to the stridulating organ of some male *Orthoptera!* It is difficult to tell whether the fragment belongs to an upper or an under wing. Its expanse of wings was probably from two to two and a half inches.

EXPLANATION OF PLATE XVII.—(Figs. 1–5).

Fig. 1.—*Haplophlebium Barnesii*, Scudder. Coal-shale, Little Glace Bay, Cape Breton, Nova Scotia. *a.* Profile of base of wing.
,, 2.—*Platephemera antiqua*, Scudder.
,, 3.—*Homothetus fossilis*, Scudder.
,, 4.—*Lithentomum Harttii*, Scudder.
,, 5.—*Xenoneura antiquorum*, Scudder.
Figs. 2–5 all from Plant-bearing Devonian shales, St. John's, New Brunswick.

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## II.—On the Remains of Insects from the Coal-Measures of Durham.

By James W. Kirkby.

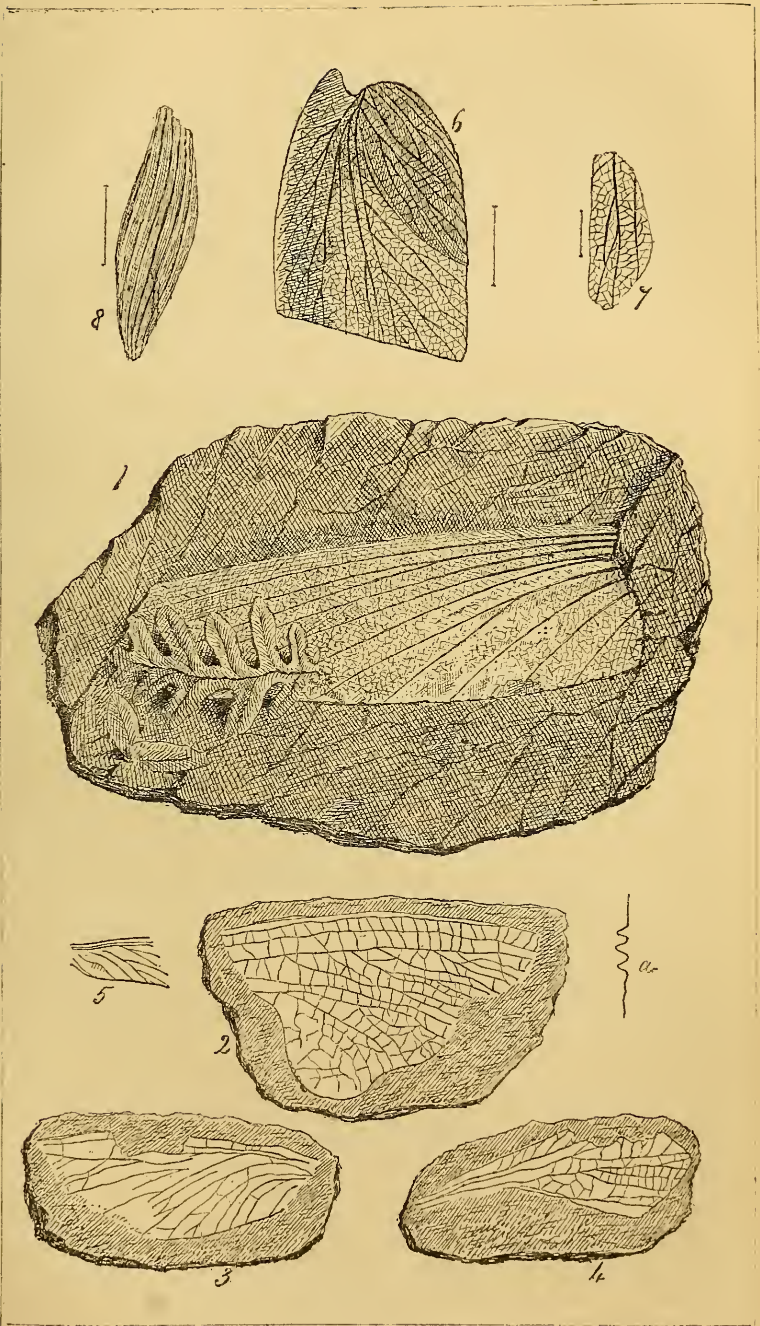
(Plate XVII., Figs. 6–8.)

As the remains of insects are rarely found in Carboniferous strata, a short account of three imperfect specimens, which have been discovered in the Durham coal-field, may not be deemed valueless. Indeed, with the exceptions of the specimens described from Coalbrook Dale by Prestwich,[1] twenty-five years ago, and the examples of *Xylobius sigillariæ* of Dawson,—discovered by Mr. Tindall, in the Lower Coal Measures, near Huddersfield,[2] and by Mr. Thomas Brown, of Stewarton, in the Upper Coal Measures of Kilmaurs,[3]—I am not aware of any other fossils of this class having been noticed as occurring in Carboniferous rocks in England.

The fossils under notice were found on the north bank of the Wear, opposite to Claxheugh, about two miles west of Sunderland. An upcast fault to the east brings into section a few of the higher beds of the coal-field, which the wash of the river has exposed in a low drift-covered cliff. About sixty yards from the fault there appears a few feet of dark-grey, compact, and fissile shale, containing three or four thin and irregular bands of clay-ironstone, from one of which the insect remains were obtained.

As the throw of the fault does not exceed seventy or eighty feet,—the upper portion of the Lower red Permian sandstone being the surface rock on the west side of the dislocation,—the position of the bands of ironstone cannot be very far below the base of the Permian series. Moreover, as the measures of this coal-field attain their maximum thickness in the vicinity of Sunderland—being more or

[1] Geol. Trans. 2nd Series, 1842, Vol. v., p 440.
[2] Trans. Lit. and Phil. Soc. Manchester, January 8th, 1867 ; and Geol. Mag., Vol. IV., No. 33, 1867, p. 132.
[3] Geol. Mag., March, 1867, p. 130.




G. R. De Wilde, fecit. Hailes & Co., Imp.

ENGLISH & CANADIAN PALÆOZOIC INSECT-REMAINS.

less denuded immediately to the north, west, and south—the ironstone must occupy a position very near to the top of the Coal-measures as developed in Durham and Northumberland.

I have, fortunately, been able to submit the specimens to the inspection of a good entomologist, Mr. T. J. Bold, whose observations thereon are freely used in the following brief descriptions.

The specimens drawn on Plate XVII., Figs. 6, 7, evidently belong to one species. The first is a very fine distinct example of the anterior portion of the fore-wing of an Orthopterous insect, which in form and neuration agrees generally with that of the recent genus *Blatta;* but although we have here the same produced, flattened fore-edge, much the same shaped disk, and lobed inner angle, still the sculpture between the nervures differs from that of the recent type, and approaches more nearly to that of the *Mantidæ.*

It is not unlikely that this fossil may prove identical with one of the species of *Blatta* or *Blattina* described by Germar[1] and Goldenburg[2] from the Carboniferous strata of Wetting, in Westphalia, and Saarbrück, near Treves, good figures of which I have not seen. To one of these, *Blattina primæva,* Jordan, it certainly approaches very closely, so far as may be judged from the woodcut given by Dana in his Manual of Geology, at page 357.

The shuttle-shaped specimen, Plate XVII., fig. 8, is difficult to determine. It approaches nearest in shape and neuration to the abortive anterior wing of some of the *Phasmidæ,* which are also Orthopterous insects; but it is impossible from such imperfect materials to speak with certainty on its affinities.

The combination of characters at present peculiar to distinct generic types, which is exemplified in fig. 6 in its double affinity to *Blatta* and *Mantis,* has been noticed previously in Palæozoic insects. Mr. S. H. Scudder has drawn attention to the fact, as being highly characteristic, of some remains of insects found in the Devonian rocks of New Brunswick, as well as of the other remains of the same class from the Carboniferous strata of Illinois. He observes that not only do some of these fossil species partake of the characters of different recent genera and families, but sometimes they unite those of two orders, as, for instance, those of the *Orthoptera* and *Neuroptera.* Of course the existence of such synthetic types among the higher articulates of the Palæozoic period is only perhaps what might have been foretold from a study of the more abundant fossils of other groups of the animal kingdom. But still it is instructive to witness the general tendency of discovery in palæontology to render this induction more clearly evident.

The ironstone containing the fossils is compact and grey, and was formerly wrought for smelting at a locality on the opposite bank of the river. It contains great quantities of a small, fragile fossil, which is almost disk-shaped or slightly ovate in outline, resembling *Estheria.* It has been described under the name of *Ancylus? Vinti;*[3] but it is evidently bivalvular, and belongs either

[1] Münster's Beitr., vol. v., pl. 13. [2] Dunker and von Meyer, Palæon. vol. iv., p. 17.
[3] Trans. Tyneside Field-Club, vol. vi., p. 221.

to the bivalve Crustaceans just named or to some of the Lamellibranch mollusca. The Entomostracans, *Beyrichia arcuata*, Bean, and *Cythere fabulina*, Jones and Kirkby, also occur, together with a few fish remains, a few stray *Anthracoptera*, and some fragments of plants.

EXPLANATION OF PLATE XVII.—FIGURES 6-8.

Figs. 6 and 7.* Portions of the fore-wing or *tegmina* of an Orthopterous insect nearly allied to *Blatta* or cockroach. From the Coal-measure opposite Claxheugh, near Sunderland.

,, 8. Part of an Orthopterous insect, apparently the abortive anterior wing of a species related to the *Phasmidæ*. From the same locality as the last.

* The original of Fig. 7 is in the collection of W. M. Wake, of Sunderland.

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## III.—Railway Geology, No. I.—From Exeter to Newton-Bushell and Moretonhampstead.

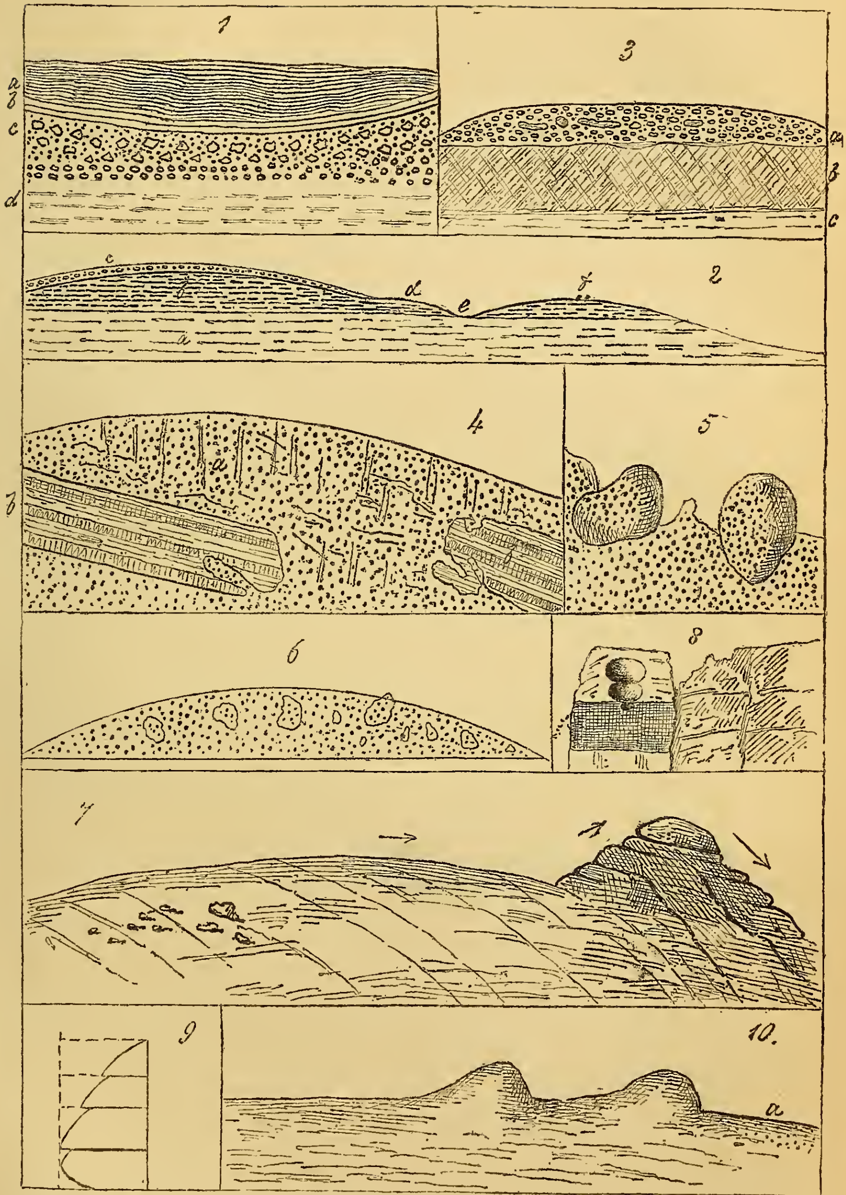
By D. Mackintosh, F.G.S.

(PLATE XVIII.)

THE district selected for this article embraces a very unusual variety of geological phenomena, consisting of different kinds of recent gravels and Tertiary deposits, Greensand table-lands and patches, Triassic sandstone and conglomerate, rocks belonging to the interval between the Trias and uppermost Silurian strata, trap, and granite.

From Exeter to Starcross the valley of the Exe widens into a plain, part of which is permanently occupied by the sea, the other part showing signs of an "unlimited liability to liquidation" during high tides and floods. On the right hand, at intervals, may be noticed a terrace of gravel. Near Alphington it is from ten to twelve feet thick, thinning out hill-wards. It consists of rounded fragments of carbonaceous grit, trap, Blackdown flints, etc., with lenticular patches of finer shingle, clay and sand, the latter sometimes exhibiting oblique lamination. Between Starcross and Dawlish the sea-beach is the most interesting phenomenon. During south-east winds the shingle is there thrown up against the railway wall to a thickness of many feet in the course of a few hours. In some places the shingle may be seen arranged in successive terraces corresponding to different tidal levels. At some height above the level of the railway, there are several fine sections of a gravel-covered old ocean-bed, commonly called a "raised beach."

*From Dawlish to Teignmouth.*—The railway here runs under a cliff of Triassic sandstone and conglomerate. The sea has left stacks and pillars, and hollowed-out recesses. The "Parson and Clerk" rock (seen best on looking northwards from near Teignmouth) is a fine specimen of an arched buttress with an adjacent slender column. The cliff, in places, has given way to gravitation, assisted by rain and frost, so as to originate combe-shaped hollows similar to many in neighbouring inland districts. Re-assorted pebble-beds may be traced on the top of the cliffs, but it is difficult to distinguish them from beds *in situ* unless where they fill up denuded hollows, or contain chalk




D. Mackintosh, delt., G. R. De Wilde, fecit. Hailes & Co., Imp.

TO ILLUSTRATE MR. MACKINTOSH'S PAPER ON

RAILWAY GEOLOGY.

flints. On the north and south sides of Dawlish Valley, near the sea-coast, there is a great thickness of gravel, which, at one time, may have extended continuously across. But to see the most instructive and easily-accessible sections of flint-gravel requires one to walk from Dawlish to Teignmouth along the old turnpike road, which cuts deep into the ridges by which the nearly parallel east and west valleys are separated. These cuttings expose Triassic sand, sandstone, and conglomerate, capped with flints mixed with re-assorted Triassic pebbles. In some places, beneath a layer of flint-gravel, there are detached flints deeply imbedded in curved, contorted, and oblique laminæ of sand. One section reveals flints and pebbles more or less stratified beneath re-deposited and finely-laminated Triassic sand (Pl. XVIII. Fig. 1, *a* laminated sand, *b* layers of light-coloured sand, *c* flints and pebbles, *d* Trias). Another section shows a mass of sand enclosing a patch of flint-gravel, and covered with re-arranged Triassic shingle and flints, the lower parts stratified. It is clearly impossible to explain the interweaving of flint-gravel with Triassic sand and shingle displayed in the above sections, without having recourse to marine currents, possibly laden with icebergs. Rain will not account for it; and its situation, on or near the tops of ridges, precludes our referring it to streams or rivers. To the south of the valley which opens on the coast at the "Parson and Clerk" promontory, I could see no trace of flints, nor anywhere between there and Bishopsteignton; an important fact showing that the flints are not the mere down-lettings of a former gravel-covering, co-extensive with the Chalk, all the softer matter above the Trias having been washed away by rain.[1] This absence of flints from considerable spaces seems to indicate a sweeping denudation by locally-directed or locally-intensified currents which left flints on certain areas, and cleared them away from others.

*Little Haldon.*—Every geologist who travels by the South Devon Railway should walk from Dawlish (two miles) or Teignmouth (one mile and a half) to the top of Little Haldon, which is about 800 feet above the sea-level. On looking north from the high ground to the north of West Teignmouth church, this hill, with the spur it sends off towards the east, presents the outline seen in Pl. XVIII. Fig. 2, in which *a* is Trias, *b* Greensand and sandstone, *c* Flint-gravel. At *d* and *e* no flints could be seen. At *f* there were two rounded trap boulders (amygdaloid passing into a kind of porphyry) between two and three feet in diameter. Between Little Haldon and Teignmouth cemetery many trap boulders may be seen on the road-side. I could find no indications in this district of any rocks *in situ* between Trias and Greensand. The main hill (Little Haldon) presents a curved surface when viewed from the south, but in a direction north and south it is a perfectly level line, which, at a distance, excites the wonder of the beholder. On the sides of the hill I examined several pits, in which the gravel was at least ten feet thick. It consisted of flint and chert fragments more or less rounded,

[1] Sir H. de la Beche long ago noticed the absence of flints from large areas lying between flint-strewn surfaces as a difficulty in the way of the atmospheric theory.

with much-rounded pebbles of quartz, and of a dark, hard rock with quartz veins, which may be seen *in situ* on the borders of Dartmoor. There were likewise pebbles of slate, a coarse kind of sandstone, etc., but I could see no granite, though it has been found on Great Haldon (farther north) by Sir H. de la Beche and Mr. Godwin-Austen. The flints often appeared as if they had been gathered into groups. In a pit on the east side of the hill the flint gravel was underlaid by laminated Greensand, containing in its upper part blocks of chert graduating into more or less ferruginous sandstone. I failed to see beds of gravel sufficiently distinct to indicate separate periods of accumulation.

*Origin of Flint-gravel, etc.*—The north and south contour of the two Haldons is a horizontal line, which is generally admitted by geologists to be a sure indication of a sea-bottom; and this line is roughly on a level with the table-lands of the Blackdowns. That both were parts of a formerly-continuous ocean-floor, and that the plains and valleys now separating them were excavated by water, is likewise generally believed.[1] As regards the Haldons the rounded stones, some of them transported, which compose part of the gravel, show that it is not a subaërial accumulation; and Mr. Godwin-Austen long ago noticed its resemblance to marine shingle. But this shingle is continued down the slopes on both sides of Little Haldon, showing that the sea not only formed the level summit line, but likewise (during a continuance of the same submergence, or during a subsequent submergence of the land) the surface of the slopes. That marine denudation extended down the sides of Little Haldon is also shown by the fact that (excepting where there are combes) at equal depths below the summit line the surface presents a succession of north and south horizontal lines to a spectator situated at distances too near to admit of the summit being seen. If so, where are we to fix the downward limit of marine denudation? The sides of many ridges and valleys in Devon present a series of longitudinally-straight lines. Transversely they are regular geometrical curves, which cut the more or less upturned edges of the strata. This is the case, not only with the Trias between Dawlish and Teignmouth, and between Teignmouth and Bishopsteignton, but likewise with many limestone undulations near Torquay, and between Newton-Bushell and Totnes. In most quarries and railway-cuttings in south-east Devon the unweathered Trias, and especially the limestone, comes up within two or three inches of the surface. Some will probably regard this uniform smoothing and rounding off as the work of grounding and grinding icebergs. Others may lean to the idea of a great flow of land ice, similar to that now moving over a great part of Greenland.

*From Teignmouth to Newton-Bushell.*—The Triassic strata on the right-hand side of the railway, though not much inclined, show no conformity to the shape of the lateral valleys which open into the

[1] Sir H. de la Beche and Mr. Godwin-Austen both believed that the excavation of the valleys commenced later than the distribution of the gravel on the ancient Blackdown and Haldon area.

estuary of the Teign, proving that these are valleys of excavation, and not of depression. Beyond Bishopsteignton the railway cuts through what has been called Carboniferous slate passing into limestone. The surface is here covered with gravel containing flints, which may have come from Little Haldon, or from Milber Down on the opposite side of the estuary. It would be very interesting to obtain sections which would corroborate Mr. Godwin-Austen's statement that a flint gravel extends under the Bovey formation farther on, as this would prove the gravel to be of pre-Miocene age. A very remarkable deposit of regularly-stratified flints and sand has lately been exposed near the summit of Woolborough Hill, south of Newton-Bushell, where Greensand is represented on the Ordnance Map. The beds must originally have been horizontal, but they now dip eastwards at a very high angle, showing that since their deposition, considerable changes of surface-configuration, resulting from elevation or depression, have occurred in this district. The above beds appear to run under the Decoy clay and lignite, which are a southerly extension of the Bovey formation, but this may be in appearance only.

*The Bovey Formation.*[1]—On leaving Newton station for Bovey-

[1] The most recent writers on this formation are Mr. Pengelly, Mr. Key, and Dr. Heer. The following is a very condensed statement of some of the principal facts contained in Mr. Pengelly's paper read before the Royal Society, November, 1861. The Bovey basin, exclusive of the part south of Newton, is four miles in greatest breadth, and six in length. In the "Coal-pit" (about half-a-mile from Bovey) the beds dip at $12\frac{1}{2}°$ towards S.W., the strike being N.W. and S.E. In Mr. Pengelly's principal section there were 72 distinct beds of lignite, clay, and sand, including the "head" or an unconformable covering, the thickness of which was $7\frac{1}{2}$ft. The upper series of beds (order descending) consisted of clay, sand (one bed of sand 6ft. 3in. thick and thinning out eastwards or along strike); many beds of clay and lignite, one of the beds of clay containing lenticular patches of sand, most of them containing fragments of lignite, and one bed of lignite 6ft. 2in. thick. Between the upper and lower series there was a bed of sand about 11ft. thick, coarse in upper part, finer towards base, containing patches of clay, and thinning out eastwards. Then came the lower series of beds containing *no sand*, but consisting of many alternating beds of clay and lignite, the former containing fragments of lignite. Towards the base the beds of lignite were very close to each other, and the lowest 4ft. thick. Some of the lignite beds consisted of, or contained, "board coal." Out of 27 lignite or coal beds only seven were more than 1ft. 8in. thick. In some places rings of annual growth of trees were seen pressed into ellipses. The beds are known to be 300 feet deep. A short distance E. of the pit, there is a fault running N.E. and S.W., which proves a vertical displacement of the beds amounting to at least 100 feet. The beds N.W. of this fault must have extended 100 feet higher than at present, making the thickness of the deposit previously to denudation at least 400 feet. The covering called "head," resting on the denuded edges of the beds beneath, consists of sand and clay, with large and small stones of granite, metamorphic rock, carbonaceous grit, trap, and flint and chert, the latter increasing in number eastwards. No stones have been found under the "head." The Bovey beds must have been accumulated in a lake; the clay and sand must have come from Dartmoor; and the stones in the surface-covering must have been brought by a current from the north.—In a paper by Mr. Key, of Newton, read before the Geological Society in November, 1861, it is stated that the "Bovey deposit" rises from under high tide level near Newton to 151 feet above mean tide on Knighton Heath. He mentions three parallel beds of clay on the E. side of the basin, associated with muddy clay, silt, sand, and gravel, dipping west. The clay beds thin out S. of Newton station, and occur again at the Decoy, where they dip E., and where several associated seams of lignite, parted by dark clay and vegetable matter, stand nearly perpendicular. The pipe clay at the Decoy has

Tracey, the geologist enters on controverted ground. There is perhaps no spot of equal dimensions in Britain on which more has been written, and less understood, The origin of the Bovey formation is still the great enigma of Tertiary geology. The railway sections between Newton and Bovey seldom or ever penetrate beneath the "head" into the body of the formation, but the coal-pit can be soon reached from the Bovey station. There the reader can form his own opinions about the mode of accumulation of the beds. It will be seen from the foregoing statements that the only fact supposed to prove their lacustrine origin is the occurrence of freshwater seeds, which (as nothing in the formation is *in situ*) may have been drifted into a saltwater estuary or creek from a freshwater habitat. The facts and considerations which seem to favour the marine or, at least, the fluvio-marine origin of the Bovey beds, partly observed by the author, and partly selected from the papers above noticed, may be briefly stated as follows:—The supposed barrier in the area of the present Teign estuary, necessary to dam up a lake, must have been, at least, 200 feet high (taking the height of the surface at the coal pit at about 100 feet above the sea, and allowing a denudation of 100 feet indicated by the fault), and it is highly probable that the Bovey beds once reached a height requiring a much higher barrier. It is, however, unreasonable to suppose that the Teign estuary valley was filled up to such a height in or since middle Tertiary times. The slopes of this valley down to the water's edge (excepting where there are small cliffs) are obviously a continuation of the general contour of the surface of the neighbourhood, including the sides of the Bovey basin, and must have been formed by a pre-Miocene denudation. As regards the "head," the occurrence of boulder-stones (I have seen some on the side of Leverton road four feet in diameter), and other facts, show that it could not have been accumulated by any motion of water in a tranquil lake. The highest *Pholas*-borings near Torquay must have been made when

been worked about 90ft. deep. Traces of clay may be found as far in the direction of Torquay as the Old Atmospheric Engine House. At the Bovey Pottery (coal-pit) the beds dip to S.E. about 11in. in a fathom (an old man who has worked among the beds nearly 40 years informed the author that about the Pottery they nowhere dip in any direction but S.W). Mr. Key gives a section taken by the late justly lamented Dr. Croker, of Bovey, in which some of the beds are represented as very unequal in thickness and of variable dip. Others have their abrupt ends apparently resting on beds less inclined, while an immense basin denuded out of the beds is filled with "head." Mr. Key believes that the Bovey deposit, both body and head, originated in the river Bovey, discharging various kinds of sediment into a deep lake. The river once ran through the lake from near Bovey to near Newton, and thence, by way of Torr, to Torbay—the estuary of the Teign having been subsequently excavated.—Dr. Heer (paper read before Royal Society, November, 1861) states that the dwarf birch found in the "head" is an arctic plant, and, along with the associated willows, points to a *cold* climate. In the body of the deposit the following *sub-tropical* plants of Lower Miocene Tertiary age have been classified:—*Cinnamon*, laurels, fig, palm, tree-ferns, etc. But the woods that mainly furnished the lignite consisted of a huge sub-tropical coniferous tree, *Sequoia Couttsiæ*, resembling the present *Sequoia* of California. The lower lignite beds consist almost entirely of stems of this and other trees, with brownish black clay. The trees never occur upright, and must have been drifted, the majority from a distance beyond the shores of the lake in which the beds were accumulated. The occurrence of seeds of *Nymphæa* shows that it must have been a freshwater lake.

the sea covered the north-west part of the present Bovey plain to a height of at least 140 feet; and, as the denudation of the body of the Bovey formation must have occurred before the deposition of the "head," it is probable that this deposition took place under a very considerable depth of salt water. Both events, the deposition of the "head," and the perforation of the limestone rocks, may have occurred during the cold period. Dr. Heer has rendered this certain so far as the "head" is concerned. The immense mass of clay and sand composing the body of the formation could not have been carried from Dartmoor by a river of a size equal to any watershed dependent on the present configuration of the ground; and the same remark applies to the timber which supplied the beds of lignite, and which Dr. Heer admits could not have principally come from the shores of a lake. The waves of a lake only about two miles in average breadth could have done little to distribute sand, clay, and heavy timber. The layers of the Bovey formation are not arranged (even in the same beds) according to specific gravity, as would have been more or less the case in the tranquil waters of a lake. The beds of sand thin out in a way indicating denudation by currents. Thus the thick middle bed of sand, in thinning out eastwards, in places exhibits an abrupt termination of its subordinate beds. Fragments of lignite, which look as if they had been denuded out of older lignite beds by currents, occur in the clay beds. In the thick bed of sand there are intercalations of clay and differently coloured sands, which point to a *to-and-fro* action, such as is *now* producing similar phenomena in tidal zones, and probably at greater depths in the sea. Approximations to false-bedding occur in the above bed of sand as well as in some parts of the "head." Nothing but currents denuding and redepositing, and at intervals changing their direction, during a long lapse of time, would seem to offer a sufficient explanation of these and other phenomena connected with the Bovey formation. On many coasts, and in bays and estuaries, in recent times, currents have brought from a distance and deposited immense quantities of pure sand or clay, sometimes alternating, and this irrespective of the nature of the immediately adjacent rocks. In lakes no such deposits, distinct from coast materials, can accumulate much beyond the delta or sides of traversing rivers; and it is improbable that the surface of the supposed Bovey lake ever reached the level of the granite on the west and north, from which the Bovey sands and clays are believed to have been mainly derived. The great masses of heavy timber, now compressed into lignite, in the lower part of the Bovey formation, would seem to imply, as an efficient cause, a neighbouring forest-area gradually, or paroxysmally, subsiding under the encroaching influence of oceanic currents.

*Old sea-bed—Slate and Igneous Rocks.*—That this district has been at least once submerged to a depth of not less than 140 or 200 feet below its present level, would appear not only from the Torquay *Pholas*-borings, but from the discovery of an extensive bed of boulder-drift very lately exposed by railway cuttings to the north-west of Bovey. It may at one time have covered a continuous slope, resembling an old tidal zone, which has been intersected by the subsequent excavation of valleys. The railway cuts through a series of the remaining ridges and platforms, revealing the same bed at different levels (See Plate XVIII. Fig. 3, *a* drift, *b* slate, *c* railway). Many of the boulders are more than three feet in diameter. Most of the stones are much rounded and often polished. The drift exhibits no order in the arrangement of the stones, which lie at all angles, and sometimes enclose lenticular patches of sand. It bears no resemblance to river-shingle, supposing a river could have distributed so great a quantity of drift over so large an area.[1] The size of many of the stones, the signs of violence apparent in the pell-mell heaping together of materials, and the extent of surface covered, render it certain that no tranquil lake could have detached, transported, and accumulated this drift. It seems only explicable by the action of the sea during a gradual rise of the land. The stones consist of an extremely hard yellowish-white igneous rock, a hard and dark-coloured rock, quartz, pebbles with quartz veins, etc.,—all indirectly local. The first railway-cutting northwest of Bovey station is through a crumbling shale or slate (Carboniferous ?) capped by boulder drift. Cutting No. 2 is through a plateau covered with six feet of drift. The slates underneath have been shaved off, in some places broken off, and re-arranged. No. 3 reveals a great thickness of drift in regular layers. In No. 4 the shale, slate, or whatever it may be called, exhibits a whitened or baked appearance, in which the stratification is often lost. In places it resembles trap. In No. 5 the rocks are much stained with oxide of iron, and only thinly covered with drift. Farther on the drift, with stones $3\frac{1}{2}$ feet in diameter, re-appears under a covering of angular detritus. In No. 6, under a great thickness of slaty detritus, the drift resembles some of the raised beaches on the Cornish coast. In some places it has become consolidated. It contains numerous rounded and polished boulders of yellowish-white igneous rock. In No. 7 the drift still shows itself, covering an indescribable kind of rock, consisting of shale, graduating into the hard dark-coloured stone, which has largely supplied the boulder drift. Dykes or veins of a yellowish-white igneous rock (Elvan?) here make their appearance. In No. 8 there is a fine display of the junction between slate and an erupted mass of yellowish-white igneous rock with dark specks (Pl. XVIII. Fig. 4, *a* igneous rock, *b*, *b* slate). As the ground has obviously been lowered by a great amount of denudation, the observer may be cautioned against regarding the right and left hand projections of the igneous rock as superficial overlaps. In some places the shale close to the erupted mass has undergone little or no alteration.[2]

[1] At a lower level, by the side of the railway, a deposit of much finer gravel may here and there be seen, part, if not all, of which may be river shingle.

[2] This igneous rock I at first took for a fine-grained granite, and on the Geological Map it seems to come within the granite area. I saw afterwards a stone on the roadside to the east of the Blackenstone rock, one part of which consisted of this rock separated by a straight and very distinct line from the other part, which was very decided granite. In the present unsettled state of petrology, it is perhaps better to be cautious in applying names.

*Cuttings through Granite—Ready-made Boulders.*—In the two cuttings south of Lustleigh station, the rock consists of irregular masses of rather hard granite *apparently* imbedded in very soft granite stained with iron, and more or less laminated (foliated ?). Here and there angular blocks, or groups of angular blocks, are surrounded by a matrix of loose-grained granite. In one place a dyke of trap, or altered slate, rises up through the granite. In the cuttings north of Lustleigh station, the granite consists of hard masses of approximately spheroidal shape, with soft granite intervening (Pl. XVIII. Fig. 5). The loose texture of the great mass of the granite may be increased by atmospheric influence; but as it occurs at considerable depths from the surface in fresh excavations, it must be partly, if not mainly, regarded as the original state of the rock. It would, indeed, be more in accordance with the appearances presented, to regard this loose and soft material more as a half-formed than a disintegrated granite. At intervals the spheroidal masses lie as if they had been imbedded, though they are really the effect of some process akin to segregation. They have a hard, well-defined, and permanent surface. The concentric layers or shells, which are sometimes in contact with these masses, exfoliate only to a certain depth, and appear to be rather hardened parts of the neighbouring matrix than the outer structure of the masses themselves, though this may be in appearance only. The matrix can be easily removed with the end of an umbrella, leaving a large round boulder. Such boulders, however, must be regarded as distinct from the boulders on the higher grounds where the granite is hard and jointed, and where the stones must have been originally cubical. While many of the latter stones have evidently been transported, those around Lustleigh are principally *in situ.* The soft granite, once filling up their interspaces, could not, however, have been washed away by rain, as they often rest on ground where rain-water could not have acquired a transporting power. The surface of the ground between these stones (some of which are 15 feet in diameter) is generally smooth and not rutted, and the outline of the knolls (revealed by railway cuttings) consisting of soft granite with included hard masses, frequently presents a smooth and uniformly-continuous curve—the obvious result of a denudation laterally directed, and sufficiently powerful to disregard the hardness and softness of materials. (See Plate XVIII. Fig. 6).

*Apparently re-assorted Granite.*—On many parts of Dartmoor, not only filling up hollows and covering slopes, but distributed over level areas, deposits of stratified granitic detritus are not uncommon. I have seen them on the road-side between the Hountor rocks and Rippon Tor. But it is sometimes difficult to distinguish between such deposits and soft granite *in situ.* At Moreton-Hampstead station a large section of soft granite presents the appearance of oblique and curved lamination with imbedded fragments of dark-coloured quartz; but a more minute inspection will be sufficient to convince the observer that the granite is *in situ,* and that whatever may have been the original arrangement of the crystals, the present apparent lamination is foliation, perhaps rendered more striking by the absorption of rain-water. Whether the foliation coincides with original lamination is a question for the petrologist.

*"Boss and Tail," near Moreton-Hampstead.*—This town is surrounded with many projections of granite which throw some light on the later denudations of the earth's surface. The Blackenstone Rock (about 2½ miles to the east) is one of the most striking granitic bosses in Europe. On account of its elevated position it can be seen from a distance of many miles round. The north-west side must be nearly 200 feet high. The most projecting part of this boss consists of cross-jointed hard granite. It has been rounded totally irrespective of structure. A close inspection will show that rain has only roughened its surface. It has been swept clean of débris all round, excepting a few stones on the north side. On the north-east side it graduates into a tail which presents a very strikingly smoothed and rounded appearance. If ice has not been here, there would seem to be little necessity for supposing it to have been anywhere. There are no distinct striations; but an iceberg, without stones in its base, would not have striated it, or supposing striations to have occurred, granite is about the worst rock in the world to have preserved them. Here the tail is in front (" upstream "), but this is generally the case with glacial bosses and tails. Plate XVIII. Fig. 7 will give some notion of the appearance presented by the tail, with the boss fore-shortened, as seen from the north. Nearly all over the undulating table-land between the Teign valley and Dartmoor, commonly so-called, there are rounded, smoothed, and levelled surfaces which can be best explained by ice-action.

*Rock-basins.*—A great number of rock-basins may be found within a few miles of Moreton-Hampstead. Geologists would do well to visit the Druid's altar (near the Blackenstone Rock) before it is quite quarried away—before its rock-basins are exploded by gunpowder, and its "ribs of beef" chopped up. The latter term is applied to six or seven ridges and furrows running down both sides of the summit of the rock. Though rain is roughening the ridges, it is certainly not forming the furrows, which are covered with moss. On this and neighbouring parts of the rock there are many basins. One, very regular and smooth-sided, is partly filled with grass-covered soil. On the north side of the rock there is a double basin which slopes (see Plate XVIII. Fig. 8) towards the brink of a precipice. In other places there are small deep, round, smooth basins like pot-holes on the sea-coast, or in the channel of a river. In one of these I observed the rain-water in a state of gyratory motion; but the round form was evidently the cause, not the effect, of the whirling of the water. On Hell Tor (commonly called Heltor Rock) there is a very large basin (at least 6ft. in diameter by 3ft. deep), one side of which is of a perfectly semicircular form, evidently hollowed out by a forcible agency. It is broken down on one side by a rent, so that it can hold no rain-water. There are many small basins on the top of this tor.

*Origin of Rock-basins.*—Mr. Ormerod, F.G.S., of Chagford, the principal writer on rock-basins, seems to follow Dr. MacCulloch and other early geologists, in attributing all rock-basins to atmospheric action. But from a very particular examination made during stormy weather, I think they ought to be divided into two kinds—pluvial and marine. The first would appear to be formed as follows:—A slight hollow on the upper surface of a rock collects a little rain water which, agitated by wind, and aided by the fall of fresh drops, detaches a little fine detritus. A continuance of the process deepens the hollow until it reaches the lower limit of the agitated water. The small wind-waves enlarge the cavity laterally, forming a miniature line of cliffs, which (except by mere accident) are destitute of any curvilinear regularity. In this way shallow flat-bottomed, rough, and steep-sided rain-pools are formed, but they are distinct (excepting when one kind of hollow has been superimposed on another) from basins with smooth, regular, and perfectly curvilinear sides. The latter occur chiefly on the inclined surfaces or sloping sides of rocks, and are often open on one side, so that they can contain little or no water. These basins are fac-similes of hollows now ground out by waves wielding stones or sand on sea-coasts, or on the projecting rocky islets of archipelagos. The tendency of rain-water is evidently to roughen their bottoms and dilapidate their brims; in other words, to ruin instead of to form them. On the Dartmoor granitic area these basins have often, in spite of rain, retained a smoothness equal to that of many stone basins chiselled out for domestic use in the neighbourhood. If the marine theory can be disproved, their artificial origin is the only explanation left, for they are generally situated on heights remote from channels of rivers.

*General remarks on Tors.*—On any intelligible theory of the elevation of the so-called igneous rocks of Dartmoor, the present cannot be the original outline which their surface presented. The hills and ridges are at least partly the effect of the denudation of the intervening valleys, and the tors are evidently the remnants of a former lateral extension of the jointed masses of which they are composed. Many of the tors exhibit clear indications of their having once been connected with other tors, and all of them may be regarded as the unscathed monuments of a stupendous denudation by which the neighbouring parts were removed. The denudation may have commenced in Tertiary if not in earlier times. The rounded forms of the hills, and many of the rocks (see "Boss and Tail"), may have been enhanced, if not caused, by icebergs. But the present shape of most of the tors of Dartmoor can be best explained by the action of waves and currents. They generally occupy the summits of eminences where the sea may not only have surrounded them, but washed over them and through them, and where it may be said to have had them at its mercy. They occupy what may be called the waterless centres of watersheds. Rain has not space to acquire an abrading power (except in the case of rain-pools) within their circumference. What falls innocuously runs off. The grass or heath comes up to the base of many tors, particularly on one side; and as no gradual shading off into parts now undergoing decomposition is generally apparent, there must have been a sudden cessation of the "sweeping denudation;" it must have finished its work within a given period; the natural edifice must have received its last touch when Dartmoor last rose above the sea; and, since the final embrace of the denuding agent, the powers of the air have not had time to mar the general effect. On one side of some tors the assailed blocks must have been carried clean away in a manner that ice will not account for, and which is altogether inexplicable on the subaërial theory. In the vicinity of other tors we find heavy blocks of granite out of place, and piled on blocks likewise out of place, on nearly level ground,—a phenomenon to which a mere wasting, trickling, dribbling agency, such as rain, could never have given rise. Many cleanly-cut passages through the tors have evidently been left by a wholesale clearance of blocks, and where these are wanting, the indentations, inlets, and incipient caves point to the insinuating, disentangling, and removing agency of breakers. The smaller crevices are not always, as has been imagined, the effect of enlargement of fractures by rain, and, therefore, stages in the passage-forming process, but often the original fractures themselves with their rain-proof sides minutely corresponding.

*Rock-pillars.*—Among the tors of Dartmoor there are many rocky projections, more or less regular, to which this term may be applied. Bowerman's Nose, near Manaton, is perhaps the most striking. The impression it must leave on an unbiassed mind is that a powerful cause has carried away the blocks by which it was once surrounded. Nothing seems more obvious than that the denudation must have been equal to the removal of whole blocks, and not merely of chips or grains. In the case of this and other rock-pillars, there are no indications of the parts removed having been softer than the parts left unscathed. Indeed, the path of denudation appears sometimes strewn with the very blocks which once composed the massive structure, of which the pillar is the only part now remaining *in situ;* and these blocks are often in positions where they could not have fallen, and where, therefore, they must have been carried.

In illustration of the above remarks on the rocky projections of Dartmoor, it may be stated that the Hountor Rocks consist of a series of cliffs formed by the removal of whole blocks, and roofless caves from one to three blocks wide, from which whole blocks must have been abstracted. The two Hey Tors (which may be seen at a distance of ten miles from the railway at Newton) exhibit similar phenomena, but they are principally remarkable for the evidence they present of the denuding agent having come from the south-south-east[1]—smoothed the projecting masses up an inclined plane—stripped bare the sides—and scattered myriads of blocks and fragments towards the north-north-west along a slightly-inclined surface, the contour of which, from a distance, presents a perfectly straight line.[2] How far

[1] Since writing the above, I have found that the ingenious author of "Frost and Fire," briefly mentions the Hey Tor Rocks as having been denuded by ice floating from the north-east, without referring to the direction of the tails and scattered wrecks. He likewise notices the ice-ground contour of the Blackenstone Rock, but leaves its tail out of consideration.

[2] These blocks and fragments consist of, at least, two kinds of granite: a reddish fine-grained variety, and the common coarse-grained variety with large oblong crystals of felspar.

floating ice or icebergs may have assisted the sea in accomplishing so stupendous a result, would form an interesting subject for inquiry. The southern side of the tors has been swept clean. The tail (directed south-south-east) of the western tor has been smoothed and rounded. Both tors, especially on the southern side, have likewise been smoothed and rounded—in many places so independently of the structural arrangement of the rocks, that Pl. XVIII. Fig. 9 furnishes a correct illustration; Pl. XVIII. Fig. 10, represents the Hey Tors as seen from Ingsdon Hill, looking south-south-west; (*a* representing scattered stones).

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## IV.—The Moulded Limestones of Furness.

By Miss E. Hodgson.

At a time when those curious forms often assumed by the upper beds of limestone rocks are thought worth attention, and are brought forward by some geologists as evidences of sea-action, it may not be wholly without interest if I re-introduce a curiously moulded bed of this rock, occurring near Ulverstone.

In a memoir on the Glacial Drift of Furness (written in 1864, and published in the last number of the "Geologist") I noticed these stones as having been met with in many places under a thick covering of drift,—in mining, in railway-cuttings, well-sinking, and excavations for building-stones, etc.; I did not consider them as immediately connected with glaciation, but simply noticed them as examples of the extreme solubility of limestone when remaining long in contact with moisture.

Not much instruction, however, could at that time be derived from their accidental appearance at various points, often some miles apart; and it is only within the last few months, owing to greatly-extended quarrying—more methodically carried on, that they have at length been well seen *in situ.*

To give some idea of the area over which these moulded stones extend, it will be necessary to describe the position and surface distribution of the Carboniferous Limestone in the district of Furness, or that part of Lancashire which forms the west side of Morecambe Bay.

This formation constitutes, doubtless, much of the floor of Morecambe Bay; and on the Furness side of it flanks the Silurians in a long band, from one to five miles broad, and about ten in length. Towards the south, where it is broadest, it is succeeded by the rocks of the Permian series, and is wholly hidden from view at the south end of the Furness promontory.

The most elevated or thickest part of this range is Birkrigg Common, a ridge rising 446 feet above the sea, and rather less than one mile from the shore. The beds dip shoreward, or south-east, at about an angle of 9°. They are nowhere scarped into great precipices on the shore line; but when not covered up by beach gravels on the one hand, or Boulder-clay on the other, present fine tabulated slopes to the spray of the sea; and, despite its defacing action, as well as that of rain, they still show remnants of glacial planing and striæ, bearing north-east-by-north, and south-west-by-south. These latter may not, however, have been very long exposed to the direct influence of either rain or sea.

There is a good deal of bare rock to the south and south-west of Birkrigg—inferior ridges out-cropping along the strike. Some of the beds are very rugged and much broken, the blocks having been apparently shifted *en masse* and carried off; others display almost exact counterparts of those on the shore, but with this notable difference, that there is in the higher rocks a far greater prevalence of branched channelling and basin-like hollowing of the stone, more rounding off of edges, and more vertical column-like fluting.

The western edge of the series skirts the lower Silurian hills in long reaches, rather difficult to define, and only, indeed, to be conjectured even with the aid of borings. It does not appear to thin out greatly, for at Tarn Close Quarry, one mile to the north-west of Ulverstone, within a hundred yards of what must be its junction with the slate, it has a depth of more than sixty feet. Some of the beds here have been found parted by very thin coal-seams, shales, and sandstones, containing *Syringopora ramulosa* and a small species of *Lithodendron.*[1]

The greater part of this limestone tract is hid under a vast covering of drift,—glacial, fluviatile, and marine.

It is principally along the western edge or junction with the slate that sinking for iron ore is attempted; and hence it is principally along the western edge also, beneath a mass of glacial deposits of varying thickness, that the moulded limestones have been disclosed. In fact, wherever a limestone surface has been reached, there invariably the upper bed is found to be deeply indented into curious forms.

The accompanying sketch by my sister is a very faithful representation of the mouldings as they are shown in the Tarn Close Quarry. (See figure, p. 403).

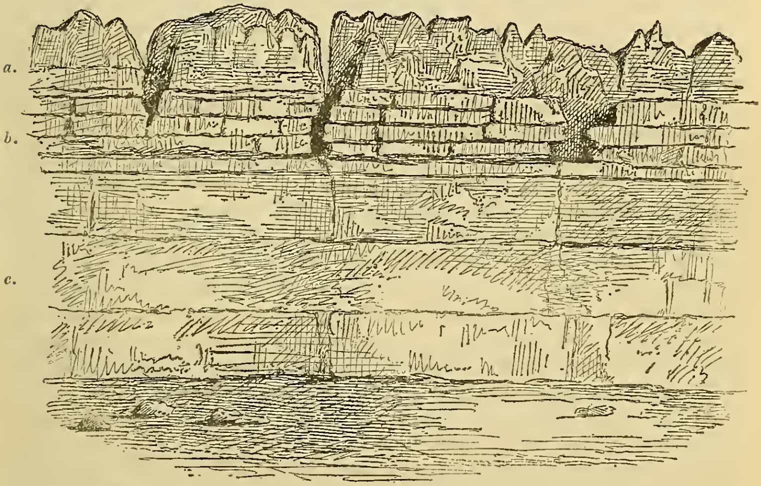
This curiously moulded bed is capped by unstratified Boulder-clay from seven to fifteen feet in thickness, containing striated stones of all sizes up to boulders thirteen feet in girth; none of them are limestone. The indentations are all filled with and covered over by a tenacious clay nearly free from stones, which on being carefully removed brought away a limy film from the mouldings, leaving the limestone surface rough and pitted. Some of the edgings of the mouldings are extremely sharp.

The indented blocks represented in the drawing are from three to five feet long between the fissures, two feet broad from the front to the next joint, and eighteen inches in depth. The blocks are easily drawn off, when they disclose similar ones behind. The bed upon which this moulded limestone immediately rests is divided into four or five thin separate layers, which are extremely regular and

[1] These and the following ill-preserved fossils from the Birkrigg rocks, were obligingly named by Mr. John Rofe, F.G.S.:—*Amplexus coralloides; Campophyllum Murchisoni; Cyathophyllum regium; Cyathophyllum Stutchburyi; Lithostrotion junceum; Zaphrentis*, etc.

uniform around the quarry, and are vertically jointed in the same regular manner. Below this "rotten rock" (as the quarry-men term it) the beds supply very good building stone.

The three or four localities where this moulded limestone has been noticed vary considerably in elevation. The Tarn Close Quarry (formerly the site of unsuccessful mining operations) is about 270 feet above the sea. The elevation of the limestone in the Lindale Moor Iron Mines is about 350 feet; in the railway cutting I believe it is found between 175 and 200 feet; and in the well-sinking instance, as nearly as can be ascertained, it would be at an elevation of 125 feet above the sea. These, but especially the Tarn Close Quarry, all afford excellent evidence of moulded surfaces under deep drift; and they extend over an area of more than three miles.




Tarn Close Quarry in the Carboniferous Limestone, near Ulverstone.

*a.* Moulded and indented limestone, originally capped with Boulder-clay 7–15 feet in thickness.
*b.* "Rotten Rock" of the Quarry-men.
*c.* Compact limestone, suitable for building-stone.

Returning to the comparatively driftless ground of the Birkrigg range, hundreds of these curiously moulded blocks occur, often within two feet of the surface, and even less: they have been dug out for many years past for rock-work. They are thinner here than those figured, and have not such a deep indented profile. The best specimens, the quarry-men say, are those under the deepest cover of drift—in these the sculpturing is carried quite through the stone, and thus, what have once been immense unmanageable slabs, are found dissolved away into detached and convenient pieces, often presenting fantastic forms of considerable beauty. They rest upon a bed of "rotten rock" exactly as in the Tarn Close Quarry, and like those under the great drifts they are not confined to any particular elevation.

It is manifestly impossible to claim any distinction for the Birkrigg rocks, however curious: they have their true imitations on the high grounds of Grange, Silverdale, Wharton, Whitbarrow, and eastward on the Scars, near Kendal. Indeed, it is needless to multiply examples, for is not this the natural appearance of the surface of the Mountain Limestone wherever it is the upper rock of the country and undisturbed?

The limestone terraces of the Burren hills in Ireland do not appear to have suggested the sea as the direct agent to the author of the "Student's Manual,"—the exposed beds are there "cut into blocks by deep fissures, the uppermost blocks are loose and tottering,—and are worn into rough knobs and holes *by the mechanical and chemical action of the weather*."[1]

The late Dr. Woodward, in a letter dated August, 1863, says, "It has always appeared to me that the drip and splash of rain and rain-water was the chief agent in honey-combing limestone *by virtue of its dissolved carbonic acid gas*."

In "Principles of Geology,"[2] due weight is given to the power of *carbonic acid* in dissolving limestone rocks.

Mr. Cameron, F.C.S. (to whom I sent specimens of rocks and clays from Tarn Close and Birkrigg), points to the same chemical action for their elucidation. He reminds me that *carbonic acid gas* is one of those agents in nature that works slowly, but gradually and surely; that it decomposes the hardest rocks, carrying away part of their constituents; that it combines with potash, soda, lime, magnesia, etc., water, the necessary medium by which it operates, absorbs its own bulk, or rather more of it, from the atmosphere, and carries it into fissures and crevices of the rocks, where it acts as a solvent upon these substances, forming carbonates and bi-carbonates.

With the Birkrigg, etc., rocks, no doubt rain-water, charged with carbonic acid, has had a great deal to do.

Mr. Cameron attaches considerable importance to the decaying vegetable matter of the soil. Liebig states that *humus* (decayed woody fibre) is a continual source of carbonic acid,—an atmosphere of carbonic acid surrounds every particle of decaying *humus*;[3] and, again, "It is evident that plants, by producing carbonic acid during their decay, and by means of the acids which exude from their

[1] "Manual of Geology," by J. Beete Jukes, p. 513.—Since writing the above, it occurred to me to turn to the memoir by Mr. Jukes on the River Valleys of the South of Ireland; and I fear the fact will scarcely be believed, that the description given there of the limestone of the Burren hills, so true to nature as it evidently is, had hitherto entirely escaped my attention.

[2] Prin. of Geol. vol. i. pp. 331, 333, Sir C. Lyell.

[3] Liebig's Chemistry of Agriculture and Physiology, p. 48. There is palpable evidence of the truth of this in the small angular stones (one cannot call them pebbles or shingle) which may be found entangled amongst the grass-roots where the sod is thin. It will be seen that there is a remarkable tendency amongst these to terminate in *points*, more or less sharp; sometimes in one, awl-like; or in two or more, often closely resembling fossil teeth of fishes. Below, where these occur, are quantities of miniature "rockery stones" of every form and shape. There could not, certainly, be a greater proof, I think, of the absence of wave-action than in these extraordinary examples of limestone débris.

roots in the living state, contribute powerfully to destroy the coherence of rocks. Next to the action of air, water, and change of temperature, plants themselves are the most powerful agents in effecting the disintegration of rocks."[1]

Mr. Cameron thinks that the fine clays found in contact and also in crevices and pockets may possibly in some cases represent the argillaceous or insoluble portion of the dissolved rock itself.[2]

The Furness limestones then seem to offer illustrations of three somewhat different dissolving processes. Firstly, that of atmospheric disintegration aided by frosts and direct rain-fall, and also by minute encrusting lichens. (These influences are well shown on many exposed rock-surfaces of this district.) Secondly, that of rain and decayed vegetation, as illustrated by rocks with a thin covering of soil and drift. Thirdly, that of rain-water acting at greater depths upon limestone rocks deeply covered with drift; the more easily soluble portions of the limestone being dissolved in every case. Assuming the correctness of this explanation, it seems needless to call in so remote an agent as the sea, even if it were capable of producing such an effect. The striated and polished surfaces here and there met with, which appear to be a few remnants of the Glacial Period, may have been preserved from honey-combing and disintegration because their polished and compact surfaces were better able to resist the chemical forces attacking them, than the naturally pitted and uneven surface of the rock elsewhere.

It was in reference to the assumed work of Mollusks in rocks that Dr. Woodward called my attention to the more likely agent of rain-water; and it has been my regret that I did not earlier perceive the force and value of his suggestions. "In Gloucestershire," he writes, "there is a bed of the great Oolite, called 'Dagham Down Stone,' because it forms the substratum of a large extent of (formerly) down-land. This must have originally enveloped a continuous bed of sponges, or something of the kind, for now the rain eats into it irregularly, leaving holes such as one could make with the fingers in dough."

I have reason to believe that many of the cavities in the Birkrigg stone may be traced to the former presence of fossils. The matrix of the bivalve shell is recognized so long as its striæ are preserved; but when these are effaced, the origin of the hollow becomes doubtful. So it may be with the tubular cavities.

At the same time it must be admitted that surface inequalities and honey-combing, if not, indeed, every other form of disintegration, are mainly due to the texture of the rock itself, inducing *unequal* weathering, independently of any fossils.

With regard to those minute punctures, sometimes accompanying a lichen encrustation, and sometimes observed apart, it is probable that the latter, as well as the former, owe their presence to the *saucers*, or fruit receptacles of these plants. We have it on the autho-

[1] Liebig's Chemistry of Agriculture and Physiology, p. 139.

[2] See Mr. George Maw's papers in the Geological Magazine, 1865, vol. ii. p. 200; 1866, vol. iii. p. 253; and 1867, vol. iv. pp. 241 and 299.—Edit.

rity of Dr. (Sir J. E.) Smith that, in one species of lichen, *L. exanthematicus*, found on limestone rocks in Yorkshire and elsewhere, *the saucers, when old, leave a cavity in the stone.* Linn. Trans. i. p. 81. Withering's Arrangement of British Plants, vol. iv. p. 19.

## NOTICES OF MEMOIRS.

### I.—Eruptive Origin of Granite and Serpentine in Asia Minor.

IN the first volume of his "Geology of Asia Minor" (1867), M. de Tchihatchef records his observations on the eruptive rocks of that country. He advocates the igneous origin of granite, and as some discussion has arisen on this subject in recent numbers of the Geological Magazine, a notice of M. de Tchihatchef's opinions may be of interest.

Under the collective term "Eruptive Rocks" the author ranges the following rocks, occurring in Asia Minor, which he considers to be of igneous origin:—Dolerite, Basalt, Melaphyre, Pyroxene, Porphyry, Gneiss, Granite, Granulite, Syenite, and Serpentine.

While advocating (with M. Naumann) the igneous origin of Gneiss, Granite, and Syenite, the author has had particularly in view these rocks as they are developed in Asia Minor, without wishing to deny the possibility of their different (metamorphic) origin in other parts of the globe. He further states that, although the metamorphic theory has received a support in the discovery by M. Sismonda of an *equisetum* in an erratic block of gneiss in the Alps, yet before generalizing on this phenomenon we must assure ourselves whether the gneiss of other countries furnishes arguments as conclusive in favour of this interpretation. But in Asia Minor, not only has nothing similar been discovered, but the gneiss is there found so intimately associated with the granite that one cannot but assign to the two rocks a common origin, and as the granite presents under more than one relation the character of an eruptive rock, he is of opinion that we must not separate one from the other until proof to the contrary is obtained.

The serpentinous rocks occur as agents of upheaval in enormous masses, intimately associated with the sedimentary deposits (Cretaceous and Eocene), and often intercalated among them. The eruptive nature of these serpentines is indicated by their action on the deposits with which they are found in contact, by the exterior aspect of the rocks themselves, as well as by the manner in which they are disposed.—H. B. W.

### II.—The Keuper Flora of North Tyrol. By Professor Ad. Pichler.

[Proceed. Imp. Geol. Inst. Vienna, February 19, 1867.]

THE vegetable remains are imbedded in a sandstone, which differs in no respect from the Keuper sandstone of Franconia. It belongs to the "Upper Cardita-strata," and is associated with argillaceous shales and marls, containing numerous remains of Mollusca (*Ostrea montis-caprilis*, etc.). The most abundant species of plants are—*Pecopteris Steinmülleri*, Heer; *Equisetites arenaceus*, Schenk; *Calamites arenaceus*, Jaeg; and *Pterophyllum Jaegeri*. The more locally-occurring species are *Pterophyllum longifolium*, *P. Haidingeri* (fine specimens with leaflets occasionally one and a half inches in breadth), and a species of *Pterophyllum*, with leaflets half-an-inch in breadth and very long, perhaps *P. Gümbeli*, Stur.—COUNT M.

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III.—ZONE OF AMMONITES TRANSVERSARIUS.—Dr. Waagen has edited, and communicated to the Imperial Geological Institute of Vienna (Meeting, Jan. 5, 1867), a paper of the late Dr. Oppel, concerning the Upper Jurassic Zone, characterized by the presence of *Ammonites transversarius*, limited above by the zone of *Terebratula impressa*, and below by the zone of *Ammonites cordatus*. The zone in question is to be traced from south-west Poland through the Carpathians, Moravia, Bavaria, the Schwäbische Alps, the Swiss Jura, the Alps, France, Spain, as far as Algeria. The number of fossil species known to occur in it amount to 217; among them are microscopic remains of Crustacea and Radiata, and many new species of Foraminifera.

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IV.—MAMMALIAN REMAINS FROM HUNGARY.—M. de Hantken has recorded the following mammalian remains from a Post-Pliocene deposit at Fünfkirchen, in Hungary:—*Ursus spelæus*, many fragments of lower jaws, loose teeth, and vertebræ; *Hyæna spelæa*, Goldf., a fragment of a jaw belonging to a young animal, with the first teeth and protruding canines; *Equus fossilis*, Cuv., a fragment of a lower jaw with a tooth; *Bos priscus*, Boj., a second collar vertebra; *Rhinoceros tichorhinus*, Cuv., a single tooth.—*Proceed. Imp. Geol. Inst.*, *Vienna*, Dec. 18, 1866.

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## V.—THE GASTEROPODS OF THE TERTIARY DEPOSITS OF PORTUGAL. By PEREIRA DA COSTA.

[Gasteropodes dos depositos Terciarios de Portugal, por Pereira Da Costa, com a versão Franceza por M. Dalhunty. 1o. Caderno, 4to. Lisbon, 1866.]

THE pages of this work are divided into two columns, one containing the original Portuguese of Señor Da Costa, the other a French Translation by M. Dalhunty, which will be very useful to those unacquainted with the Portuguese language. This first part contains 116 pages of letter-press and 15 excellent lithographic plates.

The author has followed Lamarck's classification in his description of the fossils, and explains that it is not through want of appreciating the great amelioration since introduced into the methodic distribution of the Mollusca, but on account of the great convenience in modelling the work on that of M. Hörnes, descriptive of the fossil Gasteropods of the Vienna basin, which being a deposit very similar to that in Portugal, contains the greater part of the species met with in Portugal.

The author also acknowledges the great assistance he has received from the works of M. Deshayes, and mentions the paper by the late Mr. Smith, of Jordan Hill, as the only work hitherto published on the Tertiary fossils of Portugal.

The author intends giving a summary of his results in the last part of the work, when all the species will have been described.

## REVIEWS.

I.—Santorin, the Kaimeni Islands. From observations by K. V. Fritsch, W. Reiss, and A. Stübel. (Translated from the German.) London, 1867. Trübner and Co. Folio. pp. 8. 3 Plates.

MUCH interest was excited during the early part of the past year by the announcements received in this country of repeated igneous outbursts having taken place in the Kaimeni Islands, a group of small volcanic islands situated in the Gulf of Santorin, formed by a large island of that name in the Greek Archipelago. From Greece, Germany, France, and England numerous scientific investigators repaired to study the nature of its phenomena. We have already (Geological Magazine, 1866, Vol. III. pp. 222 and 263) given some account of these interesting observations and their bearing upon volcanic phenomena elsewhere. The authors of the present work furnish not merely an account of the changes produced by volcanic action in these islands, but, by means of maps and photographs from carefully executed relievo models of the islands themselves, they have laboured—and we think successfully—to convey to the mind a picture of the theatre of these disturbances and the changes produced both upon the island and the surrounding sea-bed. These island-volcanoes offer some interesting points of comparison with other volcanic areas. They appear also to confirm two important points in connexion with volcanic action. Firstly, that the volcanic cones of the Kaimeni islands, though differing in other respects, coincide completely with the cones of eruption of other volcanoes, and afford no support to the elevation hypothesis; secondly, here, too, as in many other localities, the craters already existing were not concerned in the later eruptions, the volcanic agencies mostly finding it easier to force a new passage for the materials thrown out, than to reopen the older ones.

Besides the three plates which accompany the description, the authors announce that four other explanatory maps and views of the Kaimeni islands may be obtained from Messrs. Trübner and Co. as a separate supplement to their work, giving the configuration of the island before the eruption and also on the 30th May, 1866, with the islands of George I. and Aphroessa in active eruption. This plate gives the best idea of the relation between the supra and sub-marine parts of the islands, They are greatly to be recommended for the use of geologists.

## II.—Monographs published by the Palæontographical Society. Vol. xx. 1867.

IN the Geological Magazine for March, 1867, p. 122, we recorded the issue (in December, 1866), of the 19th volume published by this Society, being that due to its members for 1865. By the energy and zeal of the Rev. T. Wiltshire, M.A., F.G.S., the Honorary Secretary, another fasciculus has just been issued (June, 1867), being the volume for 1866. We learn that the volume for 1867 is in the press, and will be ready by October or November.

Vol. XX. contains the following Monographs:—I. Part IV. No. 1. Of the British Fossil Corals (2nd Series), by P. Martin Duncan, M.B., Lond., F.G.S.—II. Part IV. Of British Trilobites, by J. W. Salter, A.L.S., F.G.S.—III. Part VII. No. 2. Of British Fossil Brachiopoda, by Thomas Davidson, F.R.S., F.G.S.—IV. Part III. Of the British Belemnitidæ by Professor John Phillips, M.A., LL.D., D.C.L., etc. etc.

I. Dr. Duncan gives us an account of the Liassic corals found in the zones of *Ammonites planorbis*, and *A. angulatus;* and belonging to the following genera:—1. *Montlivaltia;* 2. *Rhabdophyllia*; 3. *Thecosmilia;* 4. *Oppelosmilia*; gen. nov. 5. *Isastræa;* 6. *Astrocœnia;* 7. *Cyathocœnia;* gen. nov. 8. *Elysastræa;* 9. *Septastræa;* 10. *Latimæandra.* In all 10 genera and 48 species. These are illustrated by eleven tinted and black-background plates, well executed by Mr. G. R. de Wilde. The importance of Dr. Duncan's Monograph may be readily seen when it is stated that only one good species of Coral, the *Trochocyathus Moorei*, Ed. and H., had before this been determined from the British Lias.

II. Mr. Salter contributes six plates, one of *Ogygia* and five of *Illænus.* He gives an account of the new genus *Barrandia longifrons* from the pen of the late H. Wyatt-Edgell, Esq., and describes 16 species of *Illænus*, 2 of *Illænopsis*, 2 of *Ogygia*, and begins the family of the *Bronteidæ.* We hope and trust that the health and leisure, about which Mr. Salter seems so doubtful, may be granted him to complete this grand work, a bird's-eye view of which he gives us in his "Notice to Correspondents."

III. The untiring industry and genius of Mr. Davidson have enabled him to add another charmingly-illustrated part to his monograph of Silurian *Brachiopoda*, The single-minded devotion of Mr. Davidson's attachment for the "Lamp-shells," is a sermon to all aspirants for Palæontological honours; it says plainly, "Don't have too many irons in the fire." The writer remembers hearing the late Dr. Falconer observe to a young Naturalist, "Never mind, my young friend, how narrow the groove you run in, only take care to stick to it."

Mr. Davidson's part is illustrated by ten well-filled plates, illustrating *Meristella, Athyris, Retzia, Atrypa, Pentamerus, Stricklandinia, Rhynchonella,* and *Merista* or *Camarium.*

IV. Professor Phillips continues his history of the British *Belemnitidæ,* and adds thirteen more plates, well drawn, and printed on a tinted ground, in Paris. Certainly they do these things, in some instances, *better abroad.* Professor Phillips gives figures and descriptions of 32 species of Liassic Belemnites, of which 16 are new to science.

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III.—Prize Essay upon the Encroachment of the Sea between the River Mersey and the Bristol Channel. By J. E. Thomas. 8vo. pp. 24. London, 1867.

THIS pamphlet gives a short account of some of the changes of our western coast, in great part derived from published works, which the author has diligently searched; but in part also from local traditions and from personal knowledge of the district. An essay of this sort, which refers to notices that have appeared at various times and in various ways, is very useful, as collecting together information on one subject which before was scattered about in many publications. It is to be hoped that the author will be able to extend his researches, and to treat of the changes of the western coast in the detailed way that Mr. Redman has done with the south-east of England in his two papers published in the Proceedings of the Institute of Civil Engineers.

It would have been better if there were proper references to the authorities quoted: in some cases there are none at all, the quotations being simply given as by Dr. Hume, Mr. Boult, etc.; in another case we are told that the information has been got from page 70 of the Journal of the Geological Society, but as that interesting work is now in its 22nd volume it would hardly be a labour of love to hunt up the reference. From an unfortunate misprint that occurs many times we may infer either that the author writes a very bad or a very good hand—in the former case, misleading the printer; or, in the latter, making him careless: it is the use of the word *track* (of alluvium, etc.) instead of *tract.*

At page 11 it is remarked that the "the chlorite and mica-schists have been more able to withstand the dashing of the waves than the limestone and other rocks;" but it may be questioned whether the dashing of the waves alone can do much harm to any hard rock, and one is inclined rather to think that the greater endurance may be owing to something in the composition structure or condition of the rocks by which they suffer less from those splitting and dissolving subaërial actions that are mostly the cause of the fall of cliffs.

Mr. Thomas is a Civil Engineer, and, in the course of his professional work, it may be in his power to do good service to geology by such researches as that now noticed, which it is to be hoped is an earnest of others.

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IV.—The American Naturalist: a Popular Illustrated Magazine of Natural History. Essex Institute, Salem, Mass., U.S. London: Trübner and Co. Nos. 1–5, March–July, 1867.

WE look with natural interest upon all attempts of our transatlantic cousins at rendering Natural History studies popular. It is undoubtedly the great difficulty and at the same time the great demand of the age. To a people like the American nation, at once so enterprising and possessing such boundless resources, all things seem possible, and we see no reason why they should not achieve even this critical object. Good illustrations and cleverly-written articles are necessary for the success of such a work; of both these there is a fair average, the recent Natural History articles being, as a whole, better than the Geological ones.

We should be unjust, however, to Mr. W. T. Brigham did we omit to call attention to his article on a visit to the Volcano of Kilauea, Hawaii Islands. His description of a night-display of this volcano which he witnessed is very graphic (see No. 1, p. 19) :—

"As it grew dark we were very tired, having travelled since six o'clock in the morning; and hoping to wake up in the night when the fires would be more brilliant, we rolled ourselves up in our blankets, and, with our guides near by, went to sleep a few rods from the crater.

"At nine o'clock I waked, and as the night air was quite cold, moved to the very edge of the crater to warm myself, and to enjoy the magnificent fireworks. The moon was up and almost full, but her light was dull beside the fires of Pélé. Finding the place quite comfortable, I picked out a soft rock for a pillow, and went to sleep again. At twelve I awaked with a start, and found myself in a shower of fiery drops, some of which were burning my blanket. I shook myself and jumped back, looking at my watch to note the time, and then stood gazing at the strange scene for some time before I thought of my companions. The whole surface of the lake had risen several feet, and was violently boiling and dashing against the banks, throwing the white-hot spray some sixty feet over the upper banks, causing the providential rain that awakened me to see this grand display. There was no thundering or bellowing, only the splash of the waves as they fell back, or the rattling of the cooled drops on the upper banks. The light was so intense as to be almost painful, as the crust had wholly melted, and brilliant fountains of fire covered the surface.

"When I could think of anything else I called the others, but only succeeded in awakening the guides, and just then a drop of lava came plump into a greasy newspaper we brought our supper in, and it blazed up suddenly to the dismay of our guides, who, thinking that the volcano had broken out at our feet, at once fled to a safe distance. Failing to arouse them with my voice, I threw several handfuls of gravel at the sleepers, but without effect, and I had to climb down—almost blinded by gazing at the fire—and shake them roughly. When they at last reached the edge the action had greatly diminished, and in a few minutes more the dark crust covered the central portion, extending rapidly to the sides; and after watching the last crack close, we all went to sleep again. I was glad to see such distinct flames, as their existance has been denied in volcanoes. They were bluish green, and shot up in tongues or wide sheets a foot long."

V.—Rain and Rivers; or, Hutton and Playfair against Lyell and all Comers. By Colonel Greenwood. *Second Edition.* London: Longmans, 1866.

We scarcely know what to say of this extraordinary book. That it contains many happy theoretical hits cannot be denied, and though the author's propensity for humourous digressions continually disturbs the grave attention of the reader, some portions are well reasoned and clearly expressed. One of his great objects seems to be to attack Sir Charles Lyell, Professor Sedgwick, and other great founders of the science of geology; and while he accuses Humboldt of concealing the laws of Nature "behind the double veil of Greek and Latin," he scarcely writes a page without introducing a Latin sentence or quotation. Still he must be credited with the merit of having been the first, of late years, to give to the world (in the "Tree-Lifter," in 1853, and "Rain and Rivers," 1857,) a clear exposition of the subaërial theory of denudation. Professor Jukes acknowledges this in his "School Manual of Geology;" and it would only be an act of justice if other subaërialists were to make more frequent reference to the author. It would likewise be well if they rendered their speculations more consistent by imitating Colonel Greenwood in laying the main stress on rain and not on rivers, for it is obvious that if rains cannot act effectively in a state of general dispersion so as to produce the gently-sloping declivities which characterize the majority of hills and valleys, torrents and rivers which (as the Colonel admits) act on lines only, could not have given rise to the general form of the ground. As many who have not read "Rain and Rivers" may like to know how far its author has forestalled the more recent advocates of *pluvialism*, we shall give a number of quotations from his work:—

"No marine current could make a single channel *sloping from* a height to the sea; still less the myriads on myriads of dry upper valleys which ramify in all directions, from all river valleys, through and to all sides of the tops of all elevations, whether high or low." "Soil is rotted subsoil," and "is in constant formation over the entire surface of the earth. . . . . Rain produces a denudation of an enormous breadth of hill-*side*. . . . . Rain may be said to form *hills* as well as valleys. . . . . . Valleys exist only in the dissolution of hills. . . . . A stream running through ridges, large or small, is the simple consequence of the differing hardness of the ground through which it runs. In all cases a stream cuts for itself a narrow channel, the depth of which is determined by its hardest part. . . . . . But the wash of rain digs down where the ground is soft and leaves hills or ridges where it is hard. And as a stream cuts through a hard stratum, say the North or South Downs, the wash of rain is scooping out two lateral valleys *behind* it, that is a valley behind each side of the gorge and ridge, as in the Weald clay. . . . . . The *dèbris* of these valleys is carried off by the lowering bed of the river. A ridge is then developed, and the river runs through a gorge in the ridge. . . . . . Directly as the softness, is the width.

Above each hard gorge will invariably be a comparatively wide horizontal valley. . . . . . Rivers have the power to cut narrow channels or *ravines*, but they have very little power of widening these. Disintegration and the wash of rain widen these ravines into broad valleys. While this is going on, rivers convey to the sea what rain brings to them, . . . . rain is constantly shoving the whole surface of the earth down towards the sea. . . . . . No drop of rain *runs* an inch on the surface of the earth without, as far as it goes, setting some soil forward on its road to the sea, and it wont run back again. No return tickets are given. It will wait there, and go on by the nex-t-rain. . . . . . Neither wind nor water, under any circumstances, ever travels empty-handed. . . . . In comparison to the broad waste from the wash of rain, the waste by the *direct* action of rivers may be reckoned as nothing, . . . . rivers are mere labourers or accessories in the affair. . . . . . This universal portage of soil by rain . . . . may also be seen, *oculus fidelibus*, whenever a fence runs horizontally along the side of a hill. A *natural terrace* is then formed, . . . . the good soil which was on its way to the valley is arrested. . . . . In France I have seen deep terraces result from very narrow strips left uncultivated to decide fields or properties."[1] In chapter xiv. the author advocates the theory that man may have existed during the Silurian period, and asserts that "myriads of species of megatheriums, dinotheriums, anoplotheriums, or *anyothertheriums* (*sic*), may have existed *before* the Silurian or primary and metamorphic period, without a vestige of their fossil remains being found in these strata." (!) One of the best chapters in the book is on "The Travelling of Sea-beach."

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## VI.—OUR SCIENTIFIC JOURNALS.

1. The Quarterly Journal of the Geological Society of London for August, 1867, No. 91, opens with Mr. Ralph Tate's paper "On some Secondary Fossils from South Africa," a region whose geology and palæontology has several times before occupied the pages of both the Transactions and the Journal of this Society.

The fossils described are fourteen species of plants, thirty-nine mollusca, two corals, three serpulæ, and one cidaris; illustrated by two double and three single octavo plates. The remains are, unfortunately, very fragmentary; so much so, indeed, in some instances as to render their accurate determination a matter open to grave doubt. *Cidaris pustulifera* (Plate viii., fig. 9); *Trigonia Goldfussi* (Plate vii., fig. 6), and *Hamites Africanus* (Plate vii., fig. 5,[2]) are instances of species founded on very slender evidence. Nevertheless, South African geologists may thank Mr. Tate for the work he has accomplished, and we hope they will try to send better specimens home next time for description.

[1] See a defence of this theory by G. Poulett Scrope, Esq., in Geological Magazine for July, 1866.

[2] In the Explanation to Plate vii. p. 174, the names of figs. 4 and 5 are transposed, and in that of Plate viii. fig. 9 it is omitted altogether.

Mr. J. W. Judd's paper, "On the strata which form the base of the Lincolnshire Wolds," deserves a special notice, which we propose to give in a future number. Its author, evidently a capital field-observer, has met with his proper recognition, being one of the few successful candidates lately appointed to the field-staff of the Geological Survey of Great Britain.

Mr. Boyd Dawkins has more to say about British Fossil Oxen; this chapter treats of *Bos longifrons*, which the author considers to be a comparatively modern type and to be the ancestor of our small Highland and Welsh cattle. Mr. Dawkins has also another paper, "On *Rhinoceros leptorhinus* of Owen," which he states to be synonymous with the *Rhinoceros hemitœchus* of Falconer, but not by any means the same thing as the *Rhinoceros leptorhinus*, of Cuvier. Can a specific name given by one author be transferred to another, Mr. Boyd Dawkins?

Sir William E. Logan, and Drs. J. W. Dawson and W. B. Carpenter have more to say about new specimens of *Eozoön*, of which they give illustrations in two well-executed plates.

Mr. H. W. Bristow makes out a strong case against the retention of the beds named by Mr. E. B. Tawney (Quart. Journ. Geol. Soc., Vol. xxii., p. 69), "Sutton series," and "Southerndown series" as composing a formation separate and apart from the Lias proper; and he shows (1) that there are not two series of beds, but only one; (2) that the palæontological evidence proves this group of strata to be true Lias from top to bottom. He considers the term Infra-lias to be misleading, and recommends Sir Henry De la Beche's old name "Lias Conglomerate" as distinctive and unobjectionable.

The Rev. P. B. Brodie contributes two papers—(1) "On the Purbeck Beds at Brill, Buckinghamshire, etc.;" (2) "On the drift in part of Warwickshire, and the evidence of Glacial action which it affords."

The two following papers appear only as abstracts:—(1) Mr. Charles Moore, "On the Abnormal conditions of Secondary Deposits when connected with the Somersetshire and South Wales Coal-basins, etc.," and (2) Mr. R. Etheridge, "On the Physical Structure of North Devon, and the Palæontological value of Devonian Fossils," they will form, we understand, an extra number, to be issued at a later date.

A third paper, "On Subaërial Denudation, and on Cliffs and Escarpments of the Chalk and the Lower Tertiary Beds," By William Whitaker, B.A. (Lond.), F.G.S., of the Geological Survey of England, a brief abstract of which is only given (p. 265 Quart. Journ.), will appear in full in the October and November Numbers of the GEOLOGICAL MAGAZINE.

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2. THE QUARTERLY JOURNAL OF SCIENCE, No. XV., for July, contains, among others, an article upon Mr. J. Beete Jukes and the Geological Society, being a consideration of Mr. Jukes' recently-published pamphlet, entitled "Additional Notes on the Grouping of the Rocks of North Devon and West Somerset, with a map and section;"

prefaced by a statement of the reasons which compelled the author to print and circulate this paper at his own cost among the Fellows of the Geological Society of London. Space will not permit us to enter into a prolonged account of Mr. Jukes's pamphlet here, but those who care to learn the whole matter, will find it very fairly argued in the pages of the July Quarterly Journal of Science. We give the writer's concluding remarks :—"After a careful examination of the evidence, we are unable to come to any other conclusions than the following :—(1) That Mr. Jukes, forgetting the Society's rules, has felt aggrieved at the refusal to publish in full a paper whose fate he would doubtless have predicted, had he remembered the Society's regulations ; and (2) that he has precipitately written and printed an attack on the Council of the Society, without first ascertaining that his recollection of the Society's rules was sufficiently exact—a course which can only be compared to rushing into a lawsuit without legal advice, on the strength of vague impression, and with no real knowledge of facts."

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3. The Popular Science Review (No. 23) for April contains, among other interesting original articles, one by Dr. J. D. Hooker, F.R.S., "On the Struggle for Existence amongst Plants." In it the writer shows that there is great truth in the saying (attributed to Dean Herbert, of Manchester), that "Plants do not grow where they like best, but where other plants will let them," and that circumstances of climate and soil are not omnipotent in regulating the distribution of vegetable life. The writer gives numerous instances of the way in which one class of plants affect the progeny of another class ; grasses and herbs, for example, smothering the seedlings of large and prolific trees. Dr. Hooker also cites some of the most remarkable changes which have been produced upon the floras of new countries wherever European emigration has introduced foreign plants, particularly in the spread of many of our commonest wild plants, and field and garden weeds. No instance can well be found more interesting than the change effected in New Zealand since first visited by Captain Cook, both as regards plants and animals. The domestic pig has run wild, and multiplied to such an extent on the eastern side of the island that parties employed for their destruction have been known to shoot as many as 22,000 on a single sheep-run without any apparent diminution in their numbers. The Norwegian rat, the European mouse, and other old-world pests have found their way out there, and actually dispossessed the native species. The Maoris, who are keen observers, have this saying, "As the white man's rat has driven away the native rat, as the European fly drives away our own, and the clover kills our fern, so will the Maoris disappear before the white man himself."

There is also an article on the Flint Flakes of Devon and Cornwall, by Spence Bate, Esq., F.R.S., which is well deserving the attention of Quaternary Geologists.

The July number (24) has a contribution by Mr. W. Carruthers, F.L.S., "On the Botany of a Coal-mine." It is very gratifying to find that, after a period of so many years, we have again a good palæobotanist actively at work in this country—one who, from his connection with the Botanical Department in the British Museum (so rich in memorials of the late Robert Brown, its former keeper), may naturally be expected to excel in this branch of science. The pages of the GEOLOGICAL MAGAZINE contain many valuable contributions to fossil botany from Mr. Carruthers' pen. The article in the "Popular Science Review" should be read by all who wish to obtain a good notion about the origin of coal.

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4. THE INTELLECTUAL OBSERVER maintains its character admirably, having within its pages a goodly store of information on things in general, and the heavenly bodies in particular. The very remarkable change first observed by Schmidt in the lunar crater of "Linné," situated in the plain of the Mare Serenitatis (noticed in the "Intellectual Observer" in January last, and also in many subsquent numbers) supposed to be the result of a volcanic eruption, appears (from the August number) still to rest upon very slender evidence. There is great truth in the concluding remarks of M. Elie de Beaumont, "that if observers, placed in the moon, viewed Vesuvius or Etna before and after an eruption, they would only notice very slight changes. A great eruption, even of Vesuvius, would produce no other effect than to diminish slightly the depth of the semicircular trench of the Atrio del Cavallo and to change its colour. Seen from the moon, such an alteration would appear problematical, and give rise to discussions among observers. A single change, however slight, would show that geological life exists in the interior of the moon, as well as of our earth.

The May and June numbers contain an account of the structure and systematic position of Graptolites, by Mr. W. Carruthers, F.L.S. (with two excellent plates). The author, after giving their history, structure, and classification, concludes by a consideration of their affinities to living forms, and gives good reasons for placing them among the *Hydrozoa*, although a somewhat abnormal form of that class. We should notice two other geological articles which appear in the August number, one by Mr. Bernard H. Woodward (eldest son of the late Dr. S. P. Woodward), "On the Geology and Ferns of Glen Clova;" the other "On the Origin of the Cheddar Cliffs," by D. Mackintosh, Esq., F.G.S. The latter gentleman's name is well known as a frequent contributor to the pages of the GEOLOGICAL MAGAZINE.

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## REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—June 19, 1867.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The following communications were read:—"On *Cyclocyathus*, a new genus of the Cyathophyllidea, with remarks on the genus *Aulophyllum*." By P. Martin Duncan, M.B., Sec.G.S., and James Thomson, Esq.

A careful examination of a large series of sections and weathered specimens of Corals from near the base of the Carboniferous series at Lesmahago, etc., which have hitherto been referred to the genus *Aulophyllum*, E. and H., has convinced the authors that *A. fungites*, and *A. Bowerbanki* must be referred to a new genus, which they propose to name *Cyclocyathus*. It differs from *Aulophyllum* in having a more or less essential columella of a very complicated structure, while that genus was described by its authors as devoid of any such structure. One form in the series of specimens examined by Dr. Duncan and Mr. Thomson exhibited no columella, and the space which would otherwise have been occupied by it was covered in by successive tabulæ; they therefore referred it to *Aulophyllum*, under the name of *A. Edwardsi.*

2. "On the discovery of a new Pulmonate Mollusk (*Conulus priscus*, P. P. Carpenter) in the Coal-formation of Nova Scotia." By J. W. Dawson, LL.D., F.R.S., F.G.S.

Some crushed specimens of the little shell described in this paper were found in a bed of clay, associated with numerous individuals of *Pupa vetusta*, between coals No. 37 and No. 38 of the Joggins section, during a search undertaken for the purpose of discovering, if possible, traces of land-animals in addition to the *Pupa* already known. On submitting these specimens to Dr. P. P. Carpenter, they were referred by him to the group *Conulus*,—a sub-genus of *Zonites*; and he has added to Dr. Dawson's paper a description of the characters which they present.

3. "On some tracks of *Pteraspis* (?) in the Upper Ludlow Sandstone." By J. W. Salter, Esq., A.L.S., F.G.S.

Impressions upon two slabs discovered by Mr. R. Banks in the Downton or Upper Ludlow Sandstones of Kington, Herefordshire, were described by Mr. Salter as the tracks of *Pteraspid* fish. His reasons for assigning this origin to the imprints were partly based upon their character, and partly on the fact that the *Pteraspis* was the only known creature of the period capable of making the imprints. He was of opinion that the tracks were produced by fish endowed with stiff defences to their pectoral or ventral fins. Whether the *Pteraspis* possesses such defences he was not aware, though he thought it not at all improbable.

4. "On a new *Lingulella* from the red Lower Cambrian rocks of St. David's." By J. W. Salter, Esq., A.L.S., F.G.S., and H. Hicks, M.D.

Until very recently not a vestige of any organic remains had occurred in the red rocks of the Lower Cambrian series. The fossil now in question, which has been obtained from these deposits, is unquestionably a *Lingulella*; and although apparently of the same species as one which Mr. Salter names *Lingulella ferruginea*, very common in the lowermost of the layers which have yielded *Paradoxides*, this older form is distinguished by the varietal name of *L. ferruginea* var. *ovalis*, Hicks.

5. "Observations on certain Points in the Dentition of Fossil Bears, which appear to afford good diagnostic characters, and on the

relation of *U. priscus*, Goldf., to *U. ferox*." By George Busk, Esq., F.R.S., F.G.S.

After noticing the difficulties which attend the study of the bones of the skeleton generally in Fossil Bears, and the somewhat confused and contradictory opinions as to the distinction of species which have arisen in consequence, Mr. Busk stated that his object in the present communication was merely to call attention to some points in the dentition which seemed to afford more certain and more readily ascertainable characters than could at present be drawn from the bones, and which, at any rate in the absence of other evidence, were a sufficiently sure guide in the distinction of species.

The characters derived from the teeth depend

1. On their dimensions, absolute and relative.
2. On their form.

It is not necessary, however, to consider all the teeth. The canines vary too much even within the limits of one species to be of much utility; and, with certain exceptions, the differences exhibited in the molars are not sufficiently marked to allow of their being employed.

The teeth upon which reliance is to be placed are the upper and lower fourth premolars, and the last molar in each jaw; and the distinctive characters of these teeth in *U. spelæus*, *U. priscus*, *U. ferox*, and *U. arctos* were pointed out.

It was also endeavoured to be shown that in the size, proportions, and form of the teeth, no essential differences could be perceived between *U. priscus* and *U. ferox;* and the opinion was expressed that so far as cranial and dental characters are concerned, those two species are at present indistinguishable.

6. "On the Geology of the province of Canterbury, New Zealand." By Julius Haast, M.D., F.R.S., F.G.S. Communicated by Sir R. I. Murchison, Bart., K.C.B., F.R.S., F.G.S.

The Southern Alps in the Province of Canterbury were stated to form the eastern wing of a huge anticlinal of granites; on the western base of this central chain younger granites of secondary age support semimetamorphoric strata. The eastern side of the arch consists of a succession of huge folds of dioritic sandstones, clay-slates, and breccias, overlain by either Upper Devonian or Lower Carboniferous strata.

The Southern Alps are bounded on the eastern side by a belt of old Tertiary quartzose trachytes and pearlstones, on which repose extensive agglomeratic and tufaceous deposits,—clays, sands, and lignite bands; these are succeeded by thick-bedded calcareo-arenaceous strata; the whole broken through by Dolerites, which in their turn are covered by sand, clays, and thin limestones, probably of Pliocene age.

The author concluded by describing the Post-pliocene moraine-accumulations which are found on both sides of the Southern Alps.

7. "On the Chemical Geology of the Malvern Hills." By the Rev. J. H. Timins, M.A., F.G.S.

From a detailed examination and analysis of the rocks composing the Malvern Hills, with a view to the determination of the chemico-physical processes which have contributed to their formation, Mr. Timins has arrived at the following general conclusions in regard to those rocks of eruptive origin :—(1) that, in the intrusive trap-rocks, the ratio of the oxygen of the silica to that of all the bases taken together, varies progressively from 5:4 to nearly 2:1 ; (2) that the relative proportions of the several bases vary considerably in different rocks, and often characterize particular localities ; (3) that the chemical composition of the eruptive rocks does not vary according to their age ; (4) that the atomic proportions of the silica to the bases is generally highest in the largest masses of trap, and lowest in the smallest masses ; (5) that in the same masses of trap there is an appreciable increase in the silica towards their centres, and that the *primary source* of all the trap-rocks in the Malvern Hills was nearly a bi-silicate, which, during the various processes by which it has been brought to the surface, has become united, more or less, with other substances, assimilating metallic oxides, lime, magnesia, or alkalies, according as one or another might be locally prevalent, just as, in modern times, the lava of Vesuvius takes up soda, and that of Etna lime ; and (6) that in all the eruptive rocks the atomic proportion of the silica to the bases varies according to a common law.

8. "On the Relative Distribution of Fossils throughout the North Devon series." By Townshend M. Hall, Esq., F.G.S.

The author gave a table showing the relative distribution of the organic remains throughout the members of the Devonian system of North Devon. The subdivisions of the rocks employed by Mr. Hall are :—(1) The "Pilton Beds," highly fossiliferous ; (2) "Cucullæa Zone," a term proposed in place of that of the "Marwood Beds," and suggested by the abundance of the shells of several species of *Cucullœa*, which are contained in the sandstone of the series ; (3) the "Morthoe group," unfossiliferous ; (4) the "Ilfracombe group," containing corals and several species of Brachiopods in good preservation ; (5) the "Martinhoe group," unfossiliferous ; (6) the "Lynton Beds," with few fossils ; and (7) the "Foreland grits," which are without fossils, and the lowest of the series.

9. "On the Geology of the Princess Islands in the Sea of Marmora." By W. R. Swan, Esq. Communicated by Sir R. I. Murchison, Bart., K.C.B., F.R.S., F.G.S., etc.

Mr. Swan pointed out the existence of a considerable mass of Devonian strata, partly fossiliferous, in several of these Islands, of an age different from that of the beds of the Bosphorus, which latter he has shown in a former paper to belong to the lowest of the Devonian series of the Rhine. The presence of remains of fish in the above strata, and of an ancient coral-reef in one of these islands (Andirovitho), was also noticed.

The rocks which form the remaining portions of these Islands are (1) Trachytic, of younger age than the Devonian strata, and (2) Trappean, more recent than the Trachytic. The Quartz rocks, of which some of the islands are largely, and others entirely composed, are altered sandstones of Devonian age.

10. "On the Sulphur Springs of Northern Formosa." By Cuthbert Collingwood, M.B., F.L.S. Communicated by the Assistant-Secretary.

The sulphur springs are situated amongst the hills near Tamsuy, in the north-eastern corner of the Island of Formosa, and indicate the existence of volcanic action near the surface of the region, a phenomenon otherwise afforded by the frequent occurrence there of earthquakes. One spring possessed the character of a mountain torrent, and had a temperature of about 130°. The spot containing most of the springs occupies about two acres of ground, is quite barren of vegetation, and is covered with low hillocks of friable rocks and débris, interspersed with shallow pits containing mud, sand, and sometimes water. From cracks and fissures in these depressions arose clouds of steam; and around them was strewn a quantity of sublimated sulphur, the yellow colour of which was visible from a distance.

11. "On the Geology of Benghazi, Barbary; with an account of the subsidences in its vicinity." By George B. Stacey, Esq. Communicated by the President.

The town of Benghazi is built on a stratum of clay, which reposes on a sandy foundation. It is partially protected from the action of the sea by a reef of sandstone rocks projecting two or three feet above the water-level. Between the reef and the land the water is now about five feet in depth, while fifty years ago this area was dry land; remains of buildings are to be seen under the water. The author is therefore of opinion that the land is sinking regularly, and comparatively quickly. The fundamental rock of the country is a Tertiary limestone, and the author has obtained from the neighbourhood of Benghazi specimens of Corals, Echinoderms, Oysters Pectens, and on the surface *Cardium edule.*

12. "Report on the Existence of large Coal-fields in the Province of St. Catherine's, Brazil." By Edward Thornton, Esq. Communicated by the Rt. Hon. the Secretary of State for Foreign Affairs.

The existence of Coal in this district has for many years been an established fact; but no practical exploration had been made until the years 1861–63, when Viscount Barbacena, having purchased a tract of land containing the best seams, ascertained the existence of a series of coal-beds at nine different levels, underlying a sandstone formation, horizontally disposed, and varying in thickness from 1½ to 10 feet. Analyses of specimens of the coal prove it to be of good quality, its profitable working depending solely upon the facilities for transport.

13. "On the Sources of the Materials composing the White Clays of the Lower Tertiaries." By Geo. Maw, Esq., F.G.S., F.L.S.

In examining some of the light-coloured deposits occurring beneath the Boulder-clay, in pockets in the Carboniferous Limestone, the author was led to the conclusion that some of the beds of very pure white clay could not have been derived from the mere mechanical degradation of any previously existing materials, and analyses by Dr. Voelcker showed that they contained similar proportions of silica and alumina as did the limestone; and Mr. Maw concluded that they were left behind in the cavities after the calcareous matter had been removed by watery dissolutions. The average of a number of analyses of the white Tertiary clays of Dorset, Hants, and Devon, showed a similar resemblance to the average compositions of a number of examples of Chalk and Chalk-marl, after deducting the carbonate of lime and other matters soluble in carbonated water, implying a derivation from the watery dissolution of the Chalk. The geographical distributions of the Tertiary white clays seemed to favor such an origin, and the improbability of their derivations from the felspathic rocks was supported not only on geographical but on chemical grounds. The average of the analyses of felspar showed that the proportions of silica to alumina was about as three to one, and in the average of a number of analyses of clays as two to one, indicating that felspathic rocks could not provide the proportion of alumina found in the white clays; but the proportion of silica to alumina in Chalk corresponded as nearly as possible with their composition.

14. "On the Post-glacial Structure of the South-east of England." By Searles V. Wood, Jun., Esq., F.G.S.

This paper was an outline of the principal points deduced by the author from his Geological survey of the country included in the Ordnance sheets Nos. 1 and 2, where the glacial clay approaches nearest to the Thames Valley beds; and from a survey on a smaller scale of the glacial beds over a much larger area. Both of his maps, with a manuscript memoir upon the subject, have been placed by him in the Library of the Society.

The author took up the structure at the southerly and westerly edges of the principal tracts of glacial beds, and in the parts where these are divided by great troughs of denudation; he showed the manner in which the denudation, commencing at the first upheaval of the glacial sea-bed, has descended through the Lower Tertiary and Secondary deposits, accompanied by the formation of successive gravel beds during its progress. His conclusion was, that the removal of the Lower Tertiary strata over much of the South of England, and the excavation of the Weald Valley, as well as the great denudation which the Liassic, Oolitic, and Cretaceous beds have undergone in the west of England, are to be traced principally to the progress of the post-glacial denudation. This denudation had its inception in the upheaval of a portion of the glacial sea-bed, and was accompanied by a long succession of subterraneous disturbances, which have brought up the Secondary and Tertiary rocks of the south and west to the elevations they now occupy, and left the early emerged portion of this sea bed (represented by the detached tracts of the Upper and Middle Glacial formations) at lower levels than much of the denuded area of the south and west.

The following specimens were exhibited:—

A series of Elephants' teeth from the Norwich Mammaliferous Crag and the Forest-bed of Norfolk; exhibited by the Rev. John Gunn, M.A., F.G.S., showing (*a*) the transition of the (*Loxodon*)

*E. meridionalis* into the sub-genus *Euelephas*; (*b*) the necessity for establishing a new species, called by Mr. Gunn *Leptodon,* from the fineness of the enamel; (*c*) the variation of the *E. antiquus* from the Post-glacial Mundesley lacustrine bed, and (*d*) the probable derivation of the *E. antiquus* from an old type of the *E. Africanus* in the Norwich Mammaliferous Crag.

Cotteswold Naturalists' Field-club.—This club met for the second time this season at Mickleton Manor, near Campden, by invitation from Sir Maxwell and Lady Steele Graves.

After dinner, Dr. Paine, the hon. secretary, read Mr. Bravender's paper "On the Watershed of the Upper Thames."

The subject of water supply having of late so much occupied public attention the author offered some account of the watershed of the Upper Thames, between the sources of the Thames and Oxford. The course of the Thames is eastward, and it is fed by many small rivers and brooks coming from the north and south. The highest area of the watershed of the Thames is 74 square miles. The author described in detail the various streams which feed the Thames above Oxford, the largest the Ock, draining an area of 100 square miles, falls into the Thames at Abingdon, below Oxford, and beyond the district named. The watershed on the south side of the Thames, containing 123 square miles, yields a smaller supply than the same area north of the river. The dip of the strata is south-east, descending from the Thames on the south side, but towards the Thames on the north side. The surface of the country slopes from the Chalk Hills towards the Thames, and the water which immediately runs off reaches the Thames, but at a slower rate than that from the north. Part of that which is absorbed by the soil, and part which is lost in the streams in the passage over open and porous beds, sinks through those porous beds to the upper surface of the tenacious beds of the Oxford clay, Kimmeridge clay, and the Gault, and the water descending the plane of stratification in a contrary direction to that of the river is lost to the Thames. The same remarks refer to the watershed of the Ock. The area of the watershed of the Upper Thames thus described is 875 square miles, and is made up as follows:—

| | | |
|---|---|---|
| WEST OF THE THAMES. | SQUARE MILES. | |
| Swillbrook and Thames Head ... ... ... | 74 | |
| NORTH OF THE THAMES. | | |
| The Churn ... ... ... ... ... ... ... | 73 | |
| Ampney and Marston brooks ... ... ... | 32½ | |
| The Coln ... ... ... ... ... ... ... | 87 | |
| The Leach ... ... ... ... ... ... ... | 36½ | |
| The Brampton and Thames district ... ... | 119 | |
| The Windrush ... ... ... ... ... ... | 141 | |
| The Evenlode ... ... ... ... ... ... | 189 | |
| | | ——752 |

| SOUTH OF THE THAMES. | | 752 |
|---|---|---|
| The Ray ... ... ... ... ... | 65½ | |
| Highworth district ... ... ... ... | 9½ | 123 |
| The Cole ... ... ... ... ... | 48 | |
| | | 875 |

The rainfall over this 875 square miles may be taken at 28 inches per annum, from which 12 inches should be deducted for evaporation. The rainfall on a square mile, with this deduction, will be 1,376,710 cubic yards. But to arrive at the probable available quantity a further deduction should be made for percolation into porous strata, which may not afterwards be thrown out by springs, and in consequence may not reach the Thames, but pass under it. Some of this water *we know* must be brought to the surface by faults, as at Boxwell Spring; but this can only be part of what percolates through the beds of the upper Oolite to the surface of the Fuller's earth. The water which is absorbed by the porous beds of the Inferior Oolite is very large, amounting to a third of the rainfall. Mr. Bravender then proceeded to point out that the greatest loss by percolation is in those streams which pass over the Inferior Oolite, the area of which is about 106 square miles. The Churn, Coln, Windrush, and Evenlode, lose greatly in passing over the loose and rubbly rock of the Inferior Oolite. The average yearly loss is not less than half the rainfall, after deducting for evaporation, leaving eight inches of available water. The available depth over the other strata in this watershed may be taken at twelve inches. The mean would appear to be somewhere between nine and eleven inches. Assuming it to be nine inches only, and the inhabitants of London to be 3,250,000, then 272 square miles of watershed at this depth will supply them with thirty gallons of water each per day. It will thus appear that the watersheds of the Churn, Ampney and Marston brooks, the Coln, and of the Ock, amounting to 292½ square miles, will more than supply the entire population of London. The Churn, the Coln, and the Windrush having an aggregate watershed of 301 square miles, are more than sufficient for the purpose; and the watersheds of the Churn, Coln, and Ock, containing 260 square square miles, are nearly sufficient for the purpose. London is at present said to be supplied with 643,000 cubic yards of water daily, which is at the rate of more than thirty-three gallons per head for three millions and a quarter of inhabitants. If this be correct, London is more abundantly supplied with water than many other towns. The author then gave a detailed account of a series of observations of the actual quantity of water flowing down the river in the twenty-four hours in August, 1864, near Castle Eaton, and he found it to be in one instance thirteen millions of gallons. In the September following the volume of water had decreased to seven millions of gallons. On the 8th of October only one million gallons descended in the twenty-four hours. In the morning of this day (Mr. Bravender said), "I had ascertained no water was passing down the Thames at the bridge at Cricklade; there was no water in the river there except in the hollows in a few places. I examined the Churn, which flows into the Thames near Cricklade, and found that river completely dry at South Cerney, and on descending the stream to where the water from Boxwell Spring joins the Churn I observed a considerable quantity of water flowing into the Churn from Boxwell Spring. On visiting Boxwell Spring, about a quarter of a mile up the brook from this junction, I found it discharging about the usual quantity. I had sometime before ascertained the flow of this spring, and did so at this time, and found the discharge about one million one hundred thousand gallons in twenty-four hours. The fact is that the water passing Water Eaton was from the Boxwell Spring, and in passing over about three miles of porous gravel and somewhat peaty soil there was a loss of one hundred thousand gallons per day at that time. This loss would eventually find its way into the Thames lower down the vale. It may be observed that from the middle of August to the middle of October scarcely any rain fell, and that which did fall was absorbed immediately, and made not the slightest difference to the water in the Thames. Our observations extended over forty-five days, from the 24th August to the 8th of October, and during this period the entire supply of the Thames above Water Eaton ceased, except what was supplied by Boxwell Spring." Mr. Bravender concluded by giving an account of the loss of water in the Churn by percolation, being the results obtained by a series of experiments in 1859, showing a loss of upwards of three millions of gallons per day. The loss of water descending the Coln is much greater than that of the Churn.

Two other papers followed; first, some notes by Mr. John Jones, "On Drybrook section in the Forest of Dean;" second, "On the Denudation of the Cotteswolds," by Mr. E. Mitchell.—*Wilts and Gloucestershire Standard*, June 29th, 1867.

## CORRESPONDENCE.

### FISH-REMAINS FROM THE NORTHUMBRIAN COAL-FIELD.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—The haste with which the critic (in GEOL. MAG., August, p. 378), not waiting for the 'paper,' has assailed the 'abstract,' in the July number, p, 323, would seem to show him moved by some smaller feeling than the desire to know a little more about the fossils of the coal. Howsoever that may be, any remarks which Mr. Atthey, after perusal of the paper and inspection of the fossils therein described, may have to offer will meet with due and respectful attention from me. I would, meanwhile, request your readers kindly to suspend their judgment; and I appeal to them, not so much on my own account, but lest they should attach to the words, "a short time ago" (p. 378), a meaning different from that which Mr. Atthey, speaking from knowledge, must entertain. In justice to Mr. T. Craggs I have to state that I have been favoured by receiving from that gentleman specimens from the shales of West Cramlington and other places since June, 1865. Both gentlemen are personally unknown to me, though it is possible that they may have been of the number of those who submitted fossils to my inspection after a lecture I previously delivered at Newcastle-on-Tyne.

RICHD. OWEN.

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### *SPIRIFER CUSPIDATUS* AND *SYRINGOTHYRIS TYPA*.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—Absence from home and other causes compel me to defer my reply to Dr. Carpenter's and Mr. Davidson's papers on the structure and histology of "*Syringothyris typa*" for a short time longer, when I shall be able, from ample materials in my possession, to show clearly that it is no other than *Spirifer cuspidatus*, as represented by imperforate and tubeless specimens.

WILLIAM KING.

BELMONT, near GALWAY,
*July 8th*, 1867.

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### THE CLAY-BED NEAR STANNAGE, DERBYSHIRE.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—I went up to Stannage the other day for the purpose of determining whether the bed of clay, seen by Mr. Binney, and mentioned by Mr. Maw in his paper in the June number of your MAGAZINE (page 247), was a member of the Carboniferous system or a more recent deposit. There can be no doubt that it is the former. A small pit has recently been sunk close to Spitewinter in order to get clay, it may be some fifteen or twenty feet deep, but as it was partly filled up with water I had no proper means of ascertaining the exact depth. The upper part exposes a section of thin shales, beneath are sandy clays and clay, and lastly, a thin seam of coal, which appears to have been only just touched. There is a good deal of clay under the peat in the immediate neighbourhood, and it has been dug into somewhat extensively still further to the west near the old Cupola marked on the Ordnance Map. When I have time I will endeavour to find out, if possible, the boundaries of the deposit; immediately above it, to the north, is the fine escarpment of what I conclude to be the first grit. May not the shales above-mentioned correspond with those spoken of by Messrs. Hull and Green in their paper on the Millstone Grit, in No. 79 of Geol. Journ. They say "shales, with a thin coal at the bottom, west of Buxton, lie below the Rough Rock." A thick bed of shales has also been exposed by a landslip on the north bank of the river Hipper, below Catholic hill, on the north-west side of Stannage. I may mention that the grit escarpment of Stannage has every appearance of having been an old sea-worn cliff; it has hollows or rock-pools in its face or on its summit; the escarpment is on the south-west side of the hill; on the other side the slope is more gradual, and three or four terraces look very much like old beach lines, but as they have not been cut into I cannot say for certain.

A reference to the Ordnance Map, No. 82, south-west, will explain the relative position of the localities above referred to.

I am, yours truly,
J. M. MELLO.

ST. THOMAS'S PARSONAGE, BRAMPTON, CHESTERFIELD,
*July 22nd*, 1867.

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## DR. T. STERRY HUNT'S THEORY OF THE EARTH.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—I have read with considerable interest the very ingenious theory of the "Chemistry of the Primeval Earth," by Dr. Hunt, which is contained in your issue for August, and beg your permission very briefly to ask the Doctor how his theory is compatible with the following facts respecting the mean densities of the sun and larger planets, or whether the theory of their extensive hollowness does not more satisfactorily account for their low mean densities than does that of the sun, the earth, and, by inference, all the planets increasing in density to their centres.

The following are approximately the mean densities of the sun and the larger planets :—

| | | | |
|---|---|---|---|
| Sun... ... ... ... ... | 1·42 | Uranus ... ... ... ... | 1·0 |
| Jupiter ... ... ... ... | 1·37 | Neptune... ... ... ... | 0.5 |
| Saturn ... ... ... ... | 0·5 | | |

and those of the smaller planets are—

| | | | |
|---|---|---|---|
| Mercury... ... ... ... | 6.6 | Earth ... ... ... ... | 5.5 |
| Venus ... ... ... ... | 5.6 | Mars ... ... ... ... | 5.6 |

The densities of the asteroids are unknown, but should they be ascertained, I venture to predict that they will probably be found of higher mean density than are any of the planets just enumerated. All the large planets have very low mean densities; all the smaller planets have high and nearly uniform mean densities.

How are these facts to be accounted for on Dr. Hunt's theory of condensation and increase of density to the centres?

I am, yours obediently,
T. P. BARKAS.

NEWCASTLE-ON-TYNE,
*August 6th*, 1867.

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## ON THE SEQUENCE OF THE DRIFTS IN THE EASTERN COUNTIES.

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR,—With reference to Mr. Wood's suggestion, that I should give complete sections from his "upper drift" to the beds exposed on the coast, I wish to say that I have not materials by me to work out the details he asks for, and it appears to me that the point at issue would not be explained by exact particulars of surface contour, and the position of the crags in relation to the overlying drifts. There is no difference of opinion as to this, and all are agreed that the gravels underlying the Boulder-clay of High Suffolk correspond in height with much of the gravel superimposed on the clay in the coast cliffs. This I admitted in my first paper, and am quite aware it presents a *prima facie* case in favour of Mr. Wood's views; and furthermore on the view I suggested I should expect that the variety in the component materials of Mr. Wood's "middle drift" would prevent any certain distinction being observable between them and the gravel seen on the coast, even if a section happened to expose their junction.

The difficulty Mr. Harmer raises seems to me to be equally applicable under any view; if, for example, the coast beds at Trimmingham are much above the level of Norwich why are they not, on Mr. Harmer's view, intercalated between the crag at Thorpe and the beds Mr. Harmer has identified with Mr. Wood's "middle drift." Surely some cases ought to occur among the numerous exposures of Norwich Crag in Norfolk, in which the Boulder-clay of the Cromer cliffs can be seen to intervene between the Norwich Crag and Mr. Wood's "upper-and-middle-drifts." The absence of Boulder-clay as the highest member of the cliffs of the Norfolk coast (the equivalent of that in High Suffolk) I have already admitted in my first paper *might*, on Mr. Wood's views, be the result of denudation; but its absence throughout the district, wherever Boulder-clay is known to form the base of the cliffs, is rather remarkable. Mr. Gunn and Mr. Wood I am aware believe that it does exist in the low cliffs at Pakefield and Corton, but if *all three divisions of the drifts* are developed at these points, within a height of thirty or forty feet, it involves the difficulty of a great attenuation of Mr. Wood's two upper divisions after they leave the high land and descend more than 200 feet to the sea-level. At Corton, the assumed equivalent of Mr. Wood's "upper Boulder-clay" is but from three to nine feet thick; at Hasboro' ten feet; whilst in High Suffolk the Boulder-clay attains a thickness of at least sixty feet.

The occurrence of derivative fossils would seem to be rather an uncertain guide in the classification of the drift series. Mr. Taylor (at page 238) observes that the coast clay has been formed principally by the wreck and denudation of the Lias (and the editor adds, of the Kimmeridge clay); but this is really no distinctive feature, as the Bedfordshire Boulder-clay, which is evidently an extension of the High Suffolk clay, is literally loaded with these fossils, and the late Mr. Trimmer (in the quotation given by Mr. Gunn) described his "upper Boulder-clay" (the "upper drift" of Mr. Wood) "as characterized by an abundance of oolitic detritus." Unless it is assumed that the materials of the Boulder-clays have been derived from a distance, and in each from different directions, it seems probable that successive deposits in the same localities should contain similar derivative fossils.

In the observations I have made I have wished rather to leave the succession of the drift deposits an open question than to lay down unequivocally any order of sequence. It is a subject that may well be held in suspense, and the evidence in relation to it seems scarcely of a nature to base exact conclusions upon, or to afford materials for mapping out the various subordinate divisions of the drift series. The existence, however, of Mr. Harmer's "Third Boulder-clay," as a distinct formation, seems to depend on the certainty of the coast beds being inferior to those of High Suffolk. The small patches of Boulder-clay in the Yare Valley are clearly more recent than the drifts that have been cut through to form the valley; but does it not seem less improbable that the coast beds may be identical with them, than that these isolated patches of a marine deposit should have been the solitary result of the submergence during which they were formed?

George Maw.

Benthall Hall, Broseley,
*August* 6*th*, 1867.

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"THE LOB-WORM EPOCH."

*To the Editor of the* Geological Magazine.

Sir,—Colonel Greenwood's remarks in the August number of the Geological Magazine on the "Lob-Worm Epoch" tempt me to lay before your readers a few facts concerning the rocks of that period, as shown in this neighbourhood, and the results obtained by their examination during the last few years.

Mr. Salter and myself have for some time felt convinced that most, if not the whole, of the Cambrian rocks belonged to a fossiliferous period, and accordingly in our own report to the British Association in 1865, on the "Lower Lingula-flags" (Menevian group) and its fossils, it was stated that, "though the purple band series have not yet yielded any definite traces of these higher forms of fossils, we are scarcely warranted in looking upon that as a proof of their absence; neither is it likely that so rich, though limited, a fauna should come so suddenly into existence." Since then I have been fortunate enough to find fossils in these identical purple beds, which prove the facts at that time only conjectured.

In a paper by Mr. Salter and myself, read before the Geological Society on June 19th, an account is given of the finding of a *Lingulella* in the red rocks of the Lower Cambrian-rocks, hitherto deemed quite destitute of higher organisms than worms, and belonging to the very series mentioned by Mr. Baily. I have found also, subsequently to the reading of the paper referred to, a whole colony of species (trilobites, etc.) still lower down, showing, beyond a doubt, that much, if not the whole, of the so-called "worm epoch" represents a time when animals of much higher forms than worms were in existence, and flourished in the seas of the period. I therefore feel satisfied that if active explorations be carried on in North and South Wales, it will be *proved* that the series throughout is truly fossiliferous, but I am also sensible that some time will be required to decide the fact, since the working of the strata is, in many ways, difficult, and the deposit from its very nature, as a rule, unfavourable to the exhibition of organic remains.

Moreover we are sure to find, especially in so extensive a series, much that is but very slightly fossiliferous, or, indeed, almost barren, intervening between colonies of rich faunas. Such is really the case with nearly all the groups already found, scarcely a vestige being seen in most of the beds which separate the several colonies, upon which usually we come quite abruptly. This I look upon also as one of the chief causes why a Lower Cambrian fauna has not ere now come to light.

I am, sir, yours truly,
HENRY HICKS.

ST. DAVID'S,
*7th August*, 1867.

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PHOLAS-BORINGS IN DEVONSHIRE.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—As I have observed in your journal for July some remarks on Pholas-borings found 200 feet or more above the present high-water-mark, on the cliffs in the neighbourhood of Torquay, perhaps one or two words on these ancient rock-perforations may not be out of place by one who has more than once made them the object of his search and examination.

Some time ago, in the year 1864, I happened to be visiting Ilfracombe and its neighbourhood, and, amongst other coast scenery, I spent a day on Woollacombe sands, extending my ramble to the summit of the hills called Morte Point, not forgetting to search carefully far above the present sea level, its rocky wall and face, when practicable, for the marks or signs of some ancient stone-boring mollusk.

And here I ought to mention that Mr. Pengelly was the first person from whom I learnt the supposed origin of these peculiar marks or holes in rocks near the sea-coast. As I minutely looked over its pointed heights facing the sea, after some trouble I found a number of perforations from an inch to two inches in size, and about one inch or a little more in depth. I cannot speak exactly, as I write now from my recollection of what I then saw.

Some of the rock-cuttings were much worn by the action of the weather: some, no doubt, were naturally formed by frost and other causes; while some, in a more sheltered part of the hill, appeared nearly as perfect as when left by their excavators.

In my own mind the evidence is so conclusive that these small hollows are Pholas-borings, or the work of some Mollusk, and that the rock, now 200 feet or more above the sea-level, must have been once under water at every tide.

Some five or six years before this examination of the hills at Morte Point, I happened to be staying in Plymouth, and, having a little spare time on hand, I closely explored the rocks which fringe the sea-beach below the Hoe, and there I found a number of freshly-formed holes in the limestone rock, covered at every tide, about the size of the Pholas-borings, only they extended much deeper in the rock, while at the same time there appeared to be a kind of hard, shining coating on the inside of their holes, much like the inner part of an almond shell. The reason, perhaps, why these ancient stone-borings are seldom noticed, is the fact, I think, that the old sea-coast is partly washed away, for it is only (so far as my observation extends) when the rock is some little distance inland, as at Morte Point, Devon, that they are to be found.

It is possible that what I have stated may attract the notice of some of the numerous excursionists at this season of the year, and, if so, there would be no difficulty in verifying the few observations I have ventured to send to your Magazine for publication.

I am, sir, yours truly,
William Gibbens.

Chelmsford, Essex,
*August 9th*, 1867.

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## THE BOULDER-CLAY OF THE THAMES VALLEY.[1]

*To the Editor of the* Geological Magazine.

Dear Sir,—Any one wishing to see the Boulder-clay on the southern side of the range of heights that form the northern boundary of the Thames Valley, cannot do better than go by train to Romford, and walk to Havering-atte-Bower, three miles from that place. The road is very pleasant and the view from Havering beautiful. The Boulder-clay can be seen in a pit on the right hand side of the drive leading from Havering to Bedfords, as well as in a pit very near the letter D in "lodge" on the Ordnance Map. The Boulder-clay is full of fragments of Chalk, more or less striated, of quartz pebbles, and transported blocks and fossils. The fossils have been caught up by the ice principally from the Oxfordian and Kimmeridgian zones, and consist of *Belemnites*, *Ostrea dilatata*, and other bivalves. In one fragment of shale I found *Ammonites biplex* and in a striated nodule from the Kimmeridgian there was a very well preserved shell of that species. The great interest of this deposit is its position to the south of the northern boundary of the Thames Valley proper.—Yours truly,

W. Boyd Dawkins.

Upminster, Romford.
*June 22nd*, 1867.

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# MISCELLANEOUS.

## A Dynamical Theory of the Figure of the Earth, proving the Poles to be elongated.[2] By F. C. Bakewell.

It is the author's object to prove that the general figure of the earth is that of a lemon, rather than of an orange; in short, that our planet must be elongated at the poles. "The question," he states, "is capable of being determined, without much stretch of reasoning power, by all who possess a knowledge of the first principles of mechanical science. The only thing especially required is that its consideration should be freed as much as possible from the mists of prejudice and the trammels of authority."

[1] This letter was unintentionally omitted from the August number of the Geological Magazine.—Edit.

[2] 8vo. London, 1867, pp. 26. (Weale).

The points which Mr. Bakewell has endeavoured to establish are:

1st. That the ordinary illustrations of the action of centrifugal force, as applied to the commonly assumed figure of the earth, are entirely delusive.

2nd. That the disturbance of equilibrium by centrifugal force in a fluid sphere rotating in space could not be counteracted by the accumulation of matter at the equator.

3rd. That if it were possible that the matter of a fluid sphere put in rotation in space could accumulate at the equator under the influence of centrifugal force in opposition to gravitation, it would fly off altogether.

4th. That *it would be impossible,* therefore, for a fluid mass of matter rotating in space to assume the form of an oblate spheroid.

5th. That it would be equally impossible for a solid spherical rotating nucleus covered with water to assume that form.

6th. That in accordance with the law of motion, that action and reaction are equal and in opposite directions, a fluid mass of matter rotating in space must accumulate at the poles to resist the action of centrifugal force, and in the form of greatest resistance to that force.

7th. That a prolate spheroid is the only figure in which the particles of a rotating mass of matter could adjust themselves in accordance with the form of equilibrium.

8th and lastly. That geodetic measurements, and the appearance of the heavenly bodies, tend to confirm the dynamical theory, that the earth is a spheroid rotating about its longest diameter.

Notes on Atrypa.—Mr. R. P. Whitfield has published (in the 19th Report on the New York State Cabinet) some observations on the Internal Appendages of the genus *Atrypa*; with a notice of the discovery of a loop, connecting the spiral cones. By carefully cutting and preparing favourable specimens, the author has found that in place of the short crural processes so often figured, there is an entire and continuous loop connecting the spiral cones, in a very similar manner to that shown by Professor Hall to exist in his genus *Zygospira*, but having its connection with the spiral ribbons at a point relatively much nearer to their origin on the hinge-plate; still more distant, however, than the points figured by Mr. Davidson and others. This loop, so far as observed, is confined to the rostral, or posterior part of the shell, and never passes over or in front of the spires, as in Professor Hall's genus. The author has succeeded in ascertaining the existence and form of this loop in several different varieties of *Atrypa reticularis*, as well as in *A. spinosa*, of Hall; and he finds that in the different varieties of *A. reticularis*, it is subject to considerable variations of form. The author further remarks, that should these differences prove constant in the several varieties, they may, when considered in connection with the differences in external features, and perhaps some modifications in the form of the spiral cones, serve as guides in establishing specific characters in this group of shells. In a note, appended to his paper, Mr. Whitfield states that since the preparation of his paper he has examined numbers of specimens of *Atrypa*, showing sections of the spires, and he has observed that the volutions composing the cones vary in number, with the increase in age and size of the shell; while specimens of the same size have about the same number of volutions.

ANALYSIS OF A BLACK SPINELLE.—M. Pisani has communicated to the Academy of Sciences, Paris, the analysis of a black spinelle from the Haute Loire. It is as follows:—

| | | | |
|---|---|---|---|
| Alumina | 59·06 | Ferrous Oxide | 13·60 |
| Ferric Oxide | 10·72 | Magnesia | 17·20 |

It is remarkable from its crystalline form—an octohedral pyramid—which has not before been recognized in spinelles. This mineral is chiefly found in Haute Loire, but it is also met with in the igneous rocks of Auvergne.—*Comptes Rendus.*

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ERRATA FOR JULY AND AUGUST.

Page 300, line 6, from top of page, for "Surturbrand" read *Surturband.*
" 321, " 9, from foot of page, for "silicia" read *silica.*
" 327, " 25, from top of page, for "breach" read *beach.*
" 375, " 24, " " for "outline" read "*outlier.*"
" 382, " 5, from top of page, for "Ordnance Memoir," read "Geological Survey Memoir."
" " " 6, from top of page, for "Hall" read "*Hull.*"

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DR. T. STERRY HUNT'S LECTURE.—We hoped to have received from Dr. Sterry Hunt some corrections of the Short-hand Writer's Report of his Lecture at the Royal Institution, on "The Chemistry of the Primeval Earth,"—(See GEOL. MAG. for August, p. 357,)—but his unexpected departure for Canada having prevented, we hasten to give such errata as we have been enabled, with the assistance of our colleagues, to detect, and, at the same time, we beg to apologise to Dr. Hunt for their occurrence:—

Page 361, line 26, from top of page, for "increases the act of fusion," read "raises the melting point."
" " " 38, from top of page, *delete* "largest."
" 362, " 11, " " for "the metallic bases" read "the *other* metallic bases."
" " " 25, from top of page, after the words "may be absorbed," insert "and given off."
" " " 16, from foot of page, for "seven times" read "several times."
" 363, " 11, " " for "consist only of lime," etc., read "contain only lime," etc.
" 364, lines 14 and 15, from foot of page, for "the remains of calcareous animals" read "the calcareous remains of animals."
" 365, line 39, from top of page, for "disruptive" read "eruptive."
" " " 40 " " for "decomposed" read "recomposed."
" 366, " 24, from foot of page, for "Orchid-house" read "Orchard-house."
" 367, " 4, " " for "Thompson" read "Thomson."
" " " 5, " " for "mutation" read "nutation."
" 368, " 17, from top of page, for "radiation" read "convection."
" " " 19, " " for "gault" read "*Coal.*"

We should, in fairness to Dr. T. Sterry Hunt, state that, owing to his absence in Paris during the month of July, we were unable to submit a proof of the Report, for his correction, before its publication in the August Number of this Magazine; and thus the errors above stated escaped detection.—EDIT.

THE

# GEOLOGICAL MAGAZINE.

No. XL.—OCTOBER, 1867.

## ORIGINAL ARTICLES.

### I.—On the Chemistry of the Primeval Earth.[1]

By David Forbes, F.R.S., etc.

IT will, no doubt, be admitted by all, that it is highly conducive to the advancement of any science, that some one of its votaries, more courageous than his colleagues, and endowed with a more generalizing turn of mind, shall, by the comprehensive and exact study of accumulating observations, endeavour to elevate himself above the level of the more plodding but invaluable collectors of facts, by attempting the arrangement and organization of such data, and the deduction therefrom of the laws which regulate their existence and govern their movements.

Without such generalization, science itself would be but a mere accumulation, or, rather, chaos of unconnected observations.

All honour is therefore due to such leaders in science, whose success should be appreciated in proportion to the difficulties which had to be overcome before it had ultimately been attained. It must not be forgotten, however, that in this century of rapid progress, science, in the pursuit of truth, becomes each day more and more severe in insisting upon exactitude in research, and in demanding that no hypothesis or theoretical deduction be accepted as correct before it has run the gauntlet of stringent scientific scrutiny, in order fully to test its soundness.

In this present communication it is intended to take into consideration the general views in chemical geology, recently expounded by the well-known chemist, Dr. Sterry Hunt, during his late visit to this country, and which have already appeared at length in this Magazine, in a report of a Lecture on the Chemistry of the Primeval Earth, delivered by that gentleman in the theatre of the Royal Institution.[2]

Although but few of the opinions expressed in this lecture are original, the manner in which Dr. Hunt has combined them as a whole, in his argument, is sufficiently at variance with what has

[1] In order not to extend this communication to too great a length, and to avoid going deeper into the more purely chemical points, these latter have been considered in greater detail by the author in a paper "On some points in Geological Chemistry," in the *Chemical News* of October 4th, 1867, to which the attention of the readers of the Geological Magazine is herewith directed.

[2] Geol. Mag., Vol. IV. pp. 357–369. See also pp. 432 and 477.—Edit.

hitherto been generally received in Europe, as to lead to the inference that Dr. Hunt thus gallantly throws down his glove in order to invite discussion upon the subject.

After taking the opinion of several well-known geologists and chemists upon the lecture in question, the author of these remarks concludes that in this case, at least, silence does not imply consent, since, without exception, all referred to were at variance with more than one of the views therein put forth. He would therefore have gladly seen the challenge of Dr. Hunt accepted by some one more able than himself; and, consequently, before entering the lists thinks it proper to explain that he has been induced to do so by Dr. Sterry Hunt's special invitation to "have a friendly fight," which he must confess he was not unwilling to accept,[1] especially as in a late discussion that gentleman's opinions, when quoted by one of his admirers (in the pages of this MAGAZINE) in opposition to his views, were put forward with a show of authority which opinions as yet neither generally accepted nor confirmed can be entitled to.[2]

In his introduction Dr. Hunt adopts the nebulous hypothesis of the earth's origin, assuming the chemical elements to have all been originally present as intensely heated gases, uncombined, and in a state of "indifference" to one another, which he accounts for by referring to Deville's experiments on the dissociation of certain gaseous compounds at intensely high temperatures. A subsequent lowering of the temperature is then supposed to have brought about the combination of the elements, and afterwards the condensation of their compounds into the shape of an igneous fluid globe.

So far, Dr. Hunt arrives at the conclusion advanced in the last century by Hutton, the propounder of the plutonic theory of the world's origin, which assumed the world to have been at one time a sphere of molten matter solidified by refrigeration. In considering the results attendant upon the cooling of such a molten sphere, writers, however, differ greatly in opinion; the majority have supposed the formation of a solid crust of more or less thickness, enclosing a still liquid igneous kernel; more lately some have advocated the existence of a solid central kernel along with a similar external crust, whilst the intermediate space contains still liquid igneous matter; and, lastly, evidence has been recently brought forward indicating the possibility of a solid, or nearly solid globe. Dr. Hunt insists upon the earth being a globe solid to the core, which had solidified from the centre outwards to the exterior, and further represents the first of these views, hitherto the most generally received and maintained by many of the most able geologists and

[1] In the belief that fair discussion advances science, by developing energetically both sides of the question; such discussions should however only be indulged in by those who can give and take with equal good grace, without losing temper or deviating from the subject at issue by indulging in recriminations or personalities, such as Dr. Hunt at the close of his lecture alludes to, as having disturbed the social relations of the geologists of the last century, and which unfortunately sometimes creep into discussion even in this enlightened age.

[2] GEOL. MAG., Vol. IV. p. 287. The author still agrees with "most geologists" in opposition to the opinions referred to.

mathematicians, to have been "supported to a great extent by fallacious reasoning."

That such observers, however, could, as Dr. Hunt imagines, have been led astray by the exceptional case of the crystallization of water, is sufficiently refuted by the intimate knowledge of the behaviour of melted lavas, slags, metals, etc., everywhere displayed in their researches; so that other explanations of the "fallacious reasoning" alluded to must be sought. Dr. Hunt therefore informs us that the solidification could not have commenced at the surface, because the congealed crust is heavier than the molten fluid from which it had cooled—*i.e.*, ought in other words to sink into the same.

Most of the readers of these remarks, have doubtless seen large open castings produced at foundries, and the question may therefore be put to them, whether they ever have observed in such cases, no matter how large the casting might be, that the pellicle or crust, formed upon the surface of the molten iron, sank down into the metal below it (unless purposely broken up by force) ; yet the cast iron, when solid, is well known to be heavier than when in the fluid state. On the contrary, it supports itself in the same manner as the external surface of an igneous sphere would do, if exposed to a cooling action, operating simultaneously upon the whole of its external area.

But, admitting even that it would sink, and supposing with Dr. Hunt that the mean density of the earth is 5·3, and of the solid exterior crust at one-half this, or 2·65, and also that the specific gravity of this latter, when in a fluid state, would be considerably lighter, say 2·3: then surely Dr. Hunt will not expect it to be believed that this solid crust of sp. gr. 2·65, can sink deep down into the fluid *mass of a globe possessing a mean density of* 5.3.[1]

If broken up by force, the fragments of such a crust might be imagined to sink a short way, say a few miles, through the upper or lighter stratum; which at the surface was of a density of 2·3 (becoming rapidly denser in descending, as the pressure increased by the heightened superposed column of liquid matter) until it came to rest in a liquid stratum of its own density, where it would float (in a solid state, if Dr. Hunt is to be believed in asserting that under the extra pressure at this depth, its fusing point would be elevated, and so prevent its absorption into the main mass).

Such an action would, on the contrary, tend to bring about the very formation of a superficial crust, like that which Dr. Hunt denies, for this action once commenced, would go on solidifying at the exterior, sinking to a certain depth, then resting there, superposed on that which had previously congealed and descended, and so on, until a solid crust was eventually formed, extending from this depth to the surface.

[1] If we suppose the mean density of the earth to be 5·3, and that of the surface crust to be 2·65, and further imagine the earth to be composed of three consecutive layers of equal thickness, and of density increasing in arithmetical progression, we should have 2·65 for the density of the outermost zone, nearly 10·7 for that of the middle one, and about 18·8 for the centre.

Dr. Hunt then tells us, that the cooling of the liquid globe would be "like the cooling of a great bath of metal or sulphur," and that it "would commence at the centre and extend outwards toward the surface." This may fairly be questioned. Any one who ever cast a bullet knows how long the centre remains fluid after the exterior shell is solid; the founder knows how difficult it is to get his castings perfect, with their centres solid; and the mode of causing metals, as bismuth, lead, etc., etc., to crystallize, by allowing as large a mass of the fluid metal as possible to solidify exteriorly, and then pricking a hole through the crust, so as to let out the still fluid central metal, is familiar to all, as well as, probably, the fact that this same proceeding is commonly employed to obtain crystals of sulphur.

But Dr. Hunt will doubtless object, that the above experiments were not made under pressure, and, to demonstrate that solidification must in such case have commenced from the centre, refers to the experiments of Hopkins and Fairbairn, as proving that the fusing points of bodies are elevated by pressure.

Fully aware that the fusing points of certain bodies are actually raised when under pressure, and prepared also to believe that silicates may be amongst such, still the author, after a careful analysis of both Hopkins' experiments,[1] and those of Bunsen,[2] cannot find such conclusive evidence in the same, as Dr. Hunt in his lecture would lead his audience to infer.

The results of these experiments condensed into a few words are as follows :—Hopkins and Bunsen both find by experiment that certain *organic* compounds (spermaceti, wax, stearine, and paraffine) actually have their melting and freezing points elevated (but in a very irregular manner), when exposed to pressures of from 1 to 793 atmospheres (15 to 11,880 lbs. per square inch)[3]; further, Hopkins shows that sulphur has likewise its fusing point elevated by a pressure from 1 to 520 atmospheres (15 to 7,790 lbs. per square inch), but that after this up to 793 atmospheres (11,880 lbs. per square inch), the highest pressure tried, the ratio of increase of temperature to pressure diminishes greatly, which might be supposed to indicate that at still higher pressures the fusing point might again diminish and even become depressed instead of elevated. No allusion is made to Mr. Hopkins' statement that in the case of such metallic alloys as he had tried, "*that he had not detected any elevation of fusing temperature acquired by increasing the pressure.*"

Even allowing however that the fusing points of bodies in general are elevated by pressure, it does not necessarily follow that the centre of the earth must have solidified before or even at the same time with the crust, unless it is also taken for granted that the earth's mass is perfectly homogeneous throughout, or at least com-

[1] Brit. Association Report, 1854, p. 57.

[2] Poggendorf. Ann., vol. 81, p. 562. 1850.

[3] The nature of such organic substances being totally different from any to be met with under the circumstances here under consideration, much dependence could not be placed upon the similarity of behaviour of inorganic compounds.

posed of substances all of the same degree of fusibility, neither of which views are likely to meet with general acceptation.

The density of the exterior of the earth with which geologists are acquainted, is known to be only about one-half of the mean density of the earth's mass as a whole, and at first this was accounted for upon the supposition that its components became more and more dense in depth, owing to the pressure of the superincumbent mass; experimental research tends, however, to show that a limit is soon reached, beyond which the compression or increase of density becomes less and less in relation to the force employed;[1] and there are consequently strong reasons for believing that the central parts of the globe must consist of much denser bodies, such as metals and their metallic compounds.

As we well know that such metallic bodies are infinitely more easily fusible than the silicious rocks of the superficial crust, it may be fairly advanced, that the difference between the fusing points of these bodies would more than counterbalance the influence of pressure in causing solidification at the centre of the globe, by the elevation of the temperature at which the central mass could remain in fusion.[2]

The above reasons make the author come to the conclusion that Dr. Hunt has not produced sufficient evidence to prove that the earth is really entirely solid; and he still adheres to the opinion that the earth does enclose a vast reservoir or reservoirs of still fluid igneous matter in its interior.

The chemical composition of the cooling globe, and specially of its external crust, next demands consideration. Dr. Hunt believes the primitive crust to have been composed of the alkalies, alkaline earths, earths and metallic bases in combination with silica, and surrounded by a dense acid atmosphere, consisting of hydrochloric, sulphurous, and carbonic acids, along with steam, nitrogen, and probably the excess of oxygen. The author would protest against such an atmosphere, and for reasons about to be explained, does not believe that it ever did or could have existed.

We are told in the first place, that "all the sulphur would be diffused in the atmosphere as sulphurous acid." The author, on the contrary, believes that the sulphur would have combined with the heavy metals, forming dense sulphides, which would at once sink below the lighter external crust and there be protected from oxidation. Nor does he consider it probable that at such a moment of general combination an "excess of oxygen" could possibly be present in an atmosphere highly charged with sulphurous acid.

Dr. Hunt alleges that we should find "all chlorine in the form of hydrochloric acid," which is also contrary to the opinion of the

[1] And the author thinks it probable that the same would also be the case with the relations of fusing points to pressure.

[2] In opposition to this view, it might be said that the densest of all metals, Platinum, is also one of the most infusible. To this we answer, that many of the compounds of Platinum, say with zinc, tin, arsenic, etc., are so extremely fusible as to melt in the flame of a candle.

author, who considers that the chlorine would chiefly, if not entirely, be in combination with the metals of the alkalies and alkaline earths, as chloride of sodium, etc.

According to Dr. Hunt, the hydrochloric acid in this atmosphere was derived from the mutual reactions of sea-salt, silica, and water.

This, in the first place, is supposing the pre-existence of compound bodies, in a case where he had previously informed us that there were only dissociated elements engaged in the formation of this igneous sphere. For the sake of argument, however, let it be admitted that sea-salt, water, and quartz were present, then it is still contended that the reaction, described by Dr. Hunt, could not have taken place. All chemists know that quartz, water, and sea-salt, if heated together in a confined space, or if the vapor of water and salt be passed over highly heated quartz, that such a reaction would take place forming hydrochloric acid gas along with silicate of soda. This, however, could never occur in nature in the case under consideration, for long before the quartz had attained a heat sufficient to enable it to act upon the salt, all the water would have evaporated into space; and if the heat were continued, the vapour of the salt would follow, leaving the quartz behind.

As the greater part of the sodium is considered to have been at once combined with the chlorine, it follows, of course, that the silicate of soda could not have played so important a part in the formation of the primary crust as is ascribed to it by Dr. Hunt; and there would also be no necessity for the extraordinary theory that the saltness of the sea is due to the rain of hydrochloric acid "flooding the half-cooled crust" with a highly heated acid deluge, which extracted the soda from its silicate, leaving the quartz behind;[1] and it is therefore conjectured that neither geologist nor chemist will be contented with this explanation of the salt in the sea.

Having thus opposed the views of Dr. Hunt, as set forth in his lecture, the author of this communication will in a few words sketch out the chemical reactions which he supposes to have been characteristic of this period of the earth's history.

The act of combination of the elements is regarded by him as having given rise to a molten sphere, surrounded by a gasiform atmosphere, both of which were composed of concentric layers or zones of different densities and chemical composition.

This sphere, it is imagined, would arrange itself into three grand zones, (each zone, probably, containing sub-zones), somewhat as follows:—An external zone, or crust of highly acid silicates, the bases being chiefly alumina and potash, with minor quantities of soda, lime, magnesia, oxide of iron, etc.; below this a second zone of

[1] The silica produced from such decomposition of silicates is of the specific gravity of 2·2, is soluble in alkaline solutions, and does not polarize light, which is not the case with the silica contained in any of the older rocks, which Dr. Hunt supposes to have been so formed. The chemical and physical properties of the silica of such rocks indicate them to have been derived from the breaking down of acid rocks analogous to granite.

silicates, more basic, and of greater density; the bases being lime, magnesia, alumina, oxide of iron, with soda, and but minor quantities of potash, etc.; and still deeper a far denser sphere, containing metallic bodies, more or less combined with sulphur, arsenic, etc.

On the other hand, the atmospheric zone, next the solidified crust of the earth, would be composed of a dense vapour of those compounds, volatile only at a high temperature, amongst which the chloride of sodium or salt would be probably the most prominent, above this a stratum of carbonic acid gas, and then of water, in the form of steam, whilst the oxygen and nitrogen would be elevated still higher.

It is imagined that such an arrangement would, on cooling, first condense the lowest atmospheric zone[1] (vapour of salt and other chlorides, etc.), on to the already solidified crust of the earth; covering this with a layer of these substances, in a solid state[2]; upon a further reduction in temperature the steam in the atmosphere would now be condensed on to this layer, which it would, in great part, dissolve, forming the ocean, which consequently would be salt from the first moment of its appearance on the face of the globe. The atmosphere now surrounding the globe would contain less oxygen and all the carbon, in the form of carbonic acid, (excepting only the amount of that acid already absorbed by and carried down with the rain water), but otherwise it would probably not differ much in composition from what it is at present.

From this stage in the earth's history, the author believes that all the changes which have taken place in the globe, up to the present time, have been effected by agencies similar to those going on in it at this present day; rocks were formed from the wearing down and disintegrating action of the atmosphere or weathering of the primitive crust,[3] and the subsequent stratification of the debris, so formed by the action of the sea; just as they are at present in the course of formation from the disintegration of pre-existing rocks. Eruptions of igneous matter from the still fluid interior[4] from time to time disturbed and broke through the primitive crust and the rock strata above it, in course of formation from its debris, just as at the present day (though possibly on a somewhat smaller scale), similar outbursts are produced by volcanic action. The products of such older eruptions are almost identical, in chemical composition, with those of the newer period. Thus the result of chemical analysis of the most ancient granite often cannot be distinguished from that of an

[1] The zone of carbonic acid gas would be heavier than that of steam; 1 cubic foot of the latter weighing at 212° only 265·17 grains, whilst 1 cubic foot of carbonic gas would weigh 642·09 grains, at same temperature.

[2] A rough calculation shows that the layer of sea salt alone would be sufficient to clothe the entire sphere with a crust of salt some 10 feet in thickness.

[3] This action would, no doubt, be much facilitated in the older geological epochs, by the amount of carbonic acid in the atmosphere being so much greater than at present.

[4] The contraction, consequent upon the cooling of the original sphere, would, doubtless, greatly disturb the previously comparatively even surface of the crust, and produce cracks and fissures, the sides of which, from their unequal subsidence or elevation, would often be dislocated and form lines of faults.

ordinary volcanic trachyte, and the basaltic rocks from recent volcanoes resemble very closely those from far more ancient periods; in fact it is often the case that such rocks can only be distinguished from one another by a very careful study of their less prominent characters.

Taking them as a whole, the main distinction between the eruptions of the most ancient and most modern epochs is, that in the earliest period the acid rocks, or granites, predominated, whilst at the present day the acid volcanic rocks, or trachytes, are in less proportion, the more basic rocks predominating.

Several reasons to account for this circumstance have been put forward, and are well worthy of consideration.

To return, however, to Dr. Hunt; he states that after the energetic action of the acid deluge had ceased, a second similar but slower process of decomposition and solution of the crust commenced by the action of, in this case, carbonic acid with water, resulting in the formation of clays which remained behind, whilst solutions of the carbonates of soda, lime, and magnesia, poured down into the sea where they precipitated, first the alumina, and subsequently the heavy metals. In such events geologists, although as yet unsuccessful in so doing, might still hope to find beds of alumina or of the metallic oxides or carbonates alluded to, amongst the older strata. As no beds of such character are known to occur in nature, this hypothesis must, however, be received with some distrust.[1]

The next assertion of Dr. Hunt, that the limestones have been formed by the precipitation of the lime in the sea by a solution of carbonate of soda, is so decidedly at variance with all the conclusions hitherto arrived at by geologists, zoologists, and microscopists, that it cannot but be disputed, and there is sufficient evidence now produceable to refute this hypothesis.

In making the assertion, that "the whole of the carbonates of lime which make up the calcareous strata—the marbles and various limestones which we find on the earth's surface are so formed," Dr. Hunt at the same time states that he is quite aware that geologists are of opinion "that these limestones are the result of organic action," but no doubt classes this opinion as another sample of the "fallacious reasoning" which he supposes them to indulge in, and will probably be surprized to learn that zoologists also will dispute his further assertion, that "animals can only appropriate the carbonate of lime which they find ready formed," and that they, in opposition to this assertion, believe that marine animals can utilise the other salts of lime, existing in abundance in the ocean.

Had the limestones been so formed by precipitation, whether hot

[1] It may here be remarked that Dr. Hunt, in his lecture, does not allude to what became of the sulphuric acid, which would be the ultimate product of "all the sulphur" burnt into sulphurous acid, and afterwards condensed from the atmosphere into the ocean; for since it may safely be asserted that there is fully as much (if not more) sulphur as chlorine, the sea formed, according to Dr. Hunt's hypothesis, would be as much a solution of sulphate of soda as of seasalt, and he can hardly suppose it to have been precipitated, for it is well known that no beds of sulphate of any importance whatsoever occur in the very oldest formations.

or cold, they would have, from the moment of their deposition, possessed a decided crystalline structure, visible when examined by the microscope; as in the case of stalactites, stalagmites, travertines, etc.; this, however, is not the case.

Sorby's microscopical researches prove satisfactorily that all limestones, from the most ancient up to the most recent, are solely formed of the debris of organisms,[1] and that they do not possess any crystalline structure whatsoever, unless when altered by subsequent infiltration, or other metamorphic action.

Dr. Hunt next proceeds to explain that the magnesian limestones, dolomites, and gypseous beds owe their origin to chemical "reactions hitherto unsuspected," and that his experimental researches have proved them to have been formed at a period when the surface of the earth was covered by a dense atmosphere of carbonic acid, and that this "theory is confirmed by climate, by vegetation, and by the singular series of reactions which hitherto have been a perplexity to chemical geologists."[2]

The microscopical and chemical investigations of Sorby have, however, eliminated the most conclusive evidence against the correctness of this theory of precipitation, and shown the magnesian limestones and dolomites alluded to by Dr. Hunt (whether of the Devonian, Carboniferous, or Permian period) to be mere mechanical aggregates, or true limestones of ordinary character subsequently altered by infiltration of magnesian matter.

This result had been long before arrived at by geologists, as the study of these rocks in the field showed that such magnesian limestones were frequently only portions of the ordinary limestone beds peculiar to the formation itself, altered at places, apparently by some then unexplainable chemical action. This was found to be the case even with limestones pertaining to the Devonian and Carboniferous formations, in which period it has long been advanced that an atmosphere rich in carbonic acid did exist.

As all geologists know that the grand development of magnesian limestones, dolomites, and gypseous beds really took place in an epoch when numerous air-breathing animals, both vertebrates and invertebrates, lived upon the face of the globe, it will surprise them to think that Dr. Hunt can imagine these animals living in an atmosphere of carbonic acid.

The next point in this lecture to which attention is directed is a very important one in its general bearings, although it is to be feared

[1] Even the chalk is entirely so composed, notwithstanding that its external appearance is so like that of a precipitated carbonate of lime.

[2] Dr. Hunt seems to be quite unaware that in the Brit. Assoc. Report, 1856, p. 77, Sorby has fully explained these reactions, that Harkness (Brit. Assoc. Report, 1857, p. 68) applied similar experimental investigations of Regnault, to explaining the dolomitization of the Carboniferous limestones near Cork; and, lastly, that the results of his researches on the artificial atmosphere of carbonic acid, which he has thought worthy of bringing before the French Academy (Compt. Rend., 1867, p. 815), so far from being new, have for the last twenty-two years at least, if not much longer, been employed on a large scale in the manufacture of magnesian compounds in both England and Ireland.

that the attractions of palæontological research have caused it to be of late, in a great measure, shelved by geologists in general.

It has lately been the fashion, especially amongst many of the younger votaries of the science, to "pooh-pooh" the igneous origin of eruptive rocks in general, and of granite in particular. A careful study of the literature of the subject shows, however, that this secession from opinions, previously all but universally adopted, has originated in the writings of one or two able but one-sided men of science, blindly followed, as is usual in such cases, by adherents who reason not for themselves, or who have either not sufficient leisure or inclination to examine into the true merits of the question. The author fully believes, however, that had anything like a careful study of what has already been published (*pro et contra*) upon this subject been made, that not only would an explanation or answer have been discovered to meet any and all of the arguments brought forward in opposition to the igneous origin of such rocks, but that such as are open to conviction would with the author of these remarks have come to the conclusion that nothing has as yet been advanced which can in any way tend to prove the eruptive rocks to have an origin differing from that of those rocks produced by volcanic action at the present day.

At present, however, only such arguments as are advanced in Dr. Hunt's lecture can be discussed, and these only in all brevity, since the space already occupied by this communication has extended beyond its proposed limits.

As evidence against the non-igneous origin of granite, Dr. Hunt asserts "that the composition of the primitive crust would have excluded free silica;" again, "that this very quartz, which is one of the constituent elements of granite, is only the result of a secondary process;" and yet again, in the report of his lecture contained in the "Chemical News," vol. xv., p. 317 (revised by himself previous to publication), "that granite is in every case a rock of sedimentary origin, as it includes in its composition quartz which, so far as we know, can only be generated by aqueous agencies, and at comparatively low temperatures."[1]

In making such statements, it may be asked whether Dr. Hunt is aware of the immense masses of undoubted volcanic rocks scattered all over the surface of the globe which contain abundance of free quartz? Amongst others, the Ponza Islands, for example, under the very shadow of Vesuvius; the hundreds of miles of volcanic outbursts of quartz trachytes, from the still active volcanoes situated along the range of the Andes, in South America, as well as numerous examples which might be referred to in other parts of the globe, although, unfortunately, not in Canada. Does not Dr. Hunt know that the admirable memoir of Sorby, contained in the Quart. Journ.

[1] If we, with Dr. Hunt, believe that the temperature increases in proportion to the pressure, then, as Sorby has shown that the quartz of the granite of Aberdeen has solidified at a pressure equal to a column of seventy-eight thousand feet of rock, this alone would be quite sufficient to refute the statement of comparatively low temperatures.

Geol. Soc. of London, vol. xiv., shows how perfectly identical in structure this volcanic quartz is with the quartz of granites (both containing in common, fluid, vapour, gas, and stone cavities , and that this accurate observer has concluded that the modern volcanic trachytes and old granites have one common igneous origin, in which, as is the case in volcanoes, water has played some part.[1]

That the metamorphic rocks have been formed from ordinary sedimentary strata, by their having been "depressed so that they come within the action of the earth's central heat" may be disputed; but before doing so it might be as well to learn from the author of this ingenious theory by what mechanical arrangement he supposes strata on the surface of the earth to be lowered down into a globe solid to the core. The further development of this theory, assuming a similar action to have produced the eruptive rocks emitted by the volcanoes of the present day, is at once strongly protested against; for how, may it be asked, are we, according to this theory, to account for the fact, that volcanic rocks taken from any quarter of the world, no matter how far distant from one another—from Iceland or Terra del Fuego, from the Islands of the West Indies or from those of Polynesia—that in all cases such rocks possess an absolute identity in chemical and mineralogical composition ; in physical and in optical properties. Can any geologist be expected

[1] An argument has been brought forward against the igneous origin of granite, from the fact that the specific gravity of the quartz in granite is 2·6, whilst the density of silica artificially fused before the oxyhydrogen blowpipe is only 2·2. If this style of argument is admitted in philosophical reasoning, then the silica of the carapaces of infusoria ought also to have been formed by fusion, since its specific gravity is only 2·2, as is also the silica deposited from its gaseous compounds with fluorine, etc. Sorby's before-mentioned researches have shown that the quartz in granite has solidified under enormous pressure. It might therefore reasonably be expected to possess a higher density than such as has been fused artificially, without having been subjected to pressure at all. Another argument is found in the fact that some of the more fusible minerals in granite have often solidified and crystallized before less fusible ones; in reply, it may be stated that this is also the case in modern lavas; in those of Vesuvius, it is common to find that the refractory Leucite has crystallized before the easily fusible Augite, and to be superposed on crystals of this latter mineral. It has further been argued, that rocks like granite occasionally enclosing minerals containing water, could not have been formed by igneous fusion; independently of Sorby's discovery that the quartz of volcanic rocks and the felspar, nepheline, idocrase, etc., ejected from Vesuvius, do contain water : specimens taken out of the lava current from Etna, whilst still flowing in March, 1865, contained fine crystals of Stilbite (with 16 per cent. of water). Bunsen's researches (Taylor's Scient. Memoirs, Nov., 1852) have long ago experimentally proved that hydrated silicates, analogous to those occurring in eruptive rocks, might be formed at high temperatures and retain their water at such temperatures as long as enclosed in the matrix ; if extracted from this, however, the water could be expelled by the application of a very gentle heat. Laurent has also showed that borate of Potash, fused at temperatures above the melting point of Silver, retained water which, singularly enough, might be expelled in bubbles by reheating the vitrified mass over a spirit lamp so as hardly to soften it.—Whilst correcting the proofs of this paper for the press, the author has had his attention directed to a communication made by Professor Ansted to the British Association, " On the Passage of Schists into Granite in the Island of Corsica," in which (if the report in the " Dundee Advertiser," Sept. 10, be correct) the learned Professor cites, in support of his views, the results of Mr. Sorby's researches in a manner apparently quite at variance with the conclusions arrived at in that gentleman's memoir.

to believe that such rocks have been formed by the melting up of a mere mechanical aggregate of rock-debris, possessing no analogy whatsoever, and whose chemical composition, etc., is known to vary to the widest imaginable extremes.

In conclusion the author cannot but express his feeling that it is doing an injustice to the memory of such noble minds as Hutton, Playfair, Hall, Humboldt, Von Buch, and others, to bring against them the narrow-minded charge of their wishing to create the earth "entirely by fire."[1] Their writings abound in evidence proving that they never overlooked the all important agency of water in nature's operations, and when claiming for igneous action its true share they based their plutonic theory upon the study of such agency as is exemplified in volcanos, in which, from the first, the co-operation of water (although in some, at that time, incomprehensible manner) was acknowledged; and not upon any idea of "dry fusion," which could only have originated in the brains of their antagonists.[2]

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## II.—On the Gorge of the Avon, at Clifton.

By J. Beete Jukes, F.R.S.

I OBTAINED, the other day, on my way into South Devon, another peep at the Bristol Channel, and the gorge of the Avon, at Clifton, which I had long been wishing for. It showed me, as I anticipated, that the hypothesis of atmospheric erosion, which I was compelled to adopt, a year or two ago, to explain the formation of the river valleys of the South of Ireland, is applicable to the Clifton gorge as to all other similar places.

With the existing form of the ground traversed by the Avon, above Bristol, it would, of course, be quite impossible for the river to cut a channel across the Clifton Downs. Fill up the gorge of the Avon with the mass of Carboniferous Limestone and Old Red Sandstone, that once occupied it, or even half fill it, and the waters of the Avon, after forming a lake, would, long before they overtopped that dam, run into the sea by Nailsea, as pointed out by Sir H. T. De la Beche.

This, however, only shows that the surface over which the Avon originally ran into the Severn, was not the present surface. All the rivers originally ran over a surface considerably above the present one, and they have continued to run in the same courses during all the wasting of the rock, by which the old surface has been transformed into the present one.

The rivers have been, at once, the channels by which the eroded matter was removed, and the motive power of the eroding machinery.

Colonel George Greenwood's phrase of "Rain and Rivers," gives us the whole secret in three words.

[1] Apparently an application of the "sensation" principle to geology.

[2] It is nearly half a century ago since Scrope not only pointed out the important part played by water in volcanic action, but further expatiated upon the difference between volcanic fusion and ordinary melting.

Let anyone travel through the country with Professor Ramsay's geological map in his hand, together with the sheets published by the Geological Survey, for details. Let him then look at the fretted and gullied escarpment of the Oolitic range from Northampton to Somerset, and recollect (as shown by Mr. Topley in a former number of the Geol. Mag.), that the sea does not form escarpments, but cuts sections. Let him follow the level sheets of Lias and Trias, down the coasts of Somerset and Glamorgan, till they abut against the Palæozoic hills, on both sides of the Bristol Channel. Returning to the Oolitic escarpment of the Cotteswolds, let him mark how the Oolitic outliers get fewer and smaller as he recedes from it, and let him connect them with the broad outlier of Inferior Oolite, on Dundry Hill, five miles south of Bristol, and the still more curious little patch of it that caps the Lias peak of Brent Knoll, which rises from the flats of Bridgewater. He cannot fail to come to the conclusion that not only the Lias, but the Oolites, once spread in level sheets across the district now occupied by the estuary of the Severn up to the Palæozoic Hills of South Wales.

The outlying patches of Lias that occasionally cap the red marls through Warwickshire, Staffordshire, and Cheshire, prove that the Lias, at least, formerly extended to, and wrapped round, the Palæozoic hills of North Wales.

Let the observer then stand on the highest point of Clifton Down and look up to the superior height of Dundry Hill, some six miles to the southward, and he would see at once that the extension of the old Oolitic sheet would pass some two or three hundred feet over his head. That the Lias itself rested directly on the Palæozoic rocks is shown by the fact of sheets of it still stretching across the Carboniferous Limestone to the north-east of Durdham Down, still resting in patches on the Backwell Hills to the westward of Dundry, and on that of the Mendips, in the neighbourhood of Harptree.

The Lias then formerly reposed on the Carboniferous Limestone of Clifton Down and the Oolite spread over that. The Severn and its tributaries, flowing over this Oolitic plain, of course cut channels in it. The original form of the surface was such as to turn the Avon towards the Severn instead of towards the Thames. The course it originally took, it has ever since maintained, cutting down through the horizontal Mesozoic cover, and through any Palæozoic rock it found underneath, in whatever position it might lie, or whatever materials it might be composed of. During part of the time the whole country must have been higher out of the sea than it is now, and the rivers must have run as continuous streams over the land which is now the bottom of the Severn estuary, till they had cut down to the level where the solid rock would now be met with, under the estuary mud. If the whole country got a hoist of one or two hundred feet, the Avon would be a rapid brook at Clifton, fretting over the rocks at the bottom of the gorge and continuing the work of channel-cutting, which at the present level of the land it has been obliged to suspend.

While the rivers have been cutting their channels the rain and its resulting streamlets have washed off a large part of the softer Mesozoic cover of the country and disclosed the old Palæozoic hills and ridges. Many of these are formed of Carboniferous Limestone, which, in the south of Ireland, has itself been worn down into valleys and plains. The reason is that in the south of Ireland the limestone was never protected by any Mesozoic cover, but has been subject to the dissolving power of the rain-water during the whole period. About Bristol it was so protected for a great part of the time. Had it not been so, the only hills remaining thereabouts at the present day would probably have been those of Old Red Sandstone and the undestroyed Mesozoic outliers.

The whole of England may, doubtless, have stood at a lower level than it does now during part of the time that this process has been going on, as well as at a higher level. When it was at a higher level the action was accelerated and extended; when it was at a lower, it was retarded on the part that remained dry land, and entirely stopped for all the ground that sank below the sea. Sink England now 600 feet, you make an island of Wales, and a cluster of islets of the rest of the country. On its re-elevation you might find beds of sea-shells on that which had been the sea-bottom, and sea-worn crags on the sides of the straits that had connected Bristol and Liverpool. That, however, would be no proof that the sea eroded those straits. It would be nearly as reasonable to suppose that a canal was excavated by the water that lies in it. The sea would waste the coasts doubtless, and deposit the materials at the bottom of the straits, and on the re-elevation of the country the rivers would have to set to work to scour out their old channels and the rain to wash the valleys clean again.

While looking into De la Beche's Manual for his description of Clifton, I caught sight of a passage in which, quoting from a French author, he enforces the impossibility of the Meuse having cut its own channel through the hills of the Ardennes, because in the higher parts of its course it runs over ground much lower than the Ardennes, where it is only separated from the Seine by hills of a hundred feet or so in height. This lower ground is formed of the Oolites, with the New Red rising gently from underneath them on the east. The Moselle also runs across that country on its way from the northern slopes of the Vosges to Treves, where it turns and cuts by deep winding channels through the much loftier ground of the Eifel and the Hundsruck. These, like the Ardennes are made of siliceous slate-rock.

The hypothesis of atmospheric erosion equally applies here. The Oolitic, perhaps even Cretaceous, plateau over which all three rivers orginally ran, had a surface higher than that part of the Ardennes and the Eifel, across which the rivers Meuse and Moselle took their course. The rivers have ever since been steadily cutting their channels deeper and deeper along the courses they first selected, and the districts adjacent to them have been lowered by atmospheric waste in proportion to the depth the rivers cut down to, and the difference in the nature of the rocks they cut through in different places. Where those were hard siliceous slates, the slopes of the river-valleys are steep precipitous cliffs, from the summits of which we look over the old plateau, somewhat wasted, doubtless, but still approximating to its original form. Where those rocks are New Red, or Oolite, or Chalk, the slopes of the river-valleys are mostly gentle and far-spread; a few isolated hills and ridges may have summits that approximate to the level of the old plateau, but these are few and far between, and none of them, perhaps, actually reach it by one or two hundred feet.

I believe that anyone, in any part of the world, who will apply the key here given to the problem of the production of the present "form of the ground" will find that if he adjust the wards properly it will unlock it for him.

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## III.—On Subaërial Denudation, and on Cliffs and Escarpments of the Chalk and Lower Tertiary Beds.

By William Whitaker, B.A. (London), F.G.S.,

Of the Geological Survey of England.

[Part I.]

[A paper read before the Geological Society of London, May 8, 1867.][1]

### 1.—*Introduction.*

FOR some years geologists have more or less agreed in the view that the present features of the earth, whether hill, valley, or plain (with some small exceptions, as volcanic outbursts) have been formed *directly* by denudation; though *indirectly* disturbances, whether faults upheavals or sinkings, have of course had their effect in determining the flow, so to speak, of the denuding agent.

So far all is harmony, the differences of opinion being only on the comparative effect of the two forces, disturbance and denudation: but beyond this all is discord, and of late there has been much debate on the question by what means the surface of the earth has been worn away, and its rocks carved into their present form.

Many papers have been written on the origin of valleys escarpments lake-basins etc., some of which are clear statements of carefully observed facts, with unprejudiced and logical reasonings therefrom; whilst others, on the contrary, are little else than assertions of belief, and some are made up largely of groundless suppositions and false analogies. It seems hardly to be known that to fit one to take part in such an enquiry a long and careful examination of nature is needed, and that, to quote the words of a geologist of the last century, "it is not to *common* observation that it belongs to see the effects of time and the operation of physical causes in what is to be perceived upon the surface of the earth."[2]

It may not be amiss therefore to analyse the evidence given by some special classes of rocks; and to avoid being charged with advocating opinions on slight acquaintance with the formations chosen for

[1] The title given by the editor to the short abstract in the Society's Journal (Vol. xxiii. p. 265) is not quite correct.

[2] Hutton's Theory of the Earth, vol. ii. p. 238.

illustration, it may be well to state that for the last ten years I have been doing Geological Survey work in Cretaceous and Tertiary districts; work which has slowly convinced me against what I believed before (as many of my colleagues have been in like manner convinced) that the irregularities of the earth's surface have been chiefly caused by subaërial actions, by rain rivers frost and springs, forces that can be seen in action every day and therefore have come to be looked on as things of nought. I do not say however that the sea has done nothing towards the formation of these irregularities; but allow that many of the present features may have been worked out and strengthened along lines sketched out as it were beforehand by the action of the sea, which is granted I believe by most who hold the subaërial theory, although they are often misrepresented as denying that the sea does anything. In some cases the marks of marine action may have been little effaced, but for the most part they must have been destroyed when exposed for a long time to the wasting powers that reign over the land.

2.—*Authors who have advocated the Subaërial Theory.*

It seems strange that there should now be any discussion on the subject, and that instead of subaërial denudation being the accepted theory of the day it should be held by a minority only (albeit that minority contains many well-known geologists, and increases every year); for the power of atmospheric actions in wearing away rocks was most ably treated of more that 70 years ago by Dr. Hutton, whose great work[1] is not so well known as it should be, and indeed is known mostly in a secondhand way, through Professor Playfair, who followed and defended the views of his friend and master.[2] After this Mr. Scrope *proved* their truth for a special district, showing that in Auvergne rivers have worn away large masses of hard rock,[3] and said that "the same agents (rain and rivers) must have been at work everywhere else, and produced results as stupendous during the same (comparatively) recent period," and "since, by a fortunate concurrence of igneous and aqueous phenomena, we are enabled to prove the valleys which intersect the mountainous district of Central France to have been for the most part gradually excavated by the action of such natural causes as are still at work; it is surely incumbent on us to pause before we attribute similar excavations in other lofty tracts of country, in which, from the absence of recent volcanos, evidence of this nature is wanting, to the occurrence of unexampled and unattested catastrophes, of a purely hypothetical nature."

1 The Theory of the Earth, 2 vols., 8vo.; Edin., 1795. See especially vol. 1. p. 304, and vol. ii. pp. 3–5, 98, 99, 138-40, 143 (quotation from the French), 157, 205, 209, 210, 236, 245, 295, 296, 401, 466-8, 498, 528, 529, 534, 535, 547.

2 Illustrations of the Huttonian Theory, 8vo.; Edin., 1802. Reprinted in vol. i. of Playfair's Works, 1822. See pp. 105-7, 110-14, 373-6 of the original edition (= pp. 117-19, 122-5, 370-2 of the later one.

3 Memoir on the Geology of Central France, 4to., Lond., 1827. Ed. 2, 8vo., 1858 (pp. 37, 38, 97, 158, 159, 205-9, 213, 244; and Geol. Mag., Vol. III. p. 193 (1866). Mr. Scrope touched on the subject before in his "Considerations on Volcanos," 8vo. Lond., 1825 (pp. 96, 97, 138, 139, 214, 215).

M. Charpentier also has expressed his belief in the formation of the valleys of the Pyrenees by their contained streams;[1] and in later times Colonel Greenwood has taken up the subject and strongly defended the Huttonian doctrine;[2] Mr. Prestwich has treated of the formation of valleys by the rivers flowing in them in the south-east of England and the north-west of France;[3] Mr. Godwin-Austen of the power of rain in the formation of deposits of loam, etc. (and therefore in the destruction of something else beforehand) and of the formation of Chalk valleys by "meteoric" actions;[4] Professor Ramsay, of the ploughing-out of lake-basins by glaciers and of the denudation of the Weald;[5] Professor Jukes, of the cutting-out of certain valleys and escarpments by subaërial action;[6] and M. Ch. Martins, of the formation of some inland needles of rock by weathering.[7]

Sir C. Lyell too has adopted the subaërial theory to a great extent, as may be seen by the following, which he has kindly allowed me to quote from a letter written shortly after this paper was read:—"I have long ago modified my opinions on denudation, and I now agree with you in considering that the escarpments round the Weald are not inland cliffs, as I formerly supposed, although at some points the sea may have entered through transverse valleys and modified parts of them. Two arguments, namely the fact of the escarpment of the Lower Greensand being parallel with that of the Chalk,[8] and the fact that the sea cuts its cliffs successively through different formations and never keeps for such great distances to one formation only, are I believe unanswerable." And with regard to the pinnacles and needles of Chalk in the valley of the Seine (see p. 452), Sir Charles continues: "Ever since I convinced myself that the sea had not gone up the valley of the Somme farther than Abbeville, the highest point at which marine shells occur, I had great misgiving as to its having been so effective as some eminent French geologists have thought in excavating the valley of the Seine. Even if the sea, or the rise and fall of the tide, extended as far as Rouen and further, I cannot conceive its having gone up so far as to have made the pinnacles of Chalk near Andelys, without supposing a submergence inconsistent with what we must infer respecting Picardy, which appears, like the Wealden district, to have kept its head above water during and since the Glacial Period."

The following authors have also, in one way or another, supported

[1] Essai sur la constitution géognostique des Pyrenees, 8vo., Paris, 1823, p. 25.

[2] Rain and Rivers, 8vo, Lond., 1857. Ed. 2 in 1866.

[3] Phil. Trans., vol. 154, p. 247; Quart. Journ. Geol. Soc., vol. xix. p. 497 (1863).

[4] Quart. Journ. Geol Soc., vol. vi. p. 94 (1850); vol. vii. pp. 121-6, 130, 131 (1851); vol. xi. pp. 118, 119 (1855); vol. xiii. pp. 63, 71 (1857).

[5] Ibid. vol. xviii. p. 185 (1862); Phil. Mag., vol. 28, p. 293 (1864); vol 29, p. 285. (1865); The Physical Geology and Geography of Gt. Britain, 8vo., Lond. Ed. 2. (1865).

[6] Brit. Assoc. Rept. for 1861, Trans. of Sections, p. 54; Quart. Journ. Geol. Soc., vol. xviii. p. 378 (1862); Geol. Mag., vol. iii p. 232 (1866), vol. iv. p. 444. (1867).

[7] Bull. Soc. Geol., France, 2 Ser., t. xii. p. 314 (1855).

[8] I believe that Professor Ramsay started this argument against the marine origin of escarpments.—W. W.

the theory of subaërial denudation: Dr. C. Le N. Foster and Mr. W. Topley,[1] who have worked out in detail the question of the Wealden denudation, the latter having also touched on other districts;[2] Mr. A. Geikie,[3] Mr. A. H. Green,[4] Mr. G. Maw,[5] Mr. A. R. Wallace,[6] Mr. A. B. Wynne,[7] and, to some extent, the Rev. O. Fisher.[8] In far countries, too, Professor Dana,[9] Professor Hind,[10] Mr. J. P. Lesley,[11] Sir W. Logan,[12] Dr. Newbury,[13] and Professor Whitney,[14] in America; Dr. Haast, in New Zealand;[15] Mr. T. Belt, in Nova Scotia;[16] and Dr. Rubidge, in South Africa,[17] have borne witness on the same side.

It is remarkable that most of the subaërialists are of English race (using that name in the broadest sense), but few foreign geologists allowing that anything but the sea or a cataclysm can have given rise to hills or valleys of large size; and also that a great number of these subaërialists are or have been employed on Government Geological Surveys, and therefore have been accustomed to be constantly in the field, earning their bread by their hammers, and spending their days in the more or less detailed examination of the geological structure and physical features of the districts which it has been their duty to survey and describe.

### 3.—*General Remarks.*

The following pages treat of escarpments and not of ordinary valleys, because the formation of the latter by other agents than the sea is now more generally understood. The same kind of argument holds in both cases, but the subaërial cutting out of valleys is at first sight clearer than that of escarpments, and perhaps is supported by more direct proof.

[1] Quart. Journ. Geol. Soc., vol. xxi. p. 443 (1865).

[2] Geol. Mag., Vol. III. p. 435 (1866), and Vol. IV. p. 184 (1867).

[3] Notes of Travel by Vacation Tourists, 1861.—The Geology and Scenery of Scotland, (1865).

[4] Geol. Survey Memoir on Sheets 81 N.W. and S.W., p. 86 (1866).

[5] Geol. Mag., Vol. III. pp. 344, 439, 575 (1866).

[6] Quart. Journ. of Science, vol. iv. p. 33 (1867).

[7] Mem. Geol. Survey, India, vol. v. p. 201 (1866).—Geol. Mag., Vol. IV. pp. 3, 345 (1867).

[8] Quart. Journ. Geol. Soc., vol. xvii. p. 1 (1861).

[9] United States Exploring Expedition during the Years 1838-42, vol. x., Geology, 4to., Philadelphia, 1849, pp. 384–92, 526–33, 670-7.—Manual of Geology, 8vo., Philadelphia, 1863, pp. 635–42, 676.

[10] Quart. Journ. Geol. Soc., vol. xx. pp. 125, 126, 128–30 (1864), where references to the author's other notes on the subject are given.

[11] Notes on a Map to Illustrate Five Types of Earth-Surface, 4to., Philadelphia, 1866.

[12] Geol. Survey, Canada—Rept. of Progress to 1863, 8vo., Montreal, p. 889.

[13] Part 3 (Geology) of Lieut. Ives' Report on the Colorada River of the West. 1861. References to other remarks on denudation by this author are given in Professor Hind's paper referred to above.

[14] Report on the Geological Survey of the State of Wisconsin, vol. i, pp. 117–26 (1862).

[15] Report on the Geology of Canterbury, New Zealand;—and Quart. Journ. Geol. Soc., vol. xxi. pp. 129, 130 (1865).

[16] Quart. Journ. Geol. Soc., vol. xx. p. 463 (1864)—in abstract only. The paper has been printed in full in Trans. Nova Scotian Institute of Nat. Sci., Vol. I. Part iv. p. 91.

[17] Geol. Mag., Vol. III. p. 88 (1866).

There are many points which have already been more or less gone into in detail by others, and therefore need but a passing notice here,[1] amongst them are the following:—

(1.) Escarpments always run along the strike, whilst actual cliffs rarely do so (and then only for a short way), but cut through rocks without regard to it; whereas if both had been formed by the sea they should be more alike.

(2.) The bottom of an escarpment does not keep to one level, but rises slowly inland, or towards the watershed, that is in accordance with the drainage-level of the country and without regard to the level of the sea. Professor Ramsay has called my attention to the fact that sometimes the base at one place is higher than the top at another.

(3.) Sea-cliffs run comparatively straight, or rather in curves of large radius, through homogeneous rocks (of course through a succession of hard and soft beds they have an irregular outline); but on the other hand escarpments wind about, which they should not do if they were simply old cliffs. Here the saying, "the exception proves the rule" holds good; for the wonderfully intricate coast-line of Norway and of other like countries is well known to have been caused by the sinking of the land, and not by the action of the sea, the wearing-power of which is as nothing up the deep narrow winding fjords, so clearly seen to be submerged valleys.

(4.) If escarpments have been formed by the sea, there ought to be at their foot some resultant of that agent, a beach or other marine deposit; but this is not the case (except, perhaps, in some places where masses of Boulder Drift end near the bottom of a ridge), whatever deposit there is being such as one would look for from subaërial actions.

(5.) It has been said that any beach which there may once have been at the foot of an escarpment has perhaps been destroyed by subaërial denudation wearing back the ridge. To this it has been answered that such a concession to the power of subaërial action is really much the same as giving up the question at issue in their favour; for if they are powerful enough to do so much they could surely do more in a longer time.

(6.) Sometimes two escarpments (facing the same way) run roughly parallel and near together for miles, as those of the Chalk and Lower Greensand in Surrey and Kent, and those of the Chalk and the Portland Stone in part of the Isle of Purbeck. To suppose these formed by the sea implies that there have been two long parallel ridges of land, each consisting of a separate formation, divided by a narrow strip of sea, the like of which is not to be seen now-a-days. Moreover, the sea would have little power to act in so narrow and sheltered a place, but would be as harm-

[1] It would be overburdening this paper with foot-notes were I to acknowledge the many sources whence some of the following arguments have been in great part derived; enough to refer the reader to the list of authors given before. I would gladly have quoted largely from Hutton, Playfair, Scrope, and others, but the paper would have been much lengthened thereby.

less as in the Norwegian fjords, where I have seen the old ice-scratches run down to (and, perhaps, below) high-water-mark, uneffaced by the waves. It should be remarked too that in the above cases the Chalk escarpment is mostly the larger of the two; whilst according to the marine theory it should clearly be the smaller, because the inner and therefore the more sheltered.

As far as I know the above arguments have never been thoroughly answered, much less disproved, by those who hold that the sea has been the great, if not the only, agent employed in forming escarpments. Until this has been done the marine theory has little foundation, and indeed is simply a convenient supposition, put forward to avoid a seeming difficulty, not a theory upheld by sound inferences and founded on well-established facts.

To these may be added other remarks that have a general bearing on the discussion, which, I believe, have not been treated of in such detail as the foregoing, and which refer chiefly to the style of argument that has been put forward against subaërialists.

(7.) The preservation of old ice-scratchings has often been brought forward as an argument for the powerlessness of surface-actions in wearing away rocks; but really it is not a valid one, for it is not enough that in *some* places the weather has not acted on rocks for a very long time, it must be shown that such is the case in *most* places; or, in other words, that the weather *hardly ever* wears away rocks, not that it does not always do so.

(8.) It has been objected that the subaërial theory needs a vast time to account for the work done. This is an objection only, not an argument, and few subaërialists can be afraid of allowing any quantity of time for the work of those quiet ceaseless actions which they look on as powerful enough to wear away the hardest rocks. A late writer, one I believe who is known from his papers on subjects relating to the connection of Geology and Archæology, has well said, in a Review of one of Mr. Prestwich's papers, "the main argument, as to the process of excavation (of the valleys) and of the length of time necessarily involved in it will, we are confident, eventually meet with general acceptance, even if the rising school of geologists . . . . may be induced to draw more largely than Mr. Prestwich on the enormous balance of past time which stands in their favour in the Bank of Nature."[1]

(9.) The occurrence of needles in places far from the sea has been brought forward as an argument for marine denudation in those places, and Sir C, Lyell, in the last edition of his "Elements of Geology,"[2] speaks of the needles of hard Chalk high up the valley of the Seine as "evidence of certain escarpments of the Chalk

[1] Geol. Mag., Vol. II., p. 26. (1865.)

[2] 1865. pp 351–5. As Sir Charles does not now hold that these needles are signs of the action of the sea (see before, p. 449), it might be thought needless here to controvert that idea. However, as it is contained in the last edition of his "Elements," a work constantly referred to by geologists, I have let this paragraph stand.

having been sea-cliffs." Now, as will be noticed further on, needles are formed by atmospheric actions at the top of high cliffs; indeed, in nearly all cases they are formed *from above*, by something that acts downwards along lines of joint, or fissure; and I can see no reason why they should not be formed inland, under favourable circumstances, as well as on the coast; though of course the latter is one of the most favourable parts for the weather to wear away rocks, by reason of the carrying away of the débris by the sea. Moreover the question of the formation of such inland needles in France by subaërial actions has been worked out by M. Ch. Martins in a paper noticed before.

(10.) It is however needless to take up the argument in this way; for before anyone calls forward witnesses of such doubtful character to prove the marine denudation of a long winding valley like that of the Seine, he is bound to show that the sea can make such a valley, or to point to some place where it actually is doing such work: just as those who say that the sea makes escarpments are bound to show that it can and does do that sort of work now.

I need hardly say that both these things are impossible. None of the advocates of marine denudation have given the proofs and examples needed; and they never will, for the simple reason that there are none to give.

This is a matter of reasoning simply, not of scientific truth alone, and it would be well if the rules of the former were a little more heeded by those whose wish should be to reach the latter, as else they stand little chance of getting at their object. One of my colleagues, who is a strong believer in the sea, and nothing but the sea, has gone so far as to say that "attempts at proving or disproving the soundness of speculations on natural phenomena by a logical syllogism are scarcely creditable to men of science."[1] To such a statement I must strongly object, for it is clear that the first thing needed of an argument is that it should be logical. One should not be surprised, however, at the advocates of the marine formation of valleys and escarpments looking down on logic (as an unpleasant test to apply to their arguments) and scorning syllogisms, or in other words despising true reasoning, unless they follow and "overcome those prejudices which contracted views of nature and magnified opinions of the experience of man may have begotten, prejudices that are apt to make us shut our eyes against the clearest light of reason,"[2] and give up one of the most illogical theories that the ingenuity of geologists ever invented.

(11.) Some folk begin by misrepresenting the followers of Hutton, and then go on triumphantly to disprove the theory which they have misunderstood, or sometimes I fear have not taken the trouble to understand. Thus it has been said that the Huttonians (if that old name may be used in the limited sense here meant) deny the power of the sea, and say that rivers, glaciers, rain, and frost have done everything. Now nothing could be further from the truth;

[1] Geol. Mag., Vol. III. p. 571.
[2] Hutton, "Theory of the Earth," vol. ii. p. 367.

for they allow that it has been the agent employed in those great planings-down of solid rocks of which such good evidence is given by the appearance at the surface of formations that would otherwise be deep down in the earth, and by the great unconformities shown by rocks of one age resting on the upturned truncated edges of others vastly older. In comparison to these huge, and, as they may be called, "continental" denudations and removals of rock, the present irregularities of the earth's surface are mere scratches, though to our eyes grim mountains or sheltered valleys; and until this is thoroughly understood by geologists there is small hope of their agreeing in the theory of subaërial denudation.[1]

A steam-hammer can crack a nut certainly; but man does not commonly use so strong an engine for so small a work, it would be a waste of power, nut-crackers do just as well: neither does he use the steam-plough for the tillage of a garden. Is man more careful of his resources than nature? Should we expect the latter to be wasteful of her strength and to use her steam-plough, the sea, for small work when she has plenty of small tools to do it with? Surely not: nature does not waste power; and rather does great things with small means, than small things with great means. She uses the sea to carve out continents and islands; rain and rivers to cut out hills and valleys: just as the former has deposited wide-spread masses of rock miles upon miles in thickness, and the latter here and there some thousand feet of fresh-water beds.

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## IV.—On some new Terebratulidæ from Upware.

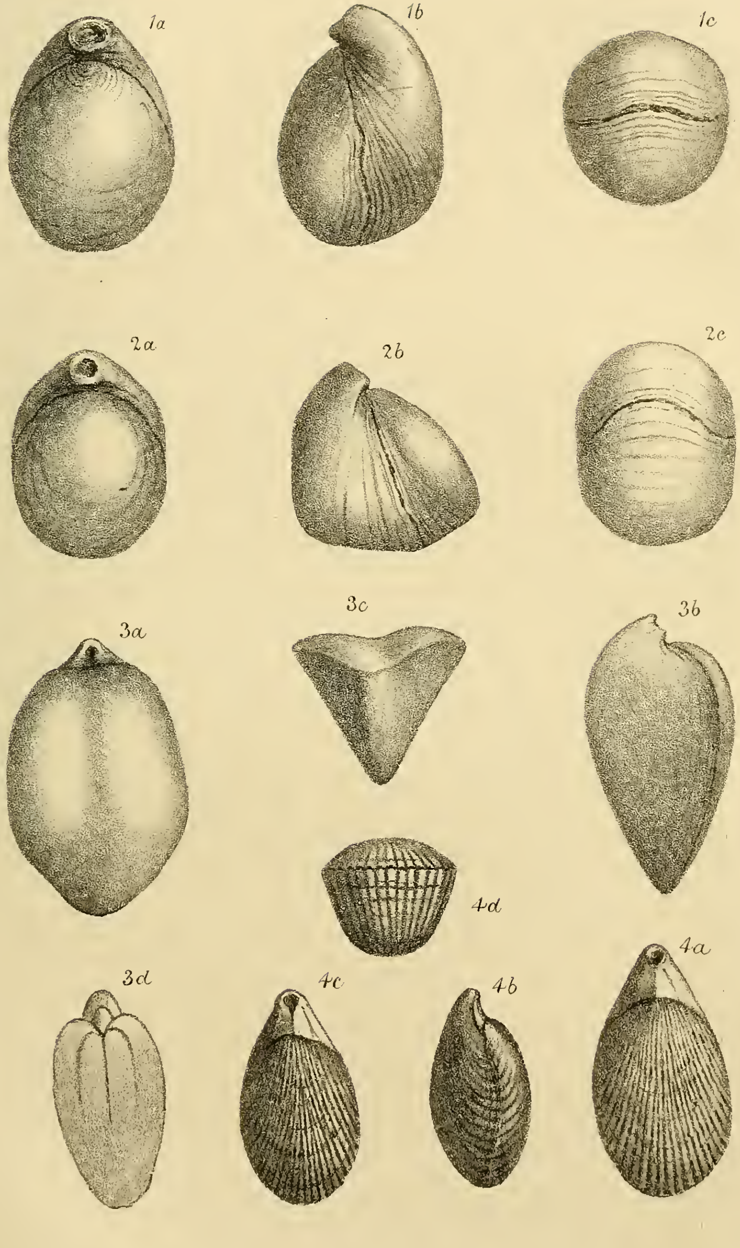
By J. F. Walker, B.A., F.G.S., etc.

(PLATE XIX.)

In my paper published in the July Number of this Magazine I gave a list of the *Terebratulidæ* from the Upware deposit; since then I have further examined them, especially with regard to the shell I named *Terebrirostra neocomiensis.* There are clearly certain well-marked differences between the Upware species and that fossil. The shell I called *T. hippopus* also proves to be a new species. Some of the specimens of the small variety of *T. oblonga* closely correspond with *T. Fittoni* of Meyer, which was described in the first volume of this Magazine; it was found at Godalming in Surrey. I have also some specimens of *T. Dutempleana* from the Upware bed; and I have no doubt the affinities of that shell with *T. prælonga* (a species not uncommon at Upware) will be able to be determined. (See Cretaceous Brachiopoda, by T. Davidson, page 59).

*Waldheimia Davidsonii*, sp. n., Figs. 4*a.–d.* — Shell elongate ovate, surface finely striated, striæ dichotomous at various distances from the hinge, and marked by concentric slightly raised lines of growth. Beak rather long, nearly straight, foramen medium-sized,

[1] Professor Ramsay has noticed the great thickness of solid rock that must have been denuded in Wales (Mem. Geol. Surv. vol. i. p. 297, and plates. 4, 5, 1846; and vol. iii. p. 236, and pl. 28, 1866). I believe that the former of these was the first attempt at showing the vast amount of denudation that has taken place.




G.R.De Wilde del. et lith. M & N. Hanhart. imp.

NEW SPECIES OF BRACHIOPODA FROM UPWARE CAMBRIDGESHIRE &c.

deltidium large, in two pieces. The dorsal valve is slightly convex, and scarcely indents the ventral valve. The ventral valve is likewise convex, or sub-carinate, and is slightly compressed at the sides. The loop extends nearly to the front of the dorsal valve. Length 1·1 in. to 1·3 in.; width 0·6 in. to 0·9 in.; thickness about 0·5 in.; of mature specimens.

This species is tolerably abundant in the Lower Greensand deposit at Upware. I regarded it as a variety of *Terebrirostra neocomiensis*, d'Orb., and indicated it under that name in my paper on the Upware deposit; but it appears to differ from that species, as was pointed out to me by Mr. Davidson, especially in the deltidium being in two pieces, and in the shorter length of the beak. The loop is that of a *Waldheimia*, and, considering the resemblance of the shell to *Terebrirostra neocomiensis*, it would seem to confirm Mr. Davidson's supposition of the probable identity of *Waldheimia* and *Terebrirostra*. *W. Davidsonii* varies somewhat in form, being sometimes longer and narrower, sometimes broader and flatter, than the specimens figured.

I have named this fossil in honour of T. Davidson, Esq., F.R.S.

*Waldheimia Woodwardii*, sp. n., Figs. 3*a.*–*d.* — Shell rather elongate ovate, external surface smooth, ventral valve strongly keeled. Keel much arched towards the beak, the sides nearly flat, so that a transverse section of the shell forms a nearly equilateral triangle. Beak short, slightly recurved, truncated by a rather large foramen. Dorsal valve ovate, rather convex towards the hinge-margin, and slightly grooved along the centre; indenting the ventral valves at the front margin. Loop (as indicated by internal cast, Fig. 3*d*) about half the length of the dorsal valve Dimensions: length 1·4 in.; width 0·9 in.; greatest depth 0·8 inches.

This shell, which is very rare, occurs at Upware. I referred it to *T. hippopus*, Rœmer, in my paper on that deposit. It appears to approach most closely to *T. hippopus* of any of the Cretaceous species; but differs in its more elongated form, in the triangular shape of its transverse section, and in having the frontal portion of the dorsal valve nearly flat, so that the ventral valve is very slightly indented. Of Jurassic forms of *Terebratula*, this species approaches nearest to *T. resupinata* and *T. carinata*.

I have named this remarkable species after the late Dr. S. P. Woodward, to whom science is indebted for many valuable observations in connection with the Brachiopoda.

*Terebratula Dallasii*, sp. n., Figs. 1 and 2.—Shell ovate, length exceeding the width, much inflated, often globose, smooth externally, marked with a few lines of growth, especially on the frontal surface. Beak short, rather straight, truncated by a large foramen, partly margined by a rather wide deltidium, formed of one piece, and generally diminished by the encroachment of the hinge margin. Loop extending nearly half the length of the dorsal valve. Dimensions of a globose specimen (Fig. 1): length 1·2 in.; width 0·9 in.; depth 0·95 in.; of an angular form (Fig. 2): length 1·1 in.; width 0·8 in.; depth (at the front margin) 1 inch.

This species occurs in the Upware deposit, and also in the conglomerate bed near Potton; in the former the specimens are calcareous, in the latter ferruginous. Calcareous casts of the interior also occur at Upware.

By its remarkable form, this species is easily distinguished from all other Cretaceous *Terebratulæ.*

I have great pleasure in naming this fossil after my friend W. S. Dallas, Esq., F.L.S., etc,

DESCRIPTION OF PLATE XIX.

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| Fig. | 1. | *Terebratula Dallasii* from near Potton. |
| | 2. | *Terebratula Dallasii*, from near Upware. |
| | 1*a* & 2*a*. | Dorsal aspect of shell. |
| | 1*b* & 2*b*. | Side view of same. |
| | 1*c* & 2*c*. | View of anterior margin of valves. |
| | 3. | *Waldheimia Woodwardii*, from near Upware. |
| | 3*a*. | Dorsal aspect of shell. |
| | 3*b*. | Side-view of same. |
| | 3*c*. | View of anterior margin of valves. |
| | 3*d*. | Ditto, cast of interior, from the same place. |
| | 4. | *Waldheimia Davidsonii*, from near Upware. |
| | 4*a* & 4*c*. | Dorsal aspect of shell. |
| | 4*b*. | Side-view of same. |
| | 4*d*. | View of anterior margin of valves. |

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## V.—On the Ferruginous Sands of Buckinghamshire, with Remarks on the Distribution of the equivalent Strata.

By J. Morris, F.G.S.

THE coarse ferruginous sands at the base of the Cretaceous series, in the counties of Bedford and Cambridge, have of late years attracted considerable notice, not only as sources of iron ore, but also of phosphatic matter. To these deposits the attention of geologists has been directed, and among other valuable papers, may be mentioned some by Messrs. Seeley and Walker,[1] who have treated of their general physical characters, and also of their interesting fossil contents. It may be useful to some of the readers of the Geological Magazine, who are interested in tracing out the range of this deposit, and the peculiar conditions under which it was accumulated in some parts of the area, to point out briefly its characters and contents in the adjoining county of Buckingham; *i.e.*, around Aylesbury[2]: more especially so, as these sands have been considered to be partly equivalent in time, or the marine conditions of the Wealden and Purbeck strata.

These beds vary slightly in mineral character in the district to be noticed; the most marked or predominant feature being, however,

[1] Ann. and Mag. Nat. Hist., Aug., 1866; July, 1867. Geol. Mag., Vol. IV. p. 199. Ann. and Mag. Nat. Hist., July, Nov., 1866; Aug., 1867. Brodie, Geol. Mag., Vol. III. p. 153. Walker, Brit. Assoc. Dundee, Sept., 1867. See also Original Article IV. in this number of the Geol. Mag.

[2] A part of this district being uncovered by Drift or Boulder-clay, good sections of the Lower Greensand, Purbeck, Portland, and Kimmeridge clay may be seen, and a little to the north, in the railway cutting, the Oxford clay. See "General Sketch of the Geology of Hartwell," London University Magazine, June, 1856, p. 102.

a more or less thick deposit of coarse ferruginous sand, with intercalated bands, or irregular concretions of ironstone, for the extraction of which this bed has been extensively worked in many places, and its general characters and contents more fully made known.

It was from these sands, in the neighbourhood of Leighton, that the specimens of *Cycadites Yatesii,* described by Mr. Carruthers,[1] were obtained, associated with coniferous wood; but no other fossils have been met with to my knowledge, although near there—at Linslade—casts of *Nucula* and other marine shells were found. In a south-westerly direction these beds are not so thick, and are seen capping the hill-tops, the intervening portions having been removed by denudation. Thus, around Aylesbury, at Hartwell and Stone, these sands overlie the Purbeck and Portland beds, but in a southerly direction have been removed over a considerable area, until their equivalents are again seen at the surface near Bishopstone, beyond which they are covered by the Gault and Upper Greensand; these again dip under the Chalk strata of the Chiltern Hills, which form a portion of the fine chalk escarpment overlooking the country to the north. The Upper Chalk is again covered by the Tertiary strata, which in some places, as at Hampden, is a hard sandstone, and silicious flinty conglomerate, identical with the so-called "Druid Sandstone," or "Sarsen-stone,"—very durable, and which has been worked for building and road-stone, and largely used for the footways at Aylesbury, and in Hartwell grounds.[2]

Dr. Fitton, in his able memoir, "On the strata below the Chalk,"[3] carefully described the district around Hartwell, and gave a full account of the sections then exposed, since which time (1827) some sections have been enlarged, and other pits opened, so that a few additional facts have been obtained, but which do not invalidate the conclusions arrived at by Dr. Fitton; thus, for example, the ferruginous or Lower Greensand has been found to contain fossils, not known at that time, from this locality. It is to these sands that this brief notice is more especially directed, reserving for a future time some remarks on the Purbeck and Portland beds of this district.

These sands and associated beds are well seen in four or five pits around Hartwell, as well as along the Dinton road, and at the brick works between that village and Haddenham, and also further west, at Thame, Hazeley, and Brill. At the red sand pit, not far from the Bugle Inn, an opening exposed about six feet of the sands overlying a partly irregular surface of one of the Portland beds. The sands are coarse, highly ferruginous, containing ochreous concretions, and many quartz pebbles (which at one time were specially collected), as well as many more or less rounded but large pebbles, consisting of different materials, as quartzite, lydian stone, and others, evidently originally derived from the older rocks. At the base of these sands,

[1] Geol. Mag., Vol. IV. p. 199. Pl. IX.

[2] Blocks of this stone, known as Hampden stone, have been extracted five or six feet in length, and used as ornamental stones, or rude pillars, as at Hartwell Park.

[3] Geol. Trans., 2 ser., vol. 4, p. 285 *et seq.* See also Ædes Hartwelliana.

but not *in situ*, are blocks of compact brown sandstone, containing casts of *Unio* (*U. Gaulteri?*) *Cyrena*, *Paludina*, and traces of plants. The sands themselves contain impressions of shells as *Lima undata* Desh., *Pecten distriatus*, *P. Cottaldinus? Exogyra sinuata*, *Rhynchonella antidichotoma*, *Ostrea macroptera*, *Spondylus*, *Teredo* and *Pholas* (*Pholadidea*)[1] *Cornuelliana*. Many Foraminifera, Rotalina, etc., some small corals and Bryozoa, and large pieces of coniferous wood, in some decomposed portions of which casts of a boring shell were observed; no phosphatic nodules were noticed, or fossils derived from other strata, except the Freshwater sandstone above noticed.

These sands may be traced in part of Hartwell Park. At Lock's pit,[2] on the Thame road, just beyond the Hartwell grounds, a section from five to twelve feet deep, presented, in the lower part, fawn-coloured sands, with thin darker, sometimes carbonaceous, layers, very irregular, overlain by sandy clays and impure fuller's earth and coarse sands above, but no fossils. Further on the road, at the white sand-pit, a better section was exposed, consisting, in descending order, of coarse ferruginous sand, sandy clay, fuller's earth, shaley clay and grey sand, large lenticular, but not continuous, masses of pisolitic hydrated oxide of iron, reposing on an uneven surface of white sand, containing large irregular hard siliceous concretions, assuming very grotesque forms called 'bowel-stones,' this sand is about 20 feet thick.[3]

Beyond Stone Church, opposite the Vicarage, and near the windmill, large excavations have been made for some years past, showing the coarse ferruginous sands and associated beds, but not so definitely as at the white sand-pit;[4] and extensive openings on the right of the road from Stone to Eythorpe, exhibit similar white ferruginous and coarse sands. Some years since, during the progress of the excavations in the sand-pit, and along the road opposite the vicarage, human remains and various implements were found, affording evidence that this spot was used as a burial-ground during the Roman

[1] This appears to be a variety of *P. Cornuelliana*, d'Orb, and is probably identical with the *P. Dallasi*, Walker; a similar form occurs at Farringdon, and at Seend, in Wiltshire.

[2] In going from the 'Bugle' to this section, we first observe the large stone-pit of Purbeck and Portland beds, uncovered by sands, which only set in as we ascend the hill towards Stone.

[3] These concretions were used as ornaments in the neighbourhood. A large number may be seen built into the wall of Hartwell Park, as well as fine specimens of *Ammonites giganteus*: the wall itself is of Portland stone, from the adjacent quarry, and the date of building picked out with the Hampden stone. The sand has been extensively worked, and sent to Birmingham for glass making, the finer and whiter portions have realized 1*l*. 1*s*. a ton, and other portions about 8*s*. to 12*s*. per ton. Large globes and prisms of glass, made from this sand, are in the Hartwell Museum.

[4] The following section was formerly exposed:—

| | |
|---|---|
| Coarse sand and pebbles | 4 feet. |
| Ferruginous sandstone and rock | 6 inches. |
| Imperfectly stratified clay (fuller's earth?) | 4 inches. |
| Ferruginous sand | 1 foot. |
| Grey sandy clay | 1 foot. |
| White and grey sand, wavy and irregular, with carstone and ironstone | 8 feet. |

occupation of Britain. An account of these discoveries was communicated by Mr. Akerman to the Society of Antiquaries in 1851.

These sands occupy a considerable area on the top of the hill near Stone, being about one quarter of a mile from north to south, and about three quarters of a mile from east to west. From their area, their ready permeability to water (having been estimated to yield about 40,000 gallons of water per day), and the geological conditions of the underlying strata, they are important as an available source of water-supply, the capabilities of which for that purpose were first pointed out by Dr. Millar, F.G.S., in 1854, after the failure of a well, 500 feet in depth, sunk in the Bucks Asylum grounds, through the Portland and Kimmeridge beds into the Oxford clay. Acting upon his suggestion, that this body of sand would always contain a sufficient store of water, the Asylum has since that time derived its chief supply from this source.[1]

During some excavations for drainage in the adjacent grounds at a lower level, and probably corresponding to the base of the sands at their junction with the Purbeck strata, masses of ferruginous sandstone with *Unio* and *Paludina* were found similar to those in the red sand-pit. At nearly the same horizon, near Stone Church, many specimens of *Endogenites erosa* were found by the Rev. Mr. Lowdnes and myself, indicating, as I believe, the former existence of the Wealden beds over this area, subsequently removed by denudation previous to or during the deposition of the sands above, and disproving to some extent the notion that these sands are the equivalents in time of the Wealden and Purbeck strata.

Having shown that these sands, containing fossils of the Lower Greensand, and at some points freshwater shells near their base, sometimes overlie the Purbeck and Portland beds with an indication of the Wealden, it may be interesting to trace the equivalent strata as they range to the north-east or south-west of this district, and compare the mineral character in different localities as given by various authors.[2]

The sands trend north-westerly from Aylesbury, through Bedford and Cambridge into Norfolk, where, under the name of "Carstone," they underlie the red chalk and cretaceous beds, as is well seen at Hunstanton. At Potton,[3] in the former county, many fossils and phosphatic nodules have been obtained, and at Woburn, in the same formation, fuller's earth has long been worked.[4]

At Upware, in Cambridgeshire, these beds have recently been shown to be fossiliferous, containing many species of Terebratula

[1] Special report in reference to the supply of water for the Bucks Lunatic Asylum, 1856, p. 17. Mr. Prestwich remarks "that the effective permeable beds of the Lower Greensand are 200 feet thick, that they occupy an area above and below ground of 4,600 square miles, that a mass of only one mile square and one foot thick will hold more than 60,000,000 gallons of water, and some idea may be then formed of the magnitude of such an undergrouud reservoir."—"Water-bearing Strata," p. 179.

[2] Dr. Fitton, Geol. Trans., Vol. iv. p. 285, *et seq.* Holloway, Phil. Trans. 1723, Vol. xxxii. p. 419. Prestwich, Water Bearing Strata, p. 85.

[3] Seeley, Ann. and Mag. Nat. Hist., Aug. 1866. Walker, ibid., Aug. 1867. Brodie Geol. Mag., Vol. III. p. 153.

[4] Conybeare and Phillips, Outlines, p. 138. Fitton, Geol. Trans., Vol. iv. p. 294.

and sponges, some similar to those at Farringdon, and also rolled specimens derived from older rocks, my friend, Mr. Huddlestone, F.G.S., has shown me a fine series collected from this bed.[1]

At Ely and Haddenham these sands rest on the Kimmeridge clay.[2] Further northwards, in Lincolnshire, a change takes place in the mineral character of the beds, presenting somewhat an approximation to the southern type. Mr. Judd[3] has described the strata, overlying probably, the Oxford clay, near Market Rasen and Tealby, to consist of—

1. Upper ferruginous sands, non-fossiliferous, twenty feet thick.
2. Tealby series, alternate beds of sandy clay and limestone, with many fossils, forty to fifty feet.
3. Lower sand and sandstone, with few fossils, thirty to forty feet.

A somewhat similar arrangement of the strata below the Red Chalk in Lincolnshire, was proposed by Mr. Conybeare, in 1822, viz.

1. Quartzose, ferruginous, pebbly sand, from eight to ten yards.
2. Calcareous clay, containing beds and concretions of Oolitic limestone, from twelve to fourteen yards.
3. Granular quartzose sandstone and sand, varying from dark-brown to light-grey, and containing shells, considerably thicker than the two former beds.

These beds rest on strata of argillaceous shale, which appear to belong, in part at least, to the Oxford clay.[4]

Crossing the Humber the equivalents of these beds pass under the Wolds, and again reappear at the well-known section of Speeton, long ago described by Professor Phillips, in which the mineral character again differs from that of Lincolnshire and Bedfordshire. This is the most northerly extension of the Lower Cretaceous rocks, which here are considered to overlie the Kimmeridge clay.

In a westerly and south-west direction from Aylesbury the Lower Greensand may be traced, but not always continuous, at Brill[5]

[1] Walker, Geol. Mag., Vol. IV. p. 309.

[2] Sedgwick, Lecture on the strata near Cambridge, Dec., 1861, p. 21.

[3] Quart. Journ. Geol. Soc. vol. xxiii. p. 243. In the year 1859, during a visit to Mr. Morel, at Bayons Manor, I traced out, with Mr. T. J. Smith, F.G.S., of Hull, the characters of the Lower-green Sand around Tealby, from Hainham to Caistor, and pointed out the existence of the pisolitic iron ore then unworked at Walesby, and arrived at the conclusion that these beds and their fossils, as well as those at Speeton, should be carefully compared with the *Hilsthon* and *Hilsconglomerat* of N. Germany (Hanover), and not with the Portland, as suggested by a geologist. I collected many fossils, such as the large *Pecten*, *Ancyloceras*, *Trigonia*, *Belemnites*, etc , some of which are now in the British Museum. A general sketch of the geology of the locality mentioned was given in the introductory lecture that I had the pleasnre of giving at the opening of the Tealby Institute (Nov. 29, 1859), established by the late Tennyson D'Eyncourt, Esq. I subsequently examined, in company with Mr. Prestwich and Mr. S. Sharp, the district around Spilsby and Horncastle, etc., and found in the sands at the former place specimens of Coniferous wood with Teredo borings and also phosphatic nodules. Mr. R. Godwin Austen considered the Speeton clay to be the representative of the Hilsthon (Proc. Geol. Soc. vol. iv. p. 196). See also Roemer, Die Versteinerungen des Norddeutschen Kreidegebirges, Hanover, 1840.

[4] Outlines of Geology, 1822, p. 164.

[5] Fitton, Geol. Trans., Vol. iv. p. 280. Estuarine sands with Paludina, Brodie, Quart. Journ. Geol. Soc., Vol. xxiii. p. 198.

(where fresh-water shells are found), Thame, and Shotover Hill; a good section is here seen with the intercalated ochre beds, and at this latter locality fresh-water shells, as *Unio*, *Paludina*, etc., have been observed in the sands overlying the Portland by Mr. Jelly, Mr. Strickland, and Professor Phillips.[1] The rich fossiliferous sands of this series, overlying the Coral rag, are well known at Farringdon,[2] and they may be seen at Swindon, above the Purbeck, Lockswell Heath (rich in fossils) above the Calcareous Grit, at Roade, with *Nucula*, and at Seend, overlying the Kimmeridge clay; at the latter place the ferruginous sandy beds have been worked for iron ore, they contain fossils, and at one spot the cavities, formed in the Kimmeridge clay below by the boring molluscs of the period (Lower Greensand), are well seen, proving that the Kimmeridge beds must have formed the sea-bottom during their accumulation.

Mr. Conybeare, in 1822, describes the beds at Seend as being a pudding-stone, composed of rounded quartz, whose cement is silicious with a calyx of iron, containing ore formerly in much request for the furnace and the forge; and forming the materials whence the ancient Britons wrought their Quernstones.[3] Further south the sands are but faintly seen in the vale of Wardour, overlying the Purbeck and Portland beds, and their equivalents are again recognised at Ridgway, near Weymouth.

These beds may be traced eastward from Weymouth, at many points, as at Lulworth, Worbarrow, and Swanage bays, and on to the Isle of Wight, separating the Wealden and Purbeck from the middle cretaceous rocks. The fine sections of the Isle of Wight, rich as they are in fossils, present, however, different mineral characters from their more eastern and northern representatives, consisting mostly of coarse and fine sands, shales and clays, and little limestone, in fact chiefly arenaceous and argillaceous deposits. Around the wealden of Kent, Surrey, and Sussex, the Lower Greensand strata are extensively developed, but vary in their mineral characters; thus from Reigate, westward, although presenting a triple subdivision, the beds are chiefly arenaceous and argillaceous; between Reigate and Bletchingley the intercalated mass of fullers earth occurs,[4] which, according to Mr. Meyer,[5] belongs to the Upper or Folkstone series, and is almost on a level with the Bargate-stone of Godalming, the latter, according to Dr. Fitton, being the equivalent of the calcareous beds of Kent. From about this point the limestones known as the Kentish Rag[6] set in, and are more or less worked, throughout their continuous range, to Hythe, as at

[1] Fitton, Geol. Trans., Vol. iv. p. 275. Phillips, Journ. Geol. Soc., Vol. xiv. p. 236.

[2] R. A. Godwin Austen, Quart. Journ. Geol. Soc., Vol. vi. p. 464. D. Sharpe, ibid., Vol. x. p. 176.

[3] Outlines, p. 142.

[4] Conybeare and Phillips, Outlines, 1822, page 152; Fitton, Geol. Trans. vol. iv. p. 141.

[5] See Geol. Mag. 1866. Vol. III. p. 15.

[6] This valuable building stone was extensively used in early Ecclesiastical architecture, and is now largely worked for the building of most of the modern London churches and for other purposes.

Seven Oaks, Maidstone,[1] Boughton, and near Ashford, etc. The coast line from Hythe to beyond Folkstone harbour, exposing, as is well known, a fine section of the Lower Green sand series.[2]

From the foregoing brief remarks it will be seen that the Lower Green-sand strata vary in their mineral characters, when traced over the British area, thus the limestones of the eastern part of the Wealden districts are wanting in the western part, as well as in the Isle of Wight, where arenaceous and argillaceous beds predominate. On this point Mr. Meyer and Dr. Fitton have made some suggestive and valuable observations.[3] So also on tracing them from Dorset to Yorkshire, they chiefly consist of ferruginous sands, and sandstones, which in Lincolnshire are intercalated by sandy calcareous beds, called 'greystone,' and still further north at Speeton, are represented by argillaceous strata. Further, it may be observed with regard to their position that, in Southern England, these beds always directly overlie the *Wealden beds,* whilst as they trend from Dorset to Yorkshire, they are found lying upon either the Purbeck, Portland, Kimmeridge, Calc grit, Coral rag, or Oxford clay, some of which from the evidence afforded by the boring mollusca, must have remained for a period uncovered by the now overlying sands.[4] That a certain amount of denudation took place prior to the deposition of the Lower Green-sand, in the northern area, is, I think, evident,[5] but that the Purbeck and Portland strata ever extended far beyond their present limits is not so probable, as they may have thinned out in that direction, a point to which I may again refer, when treating of these formations as they occur in Bucks.

## NOTICES OF MEMOIRS.

British Association for the Advancement of Science. Dundee, September 5th, 1867.—List of Papers read before the Geological Section. (Section C.) President, Archibald Geikie, F.R.S., etc.

Dr. Robert Chambers—Notice of an "Esker" at St. Fort.

[1] From the quarries of this stone belonging to Mr. Bensted of Maidstone, the fine specimen of *Iguanodon Mantelli,* now in the British Museum, was obtained in 1834.

[2] Fitton, Geol. Trans. vol. iv. plate 8.

[3] C. J. A. Meyer, "On the Correlation of the Cretaceous Rocks of the South-east and West of England," Geol. Mag. vol. iii. Jan. 1866; Fitton, "Comparative remarks on the Sections below the Chalk at Hythe, Kent, and Atherfield, Isle of Wight, Geol. Journ. vol. i. p. 179, May, 1844. Dr. Fitton shews that the prominent points of difference between the sections of the Kentish coast and the Isle of Wight, are considerable variation in mineral composition,—the almost total absence of Limestone at Atherfield, and the greater thickness of the Lower Green-sand at this latter place (by 346 feet) than at Hythe.

[4] Where the "Tourtia," or part equivalent of Lower Green-sand, in Belgium, overlies the denuded surface of the contorted beds of Palæozoic limestone, numerous borings of mollusca may be seen, as at Montigny-sur-roc and other places.

[5] The former existence of the Upper Wealden strata, in the interior of England, is rendered probable by the erosion of the Purbeck beds, in many places, where the Lower Green-sand comes in contact with them. Fitton, Geol. Trans., vol. 4, p. 325. See also Mr. Walker, An. Mag. Nat. Hist., August, 1867.

D. Milne Home—On the Old Sea Cliffs and Submarine Banks of the Frith of Forth.

Dr. J. Bryce—Account of Recent Researches into the Age of the Arran Granites.

E. A. Wünsch—On some Carboniferous Fossil Trees, embedded in Trappean Ash, in the Isle of Arran.

Professor Harkness and Dr. H. A. Nicholson—On the Coniston Group of the Lake District.

Dr. H. A. Nicholson—On the Graptolites of the Skiddaw Slates.

Dr. H. A. Nicholson—On the Nature and Systematic Position of the Graptolitidæ.

R. H. Scott—Preliminary Report of the Committee for the Exploration of the Plant Beds of North Greenland.

J. Wyatt—On the Gradual Alteration of the Coast Line in Norfolk.

George Maw—On the Cambrian Rocks of Llanberis, with reference to a break in the Conformable Succession of the Lower Beds.

Dr. Oldham—On the Geology of India.

The President—An Account of the Progress of the Geological Survey of Scotland.

H. Woodward—Third Report on Fossil Crustacea.

F. M. Burton—On the Lower Lias, and traces of an ancient Rhætic Shore in Lincolnshire.

J. E. Taylor—On the Norfolk Chalk-marl.

H. S. Ellis—On the Mammalian Remains from the Submerged Forest in Barnstaple Bay, Devonshire.

W. Pengelly—Third Report of the Committee for the Exploration of Kent's Cavern, Devonshire.

Professor Ansted—On the Conversion of Stratified Rock into Granite in the north of Corsica.

Dr. Julius Schvarcz—On the Internal Heat of the Earth.

Dr. C. Le Neve Foster—On the Preseberg Iron Mines, Sweden.

F. Gordon Davis—On the Calamine Deposits of Sardinia.

Dr. C. Collingwood—On the Geology of the North of Formosa, and of the adjacent Islands.

—————On some sources of Coal in the Eastern Hemisphere.

—————Notes on the Geological Features of the Sarawak River.

W. Carruthers—Enumeration of British Graptolites.

E. Hull—On the Structure of the Pendle Range, Lancashire, as illustrating the South-easterly attenuation of the Carboniferous Sedimentary Rocks of the North of England.

W. S. Mitchell—Second Report on the Alum-Bay Leaf-bed.

E. Hull—Observations on the Relative Geological Ages of the principal Physical Features of the Carboniferous District of Lancashire.

W. Carruthers—On British Fossil Cycadeæ.

—————On Calamiteæ and Fossil Equisetaceæ.

Professor Charles Martins—On the Ancient Glacier of the Valley of Argelez, in the Pyrenees (read in French by the Author.)

C. W. Peach—On new Fossil Fishes from Caithness and Sutherland.
E. Ray Lankester—On some new Cephalaspidean Fishes.
J. F. Walker—On a new Phosphatic Deposit.
Captain F. Brome—Notice of recent discoveries in Caves of Gibraltar, communicated by G. Busk, F.R.S.
Professor Ansted—On the Lagoons of Eastern Corsica.
Rev. W. H. Crosskey—Notes on the relation of the Glacial Shell Beds of the Carse of Gowrie to those of the West of Scotland.
John Plant—On the Geology and Fossils of the Lingula Flags, at Upper Maddach, North Wales.
Rev. J. Gunn—On Tertiary and Quaternary Deposits in the Eastern Counties, with reference to periodic oscillations of level and climate.
Mr. James Thomson exhibited a large series of sections of Corals from the Carboniferous Limestone, etc., prepared to illustrate Dr. P. Martin Duncan's Monograph on British Fossil Corals, for the Palæontographical Society.
Mr. R. Slimon's collection of Upper Silurian Crustacea, from Lesmahagow, in Lanarkshire, were exhibited, and Mr. Woodward called attention to some of the new forms.

## REVIEWS.

Figures of Characteristic British Fossils: with Descriptive Remarks. By William Hellier Baily, F.L.S., F.G.S., Acting Palæontologist to H.M. Geological Survey of Ireland, etc., etc. Part I., Plates 1-10, Cambrian and Lower Silurian. 8vo. pp. 54. 1867. London: J. van Voorst.

THIRTY-SEVEN years ago Samuel Woodward (Author of "An Outline of the Geology of Norfolk") published his "Synoptical Table of British Organic Remains," being the first attempt in this country to furnish a systematically and stratigraphically arranged list of British fossils since the Ichnographia of Lhwyd in 1699.

Thirteen years later (1843) the progress of geological studies necessitated a new edition, but Mr. Woodward being dead, Professor Morris brought out the first edition of his "Catalogue of British Fossils," a work which has justly maintained the first place in all geological libraries. The second edition appeared in 1854. We are glad to learn from the author that the third edition is now in preparation, and shall be still more so to announce it as "now ready."

Only those who have the work of arranging a geological collection can fully estimate the value of a reference catalogue. And this need increases with the size and varied nature of the collection to be named. The book before us does not chiefly aim at supplying the wants of the scientific worker and museum curator, but it is intended rather to assist geological students, and others, who, from their limited knowledge of palæontology, require to have figures of the various fossils placed before them, as well as their names and references, in order to enable them to identify their specimens. When it is borne in mind how many geological students there are living scattered through the length and breadth of the land, to whom access to a geological library is for ever denied, it is easily to be understood what a boon such a work as a well illustrated catalogue of British Fossils must be to them, even if it takes in only the characteristic British species. Of course it will occupy some time for the completion of such a work as this which Mr. Baily has undertaken; but the present number is an earnest of the future, and promises well for those who have subscribed to so good an object.

The ten plates which accompany this number are carefully drawn on stone by Mr. Baily, some from the original fossils, some from the memoirs of the Geological Survey, the Palæontographical Society's Monographs, and other sources.

We would counsel the adoption of finer grained lithographic stones in illustrating the future numbers of this work, as the merit of the artist's style is occasionally injured by the want of sharpness in some of the figures.

The woodcuts, interspersed through the pages of descriptive remarks, are well executed, and add much to the interest of the text.

We wish Mr. Baily all the success he so well deserves in the carrying out of this important work.

# REPORTS AND PROCEEDINGS.

## British Association for the Advancement of Science.

## ADDRESS TO THE GEOLOGICAL SECTION

By Archibald Geikie, F.R.S., &c.

Director of the Geological Survey of Scotland, President of Section C. Dundee, September 5th, 1857.

After some introductory remarks, the President said:—

In that combination of features which renders the British Islands so remarkable an epitome of the geology of the globe, not the least important item, as it seems to me, is the development of igneous rocks which we possess. From the massive feldspathic lavas and ashes of the Lower Silurian rocks, up to the great basaltic plateaux of Miocene age, most of our geological formations contain somewhere evidences of contemporaneous volcanic activity. And these traces, instead of being confined to limited districts, are found often to range for many miles through groups of hills and wide stretches of lowland.

This copious development of volcanic rocks cannot but present many facilities for the study of volcanic phenomena. The investigation may be approached from a number of different sides, resolving itself in this way into several distinct lines of research. Thus, these igneous masses may be studied stratigraphically with the proofs of their having been successively erupted at the surface during the growth of the various formations among which they occur. Hence, on the one hand, we may obtain much curious insight into the geological history of a district, while, on the other, by taking a broader view of the whole subject, we may to some extent trace the progress of volcanic action over the whole country. Again, the rocks may be examined, irrespective of the formations to which they belong, as repositories of data respecting the phenomena of volcanos. They may be studied as chemical or mineralogical compounds, and compared or contrasted with the products of modern volcanos. When, moreover, we reflect how many of these igneous masses must have consolidated on the floor of the sea, and how rare are the opportunities of investigating the progress of an active submarine volcano, we perceive that an attentive study of our own volcanic rocks may even elucidate some of the less observable features of modern volcanic action. Or these igneous masses may be examined with the view of ascertaining how far volcanic activity may influence submarine life. Thus, in some of our geological systems, among the Silurian rocks of Wales, for example, or the Carboniferous limestone group of Fife and the Lothians, many instructive sections occur where an abundant series of crinoids, corals, brachiopods, and other organisms, is gradually or suddenly enveloped in a mass of tuff. Other instances likewise abound in which a suite of fossils may be found slowly struggling through the upper part of a bed of tuff, until the ashy sediment dies away, and the fossils gather together into a bed of limestone. Even among the coal seams and ironstones of Scotland such intimate relations to contemporaneous volcanic action may be traced.

I purpose, at this time, to point out, by one or more illustrations from each of our geological formations wherein volcanic rocks occur, how varied and long-continued has been the progress of volcanic action in these islands. I shall offer, in conclusion, some suggestions as to phases of the subject which seem to me deserving of more special study than has yet been accorded to them.

*Lower Silurian.*—The oldest recognisable volcanic rocks in this country belong to the lower Silurian period. They are best displayed in North Wales, where, as was shown long ago by Sir Roderick Murchison, they rise into conspicuous ranges of hills. Two principal epochs of eruption have been detected by Professor Ramsay and his colleagues of the Geological Survey. One of these occurred during the deposition of the Llandeilo rocks, and is indicated by the igneous rocks of Aran Mowddwy, Cader Idris, Arenig, and Moelwyn; the other is marked by those of the Snowdon district, which lie among the Bala beds. These volcanic rocks consist partly of massive sheets of felstone, varying in texture and colour, and partly of thick accumulations of tuff or ash. The former are true lava flows, the latter point to frequent showers of volcanic dust, and to the settling of such dust and stones on the sea bottom, where they mingled with the ordinary sediment, and with shells, corals, and other organisms. Some of these ashy deposits attain a great thickness. Thus, at Cader Idris, "they are about 2,500 feet thick, the accumulated result of many eruptions." Northwards this mass thins entirely away, and the ordinary sedimentary strata take its place. Equally local are the massive beds of felstone which reprosent the submarine lava flows of the time. Sometimes they still preserve the slaggy vesicular character which marked their surface when the melted rock was in a state of motion along the sea bottom. By this and other evidence of a like tendency we learn the existence and position of true submarine volcanos during the lower Silurian period in Wales.[1]

Northwards, in the Lake District, Professor Sedgwick has found similar proofs of volcanic action among the lower Silurian rocks of that region, and those rocks are now being worked out in detail by Mr. Aveline and his colleagues of the Geological Survey.

No very distinct traces of contemporaneous volcanic activity have yet been detected among rocks of this age in Scotland.

Among the lower Silurian rocks of the south-east of Ireland beds of ash and felstone are interstratified, resembling in general character and mode of occurrence those of Wales, but on a much smaller scale. It has been observed that the Silurian fossils of that region occur only in the upper part of the series in the neighbourhood of the trap rocks and calcareous bands.[2]

*Upper Silurian.*—In Wales volcanic action does not appear to have outlasted the lower Silurian period, but in the south-west of Ireland, among the headlands of Kerry, massive sheets of ash are intercalated in grits and slates, which from their fossils have been assigned to the age of the Wenlock series.[3]

*Old Red Sandstone.*—The Old Red Sandstone of the southern half of Scotland abounds in igneous rocks, from the base of the series to the top. In its lower band lie the chains of the Sidlaw and Ochil Hills, and many detached masses scattered over the lowlands along the southern flank of the Grampians. These are composed of different felstones and porphyrites, with interbedded sheets of tuff, trappean conglomerate, and sandstone, stretching in the Ochil and Sidlaw range for sixty or seventy miles, and rising here and there to heights of 2,000 feet above the level of the sea. This group of hills contains some of the thickest masses of trappean rock in the country. In what seems to be a middle portion of the formation comes the group of the Pentland Hills, consisting of long massive beds of trap, like the different varieties in the Ochils, with intercalations of tuff, conglomerate, and sandstone, the whole reaching a thickness of fully 5,000 feet.[4]

In Ireland, also, the Old Red Sandstone furnishes evidence of active volcanic vents. Among the picturesque glens and cliffs of the

[1] See Murchison, "Siluria," p. 83. Ramsay, Descriptive Catalogue of Rock Specimens in Jermyn Street Museum, 3rd Edit., p. 8. Mem. Geological Survey, vol. iii. p. 21 *et passim*.

[2] Jukes, Manual, p. 454. See also Memoirs of Geol. Surv. Ireland, Explan. to Sheets 102, 111, 147, 167.

[3] Mem. Geol. Surv., Ireland. Explanations to Sheet 160, etc., p. 21.

[4] In the Upper Old Red Sandstone of Scotland proofs of volcanic activity remain to be gathered. The chain of the Pentland Hills which I formerly regarded as belonging to the upper member of the formation, I have since found to be covered unconformably by it, while the chain of the Campsie, Kilpatrick, and Renfrewshire Hills seems to belong wholly, or at least in great measure, to the lower part of the Carboniferous series.

county of Kerry, numerous bands of ash—one of them reaching a thickness of from 500 to 600 feet—stretch from mountain to mountain under many hundred feet of overlying sandstones and slates.[1]

Nor are traces of volcanic activity wanting in England during the same great geological period. In Cornwall and South Devon, Sir Henry De la Beche recognised frequent proofs of contemporaneous igneous action among the limestones and slates of the middle Devonian series, and thence through the Upper Devonian into the lower part of the Carboniferous group. These consist in frequent bands of trappean ash and of crystalline amygdaloidal and vesicular greenstone or other trap rock. The ash passes by insensible degrees into the ordinary sedimentary strata of the series. Sometimes it contains fossils, and in certain places it becomes so calcareous, and so interlaced with bands of limestone, as to have been quarried for lime. The compact trap rocks associated with the ash bear evidence of their contemporaneous origin in their frequently cellular and pumiceous character.[2]

*Carboniferous.*—The base of the Carboniferous series in Cornwall and South Devon is marked by the occurrence in it of sheets of trappean ash and of crystalline amygdaloidal greenstone, similar to the igneous masses among the neighbouring Devonian rocks. The ash is sometimes coarse and full of fragments of cellular trap, as in the conspicuous hill of Brent Tor. In describing the rocks of that locality, Sir Henry De la Beche pointed out the remarkable resemblance of the Brent Tor to a volcano, and the probability that the ash and greenstone were erupted over the sea bottom, where they became interstratified with the ordinary marine sediments.[3]

In the centre of England the well-known toad-stones of Derbyshire indicate intermittent volcanic activity during the formation of the Carboniferous Limestone. They consist of three principal beds of trap, sometimes compact and dark, approaching basalt in texture, but usually more earthy and highly amygdaloidal. These beds average each about 60 or 70 feet in thickness, and preserve their course for many miles between the strata of limestone. Mr. Jukes has pointed out that each of them is probably the result of not merely one eruption, but rather consists of different flows proceeding from distinct vents, and uniting into one sheet along a common floor.[4]

Further north the counties of Durham and Northumberland are traversed for many miles by interpolated sheets of dolerite, of which the most important is known as the Great Whin Sill. It does not appear that these masses have yet been investigated in such detail as to indicate how far they may be actually contemporaneous with the Carboniferous Limestone series in which they occur.

Passing into Scotland, we find the Carboniferous formation of the broad midland valley full of the most striking evidences of volcanic

[1] Mem. Geol. Surv. Ireland. Explanation to Sheet 184. See also Explanation to Sheet 153, p. 18.

[2] De la Beche, Devon and Cornwall, pp. 51, 70.

[3] Ibid., p. 122.

[4] Manual, p. 523.

activity. From the very bottom of the series up to at least the top of the Carboniferous Limestone group volcanic rocks of many varieties abound. In the West, great sheets of different porphyrites, with interbedded tuffs, sandstones, and conglomerates lie in the lower part of the formation, and, rising in broad masses, bed above bed, form that conspicuous chain of terraced heights, which stretches from near Stirling through the range of the Campsie, Kilpatrick, and Renfrewshire hills, to the banks of the Irvine in Ayrshire, and thence westwards by the Cumbrae Islands and Bute, to the south of Arran.[1] In the eastern districts, instead of such wide-spread sheets of volcanic rock, the Carboniferous series includes hundreds of minor patches of tuff, dolerite, basalt, and porphyrite. The area of the Lothians and Fife seems to have been dotted over with innumerable little volcanic vents breaking out and then disappearing one after another during the lapse of the Carboniferous period up to at least the close of the Carboniferous Limestone.[2] The very limited area occupied by the erupted material is often remarkable. A mass of ash, a hundred feet thick or more, may be found intercalated between certain strata, yet, at a distance of a mile or two the same strata may show no trace of any volcanic material. Nowhere is this feature more wonderfully exhibited than in the coalfield of Dalry in the northern part of Ayrshire. The black-band ironstone of that district appears to have been deposited in hollows between mounds and cones of volcanic tuff, sometimes 600 feet high, round and over which the later members of the lower Carboniferous formation were deposited. Hence the shafts of the pits are sometimes sunk for 100 fathoms through the tuff, and at that depth mines are driven horizontally through the volcanic rocks to reach the ironstone beyond. In other districts the interstratification of beds of ash and sheets of basalt and dolerite amongst highly fossiliferous limestones and shales present many points of interest. In this respect the range of the Linlithgowshire hills is specially deserving of study.

The great Carboniferous Limestone series of Ireland contains evidence that here and there, at various intervals during its formation, minor volcanic vents were active on different parts of the sea bottom. In the county of Limerick masses of trap 1200 and 1300 feet thick, with well marked ashy interlacings, lie among the limestones.[3]

*Permian.*—Among the Permian sandstones of the south-west of Scotland there occur some interesting proofs of contemporaneous volcanic action. In Nithsdale, and still more conspicuously in the centre of the Ayrshire coal-field, these sandstones contain towards

[1] The trap-rocks forming these hills are interstratified in their upper portion with the Carboniferous Limestone. Their base rests sometimes on a set of marls, shales and cement-stones, and sometimes on a thick group of red sandstones. These strata contain Carboniferous plants; even thin coal seams lie among their higher members, and although the red sandstones have been hitherto generally called Old Red Sandstone, it is not unlikely that they may require to be relegated wholly to the lower portion of the Carboniferous series.

[2] See Maclaren's Fife and the Lothians. Mem. Geol. Survey, Geology of Neighbourhood of Edinburgh. Trans. Roy. Soc., Edin., Vol. xxii., p. 644.

[3] See Mem. Geol. Surv., Ireland. Explan. to Sheets 143, 144, 153, and 154; also Jukes' Manual, p. 325.

their base a thick group of dark reddish-brown amygdaloidal porphyrites and tuffs. Connected with these rocks are numerous bosses of a coarse volcanic agglomerate, which descend vertically through the coal-measures altering the coal. They are the "necks," or orifices, from which was ejected the volcanic material which now forms a conspicuous range of rising grounds overlying the heart of the coal-basin of Ayrshire.[1]

*New Red Sandstone.*—The New Red Sandstone series of Devonshire, in the neighbourhood of Exeter, furnishes clear proofs of volcanic activity. Sheets of a dark reddish-brown feldspathic rock, sometimes compact or porphyritic, but usually of scoriaceous character, are intercalated among the lower parts of the Red Sandstone series of that neighbourhood. That these are not intrusive masses, but belong to the same geological period as the Red Sandstones themselves, is shown by the occurrence of fragments from them in the overlying conglomerates. Sir Henry De la Beche, who described these igneous rocks many years ago, noticed that the more compact portions, instead of extending horizontally as beds among the sedimentary strata, descend vertically through them, as if these detached parts marked the site of some of the orifices whence the melted lava was erupted.[2]

The series of successive volcanic phenomena, which may thus be traced through the Palæozoic rocks of the British Islands up to the New Red Sandstone, is now abruptly broken. I am not aware of any satisfactory proofs of contemporaneous volcanic rocks among the Secondary rocks of Britain, save in the Red Sandstone of Devonshire just referred to. Following a suggestion of Professor Edward Forbes, I formerly regarded the great trappean masses of Skye, and the other Western Islands, as probably of Oolitic age. But more recent investigations in Antrim, Mull, and Eigg, have convinced me that in these districts, and probably also in Skye, the great basaltic plateaux, which form so conspicuous a feature in the scenery of our north-western sea-board, date from Tertiary times.[3] As the importance of these later volcanic phenomena in the general geology of the country is not, perhaps, adequately understood, I may be permitted to refer to this part of the subject at somewhat greater length.

*Tertiary.*—From Antrim northwards through the inner Hebrides and the Faroe Islands to Iceland there is a broken chain of volcanic masses, part, and not improbably the whole, of which date from the Miocene period. In Ireland sheets of dolerite and basalt, in all 500 or 600 feet thick, and some 1200 square miles in extent, repose directly upon an eroded surface of Chalk. In Mull similar plateaux, overlaid with masses of porphyrite and trachyte-like rocks, attain a united thickness of more than 3000 feet, yet at their base they con-

[1] See Geikie, Geol. Mag., Vol. I. for June, 1864, p. 22.

[2] Sir H. De la Beche, Devon and Cornwall, p. 199. See, also, Conybeare and Phillips, Geol. England and Wales, p. 294.

[3] See E. Forbes, Quart. Journ. Geol. Soc., vol. viii. p. 108; Geikie, Trans. Roy. Soc., Edin., vol. xxii. p. 649; and Proc. Roy. Soc., Edin., 1866–67.

tain recognisable plants of Miocene species. This vast depth of old lavas and tuffs points to a lengthened continuance of volcanic activity along the north-western margin of our country—an activity, however, marked by prolonged periods of repose, as the Scuir of Eigg,[1] and the coal and shales of Mull, sufficiently prove. For magnitude, alike in thickness and extent, these Tertiary volcanic rocks surpass those of any of the other formations in our area. But I believe that these masses, vast though they be, are by no means the only, if they are indeed the chief, relics of Tertiary volcanic action in Britain.

If, starting from the basaltic plateaux of the north of Ireland or of the inner Hebrides, we advance towards the south-east, we soon observe that an endless number of trap dykes, striking from these plateaux, extends in a south-easterly direction athwart our island. The south-western half of Scotland and the northern parts of England, are, so to speak, ribbed across with thousands of dykes. These are most numerous near the main mass of igneous rock whence they become fewer as they recede towards the North Sea. Usually a dyke cannot be traced far: I am not aware that any single one can be followed completely across the island, though the well known Cleaveland dyke in the north of England runs for at least sixty miles, cutting in its course Carboniferous, Permian, Triassic, Liassic, and Oolitic rocks till it reaches the sea on the coast of Yorkshire, at a distance of more than 200 miles from the nearest point where the sheets of Miocene trap are now visible. In Berwickshire and the Lothians, these E. and W. or N.W. and S.E. dykes, often less than half a mile long, are well shown; in Ayrshire they become still more numerous, traversing the coal-field and altering the coal seams; in Arran and Cantyre their number still increases; until, after a wonderful profusion of them in Islay and Jura, they reach the great volcanic chain of the Hebrides. From their manifest intimate connection with that chain, from the fact that they cut through all the formations they encounter up to and including the Chalk, and that they cross faults of every size that may lie in their way, I regard these dykes as of Tertiary age. If this inference is sustained, as I have little doubt it will be, by a more detailed investigation of the north-western districts, it presents us with striking evidence of the powerful activity and wide range of the volcanic forces in our country during the Miocene period. With these dykes (to which further allusion will be made in the sequel), and the Tertiary igneous masses from which they proceed, the record of volcanic action in Britain appears to close.

This brief reference to the proofs of contemporaneous volcanic eruptions during the growth of the successive geological formations in the British Islands may suffice to indicate the wide area of research which here presents itself to geologists. Let me allude to one or two portions of this broad field, which seem to me worthy of special notice.

One of the first features to arrest attention is the singular per-

[1] See Scenery of Scotland, viewed in connection with its Physical Geology, p. 278

sistence of volcanic phenomena in a limited area. This remark applies either to our country viewed as a whole, or to many of its minor districts. These islands are but a small fragment of the surface of the globe, and yet we see that volcanic action has been rife here from Lower Silurian up into middle Tertiary times. But the fact comes before us still more impressively when we discover it in the geology of a single county, or even of a parish. Take, as an illustration, the neighbourhood of Edinburgh within a radius of ten miles from the town. First and oldest comes the long range of the Pentland and Braid Hills, consisting of a mass of bedded igneous rocks in a middle series of the Old Red Sandstone. These old lavas reach a thickness of 4,000 or 5,000 feet. Next in chronological order are the Calton Hill and lower portion of Arthur's Seat, which mark the continuance of volcanic action (though in a lessened degree) into the Lower Carboniferous period. The Carboniferous rocks for miles around these hills are full of the traces of contemporaneous volcanos, sometimes in the form of sheets of tuff marking the occurrence of little detached tuff-cones, sometimes in wider areas of tuff, basalt, and dolerite, where a group of minor volcanic vents threw out showers of ash and streams of lava. To the east rise the isolated Garlton Hills, which date from before the Carboniferous Limestone; westwards, scores of little basaltic crags and rounded tuff-hills mark out the lower Carboniferous volcanos of Linlithgowshire. To the north the endless crags, hills, and hillocks of the Fife coast contain the record of many eruptions from the middle of the Calciferous Sandstones high up into the Carboniferous Limestone group. Even the Coal-measures of that county are pierced with intrusive bosses of trappean agglomerate which indicate the position of volcanic vents, possibly of Permian age. The same or a more recent date must be assigned to the later unconformable agglomerate and basalt of Arthur's Seat. Nor is this the whole. Latest of all, come innumerable trap-dykes, running with a prevalent east and west trend, and cutting through all the other rocks. These, for the reasons already stated, may, with probability, be assigned to a Tertiary age. Here, then, in this little tract, about the size of a small English county, there are the chronicles of a long series of volcanic eruptions, beginning in the middle of the Old Red Sandstone, and coming down to a time relatively so near our own as that of the Miocene rocks. Nor is this by any means an exceptional district. Illustrations of a similar persistence of volcanic action may be gathered in many other tracts of equally limited extent.

Another fact, which a general survey of the character of our volcanic rocks soon brings before us, is that, as a whole, those of earlier date differ distinctively in composition from those of more recent origin. From the first traces of volcanic activity in this country up to about the close of the Old Red Sandstone or beginning of the Carboniferous series, the interbedded (that is, contemporaneous) igneous rocks consist for the most part of highly feldspathic masses, to which the name of clinkstone, claystone, compact feldspar, porphyry, hornstone, felstone, etc., have been given. In most of these rocks there is an excess of silica (55 to 80 per cent.), which is sometimes found separated out into distinct granules. On the other hand, from the upper part of the Old Red Sandstone, or the lower members of the Carboniferous series, up to the end of the long history, the erupted masses are chiefly augitic, as basalts and dolerites (or greenstones as the latter have been usually termed in Scotland). In these rocks free silica is not a normal constituent, while the alkalies, alkaline earths, and metallic oxides form on an average about half of the whole mass. In the former class the acid element predominates, in the latter the bases are specially conspicuous. According to Durocher the earlier series arose from an upper acid magma, while those of later age came up from an underlying basic magma. Were these rocks subjected to further and more detailed chemical examination, additional knowledge might possibly be acquired respecting the history of the changes which have taken place within the crust of the earth.

As geologists, however, it is important for us to note that, though two classes of volcanic rocks can thus be determined by analysis of their composition, no broad essential distinctions appear to be traceable in their mode of occurrence. The earlier volcanos, which threw out siliceous lavas and ashes, seem to have acted very much in the same way as those of later date, which gave out the heavier pyroxenic lavas. Certain minor differences are indeed readily observable. Thus the older lavas occur as a rule in much thicker beds than the later ones, which, indeed, are distinguished by that markedly bedded character which results from the number and thinness of their successive flows. As a concomitant of this arrangement also, columnar structure is much more frequent among the pyroxenic than among the silicious rocks. Perhaps, if these and other distinctions were collected and compared, each class of rocks might be found to possess certain characteristic peculiarities of its own, sufficient when taken together to give us a type for general reference. Nevertheless, in its broader features, there would seem to have been a striking uniformity in volcanic action from the earliest times down to our own day.

This leads me to remark that a study of the igneous rocks of Britain furnishes no proofs that volcanic action has been slowly diminishing in intensity during past geological time. The amount of volcanic material preserved in our Old Red Sandstone group probably exceeds that of our Silurian system, even after all due allowance for the greater denudation of the older formation. The number of distinct volcanic centres traceable among the Carboniferous rocks in like manner surpasses that of the older formations. But by much the most extensive mass of volcanic material in these Islands belongs to the latest epoch of eruption—that of the Miocene period. In one mountain alone, Ben More in Mull, these youngest lavas rise over each other, tier above tier, to a height of more than 3,000 feet; yet their base is concealed under the sea, and their top has been removed by denudation. We have here, therefore, no proof of a slow diminution of volcanic activity. The period separating the Miocene basalts from the New Red Sandstone trap-rocks, which seem to come next to them in point of recentness, was immensely vaster than that which has elapsed between the Miocene basalts and the present time. There is thus no improbability in the eventual outbreak once more of the subterranean forces. Nay, further, were a renewed series of volcanic eruptions to take place now, they might in the far distant future be thrown together with those of Miocene date, as proofs of one long period of interrupted volcanic activity, just as we now group the igneous rocks of the lower Silurian, or of any other geological formation. So near to us, in a geological sense, are those latest and grandest of our volcanic phenomena.

Among the different forms assumed by our igneous rocks, one of the most interesting and, at the same time, most full of difficulty, is that of the trap-dykes. To my own mind there are few parts of the geology of the country so hard to understand as the extravasation of the thousands of dykes by which the north-western portion of this island is so completely traversed.[1] For the reasons already assigned, I would refer the leading system of these dykes to the same geological age as the Tertiary volcanic rocks of the north-west. Yet we find them rising to the surface, and extending for leagues, to a distance of fully 200 miles from the nearest point of the basaltic plateaux. Did they reach the surface originally? If so, were they connected with outflows of dolerite, now wholly removed by denudation? I confess that this supposition has often presented itself to me as carrying with it much probability. It seems to me unlikely that so many thousands of dykes should have risen so high as the present surface, retaining there (as shown by deep mines) much the same proportions as they show many fathoms down, and yet that none of them should have reached the surface which existed at the time of eruption. I regard it as much more probable that some of them, at least, rose to daylight, and flowed out as *coulées*, even over parts of the south of Scotland and north of England, where all trace of such surface masses has long been removed. Some of the surface-masses of dolerite in these districts may indeed be of Tertiary age; yet the proofs which the great Miocene basaltic plateaux present of enormous denudation are so striking as to make the total disappearance of even wide and deep lava-currents quite conceivable.

But a much more serious difficulty remains. These dykes, as a rule, do not come up along lines of fault, yet they preserve wonderfully straight courses, even across fractured and irregular strata. Each dyke retains, as a rule, a tolerably uniform breadth, and its sides are sharply defined, as if a clean, straight fissure had been widened and filled up with solid rock. More than this, they are

[1] Boué felt this difficulty, but he conceived that the fissures had been filled from above by masses of basalt, erupted at different points, and spreading over the country, though now removed by denudation. He says:—"Nous croyons infiniment probable que ces filons ont tous été formés de même [*i.e.*, remplis par des courans de lave dans leur marche], malgré les grandes destructions qu' entraine cette supposition, et que rarement il y en a eu quelques-uns qui ont été remplis latéralment ou de différentes manières bizarres."—*Géol. d' Ecosse*, p. 272.

found cutting across large faults without any deflection or alteration. In short, no kind of geological structure, no change in the nature of the rocks traversed, seems to make any difference in the dykes. These run on in their straight and approximately parallel courses over hill and valley for miles. The larger faults of this country tend to take a north-easterly trend, and correspond in a general way with the strike of the formations. At right angles, or more or less obliquely to these, are numerous faults of lesser magnitude which follow roughly the dip of the rocks. But though these different systems of fissures already existed, and, as we might suppose, would have served as natural pathways for the escape of the subterranean melted rock towards the surface, the latter rose through a new series of fractures, often running side by side with those of older date. How were these new fractures produced, and how is it that they should run through all formations, up to and including the older parts of the Miocene basalts, not as faults, with a throw on one side, but as clean straight fissures, with the strata at the same level on each side? I do not pretend to answer these questions. Let me only remark that had the trap-rock been itself the disrupting agent it would have risen through the older fractures which already existed as the planes of least resistance. The new fissures must be assigned to some far more general force, of the action of which the trap itself furnishes perhaps additional evidence.

Another feature of our igneous rocks, deserving more special consideration, is the occurrence among them of true vents, or the sites of volcanic orifices. A very considerable number of these vents is filled up, not with basalt, dolerite, or other melted rock (in which cases the character of the mass as occupying an old vent is apt to be less distinct), but with a coarse agglomerate consisting of fragments of different trap-rocks, with pieces of the surrounding sedimentary strata. Such vents are sometimes not larger than a dining table. In many cases, where the material filling them is fine in texture, it is well stratified; but its beds are on end, or thrown into different inclined positions. The strata around them are much indurated, and frequently, perhaps usually, are bent sharply down round the margin of the vent, as if the ash or agglomerate, from contraction or otherwise, had sunk and pulled the adhering strata down with it. A careful mineralogical study of these vents, and of the strata around them, would doubtless reward the observer with the detection of many points of similarity to the products of modern volcanos. Instructive sections of these rocks abound along the coast line of Fife and East Lothian, and they occur likewise in Ayrshire.

It may be possible eventually to arrive at somo approximate realization of the form assumed by the surface of the country during successive phases of volcanic action. There are, indeed, indications that the eruptions were apt to occur along lines of broad valley. The long depression, for instance, between the Highlands and Southern Uplands of Scotland continued to be the site of active volcanos during the Old Red Sandstone and Carboniferous periods;

yet the high grounds on either side seem to have in great measure escaped, for few of the trap-beds, or of the "necks," marking the points of eruption, have as yet been detected there. Again, the Tertiary basalts of the north-west lie in a long hollow (at least as old as the Lias) scooped out of the metamorphosed Silurian and Laurentian rocks. In these instances it is evident that the numerous volcanic orifices were grouped linear-wise.

One other part of the subject I would allude to as deserving of inquiry. There seem to me indications that local but well-marked metamorphism and the extravasation of syenitic and granitic rocks have taken place in connection with some of our most recent volcanic phenomena. In Skye, for example, as first pointed out by Macculloch, the Lias limestones are much altered and pierced by masses of syenite, which is in some places a true granite. This crystalline rock must have been erupted after the deposition of the middle Oolitic rocks, for it disrupts and sometimes overlies them. It is manifestly connected with the trappean plateaux and dykes of that region. Southwards in Mull, masses of syenite of a like kind are found in the heart of the great Tertiary basalts, and these basalts show there a marked change in texture and aspect, as if they had been more or less metamorphosed. Still further south lies the granite of Arran, which is, at least in part, of later date than the lower Carboniferous rocks, for these are pierced by it. In and around it, as is well known, there is a profusion of trap-dykes like those of Skye and Mull. This association of syenite or granite with hundreds of dykes, or with vast piles of basalt, deserves to be worked out carefully in the field. It will, doubtless be found to furnish additional data towards elucidating the origin of granite, and even perhaps some portion of the still obscure subject of metamorphism.

In concluding these somewhat desultory remarks, let me add that I have brought this subject under the notice of the Section with the view of indicating a field of research in British geology where it appears to me that much remains to be discovered, and where the labourers are but few. There was indeed a time, still within the recollection of some of our older members, when the igneous rocks of this country received a much larger share of attention than they do now. After they had ceased to furnish material for the battles of the Vulcanists and Plutonists, they continued to be studied by able observers, more especially in Scotland, where they attain their greatest prominence. Foremost were the names of Macculloch, Jameson, and Boué, who, with their associaies and disciples, worked long and well until they had given to the igneous rocks of this country an European reputation. Since their days, however, this branch of the science seems in this country to have gone sadly out of fashion. De la Beche, Murchison, Sedgwick, Ramsay, and others, have indeed furnished excellent illustrations of the geology of different parts of the country where volcanic rocks abound. But, apart from local or descriptive geology, little has recently been done in the investigation of our volcanic rocks.

As a result of this neglect, the nomenclature of this portion of British geology has been virtually at a stand for about half a century. While so much has been done in this respect by chemists and geologists abroad, we are but little further forward than when the great outlines of the subject were sketched long ago by the early leaders in the science. The same vague names, the same confused and defective arrangement, the same absence of careful chemical and mineralogical analysis, so excusable in the infancy of the science, still disfigure our geological writings and even the best of our geological collections. Field-geologists must be content to bear their share of the blame, yet it is not from their hands that the needed reform is mainly to be looked for. They can do but little till chemistry comes to their aid with information regarding the composition of the rocks which they investigate, and the extent to which the nomenclature adopted in other countries can be applied in their own. Surely the time must come ere long when it will be deemed a task worthy of years of long and patient research to work out the nature and history of the volcanic rocks of this country. Such a task will not be the work of merely a single observer. It will require the labour of the geologist skilled to glean the data that can only be gathered in the field, and of the chemist, who, aided and guided by these observations, shall seek to determine the composition of the different igneous rocks, and the relation which in this respect they bear to the rocks of other regions, and to the products of modern volcanos. But, whether distant or near, the day will doubtless arrive when we shall be able to connect into one story, as far at least as our fragmentary records will permit, the narrative of the varied volcanic eruptions which from early geological times have taken place in the British Islands, and to link that chronicle with the long history of volcanic action over the globe.

## CORRESPONDENCE.

### THE CHEMISTRY OF THE PRIMEVAL EARTH.

By referring to page 432 of the September Number of the Geological Magazine it will be seen that every effort was made on the part of the Editors to furnish as complete a list of corrections as possible of Dr. T. Sterry Hunt's Lecture, which appeared in August last. On August 27th—the Magazine having gone to press—we received the subjoined letter from Dr. Hunt, which we publish intact, only omitting those errata which are already noticed in our last Number. We are glad Dr. Sterry Hunt does the short-hand writer the justice to state that he is doubtless a competent reporter, and has in most cases reproduced his language with fidelity,—the errata being for the most part obvious to the scientific reader, and that they do not in any way affect his argument, all the points of which may be well enough understood from the report. We cannot, however, agree with Dr. Sterry Hunt in considering the abstract, which appeared in the *Chemical News* of June 27th, superior to the very full report—

faulty though it be—which appeared in the Geological Magazine for August last.—Edit.

*To the Editor of the* Geological Magazine.

Sir,—In the number of your Magazine for August appears a report of a lecture delivered by me at the Royal Institution on the 31st of May, on the Chemistry of the Primeval Earth. It is there described as "a full report taken down verbatim in short-hand, and now printed for the first time." For the sake of your numerous readers I regret that this report, disfigured by many errors, should have appeared in the pages of the Geological Magazine. When, moreover, I am aware that those who counselled its publication were aware that I had preferred to substitute for it a carefully revised one, prepared from this short-hand report, together with my own brief notes containing the heads of my extempore lecture, I can but feel that the proceeding was inconsiderate and unjust alike to the lecturer and to your readers. This revised report, as many are aware, has already appeared in the proceedings of the Royal Institution, and also in the *Chemical News* of June 27th, where it is expressly stated that it is the report revised by the author.

The short-hand writer is doubtless a competent reporter, and has in most cases reproduced my language with fidelity; but, especially in the more technical portions, has fallen into numerous errors, for the most part obvious to the scientific reader. These, with one or two little omissions, do not in any way in fact affect my argument; all the points of which may be well enough understood from the report when corrected as below, as the reader may assure himself by comparing it with my revised report in the proceedings of the Royal Institution, and in the *Chemical News*.

I subjoin a list of *errata*, which will show some of the mistakes into which the reporter has fallen—in the report published in your Magazine of August:—

On page 361.—The six lines from line 25, beginning with "Messrs. Hopkins and Fairbairn," present an unintelligible confusion, in reproducing my statement that these gentlemen had shown pressure to augment the fusing point of such bodies as contract in solidifying, and that, as we might suppose, the solidification of the earth to commence at the centre, the temperature there would not be above that of congelation.

Page 361, line 30, *after* "increase" *read* "of temperature."
" " " 43, *for* "first few metals" *read* "elements."
" 362, " 32, *before* "gases" *read* "acid."
" 363, " 2, *for* "whole of the affinity of the acid was" *read* "whole of the acids were."
" 364, " 6, *for* "whole" *read* "most." It is obvious that dolomite and gypsum, together with numerous silicated rocks, such as steatite and serpentine, of which I have elsewhere maintained the aqueous and chemical origin, are excluded.
" " " 39, *for* "their hands" *read* "at hand."

Trusting that you will do me the justice to insert the above remarks and corrections, I remain, Sir,

Your obedient servant,

T. Sterry Hunt.

*August 24th*, 1867.

BOULDER-CLAY AND DRIFT OF NORFOLK AND SUFFOLK, AND ON THE NORTH SIDE OF THE THAMES VALLEY.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—It is a pity that Mr. Maw should mix up doubts as to the age of the Boulder-clay capping Corton Cliff with those as to the age of the Cromer beds. If there is one question connected with the Drift free from doubt, it is the identity of the capping clay of Corton with the Boulder-clay of High Suffolk; and no one would, I feel sure, be more ready to admit this than Mr. Maw himself, if he examined the country between Corton and High Suffolk. With the beds of the Cromer coast, however, the case is quite the reverse; for the features displayed by the north and north-east of Norfolk are so excessively perplexing, that I should desire to pay respect to the views of any one as to the structure of this part, however much they differed from what I believed to be the truth, and especially to those of so courteous an opponent as Mr. Maw; but that gentleman does not seem to be aware that the *physical* formation of the country, apart from any geological question, is entirely at variance with the diagram illustrating his paper,—the whole of the land between the Boulder-clay country of High Norfolk and Suffolk, and Cromer, being (except where the valleys of the Yare and Bure cut through it) one continuous table land: and, although the elevations are not given in the map, the country behind Cromer and Sherringham cannot, I imagine, be any lower than the High Suffolk country from which Mr. Maw starts in his diagram. Another error of fact into which he has fallen is that of confounding my views with those of Mr. Gunn. The red loam at the base of Corton Cliff, which Mr. Gunn calls the "Lower Boulder-clay," and identifies with the Cromer Till, I regard as the mud deposit overlying that Till called by Sir Charles Lyell the "contorted drift." Mr. Gunn finds his Upper and Lower Boulder-clays in the Cromer and Hasboro' cliff sections, whereas I do not recognize any portion of the Upper Glacial (and but very little of the base of the Middle) along the whole twenty miles line of cliff from Hasboro' to Weybourne. Mr. Gunn further seems disposed to identify his "laminated beds" with the Chillesford-clay, whereas I cannot discover their geological existence, and regard them as only the easterly modification of the Weybourne sand. Immediately upon the distribution (in July, 1865) of my small map of the East of England Drift, and remarks in explanation, Mr. Harmer, of Norwich, took up the task of mapping geologically the beds from the Crag upwards in the Ordnance sheets of that part of Norfolk which contain the principal drift deposits. Much time must of course elapse before such a labour can be completed, or even put in an intelligible shape, although I hope nothing may prevent his eventually doing so. I mention this because, having been furnished with all his results as he has proceeded, and visited with him from time to time all the sections of importance met with, nothing has yet transpired from them to show that the views of structure adopted by me are in any material degree erroneous. Some modifications—not affecting, however, the main points of structure—I perceive, will have to be made, especially the absence of the Middle Glacial sands in the north-west part of central Norfolk, and the presence there of extensive Post-glacial gravels; and I think it not improbable that the Till of Cromer, which in the structural section given by me in the 22nd volume of the Quarterly Journal of the Geological Society, is shown as occupying the same position of inferiority to the contorted drift as that possessed by the Chillesford clay, although necessarily for want of connexion along the line of section distinguished by a separate letter, may prove to be an expansion of that clay itself. It is a step, however, gained, that one point, for which I have long contended, is now admitted to be correct by my principal opponent,[1] viz. the superiority of the Chillesford shell-bed to the Fluvio-marine Crag; and that the identity which I pointed out between this bed and the Upper Crag of Mr. Taylor, has now received the assent of Mr. Taylor, Mr. Gunn, and Mr. Maw.

Perhaps you will permit me to observe, in reference to Mr. Dawkins' letter respecting the Boulder-clay of Havering, that if by the phrase, "on the southern side of the range of heights that form the northern boundary of the Thames Valley," he means to imply that the Boulder-clay lies *in* the valley of the Thames, I demur wholly to such an implication. The patch at Havering (as Mr. Dawkins knows) is shown in my survey map, placed in the library of the Geological Society, and its position illustrated by section.[2] It may be seen from the map and sections that the heights of the north side of the Thames Valley are formed of Bagshot sand and Boulder-clay together (the latter having taken the place of the former, and of the uppermost part of the London clay), and that the northern valley slope has been cut down from these two formations indifferently; so that, instead of the Boulder-clay at Havering lying on the southern side of the heights, it is essentially a part of those heights themselves.—I am, Sir, your obedient servant,

SEARLES V. WOOD, JUN.

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## BRITISH FOSSIL CORALS.

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR,—The generic name of the Carboniferous corals, formerly confounded with *Aulophyllum,* should be *Cyclophyllum,* not *Cyclocyathus* (see GEOL. MAG., September, 1867, p. 416). There is an error in my monograph of the Liassic Corals, which makes *Trochocyathus Moorei,* Ed. and H., stand in the place of *Thecocyathus Moorei,* Ed. and H. As these errors may give rise to much bewilderment will you kindly insert this note. Yours truly

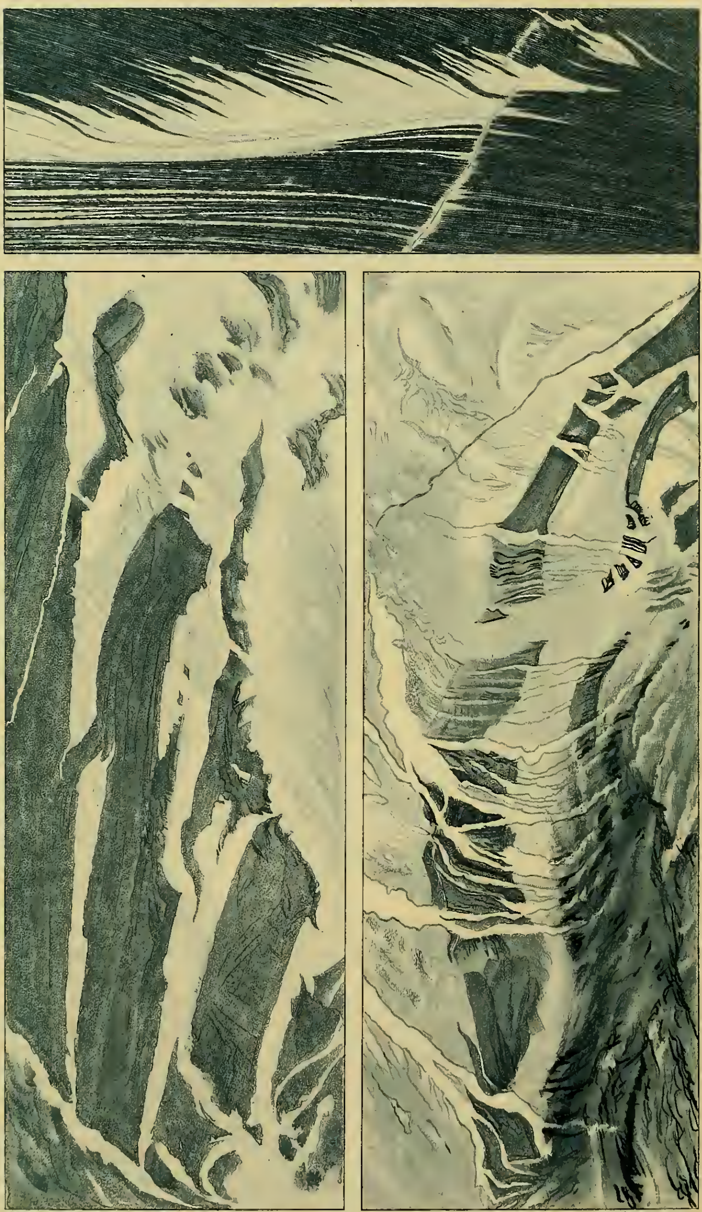
P. MARTIN DUNCAN.

*September* 18*th,* 1867.

[1] Fisher, Quar. Journ. Geol. Soc., Vol. xxiii. p. 175.

[2] See also Section No. 4 of my paper in the forthcoming number of the Quarterly Journal of the Geological Society, and Vol. III. p. 57, of the GEOLOGICAL MAGAZINE.

Fig. 1.



J. Ruskin del.t G. Allen inc.t

Fig. 2. Fig. 3.

ROCK VEINS.

under Contraction; at two periods.

THE
# GEOLOGICAL MAGAZINE.

**No. XLI.—NOVEMBER, 1867.**

## ORIGINAL ARTICLES.

### I.—On Brecciated Formations.

By John Ruskin. Esq., F.G.S.

(PLATE XX.)

(Continued from the August Number, p. 339).

I WROTE the first of these papers more with a view of obtaining some help in my own work than with any purpose of carrying forward the discussion of the subject myself. But no help having been given me, I must proceed cautiously alone, and arrange the order of my questions; since, when I have done my best as carefully as I can, the papers will be nothing but a series of suggestions for others to pursue at their pleasure.

Let me first give the sense in which I use some necessary words:

1. Supposing cavities in rocks are produced by any accident, or by original structure (as hollows left by gas in lava), and afterwards filled by the slow introduction of a substance which forms an element of the rock in which the cavities are formed, and is finally present, in the cavities, in proportion to its greater or less abundance in the rock; I call the process "secretion."

2. But if the cavities are filled with a substance not present (or not in sufficient quantity present), in the surrounding rock, and therefore necessarily brought into them from a distance, I call the process, if slow, "infiltration"; if violent, "injection."

It is evident that water percolating a rock may carry a substance, present in the mass of it, by infiltration, into the cavities, and so imitate the process of secretion. But there are structural differences in the aspect of the two conditions hereafter to be noticed. The existence of permanent moisture is however to be admitted among conditions of secretion; but not of fluent moisture, introducing foreign elements.

3. If a crystalline or agatescent mass is formed by addition of successive coats, I call the process "accretion."

4. But if the crystalline or agatescent mass separates itself out of another solid mass, as an imbedded crystal, or nodule, and then, within its substance, divides itself into coats, I call the process "concretion." The orbicular granite of Elba is the simplest instance I can refer to of such manifest action; but all crystals, scattered equally through a solid enclosing paste, I shall call "concrete" crystals, as opposed to those which are constructed in freedom out of

a liquid or vapour in cavities of rocks, and which I shall call "accrete."

The fluor nodules of Derbyshire, and amethystine nodules of some trap rocks, present, in their interiors, the most beautiful phenomena of concrete crystallization, of which I hope to give careful drawings.

It is true, as I said in the last paper, that these two processes are perpetually associated, and also that the difference between them is sometimes only between coats attracted and coats imposed. A small portion of organic substance will, perhaps, attract silica to itself, out of a rock which contained little silica in proportion to its substance; and this first knot of silica will attract more, and, at last, a large mass of flint will be formed, which I should call "concrete;" but if a successive overflowing of a silicious spring had deposited successive layers of silica upon it, I should call it "accrete." But the resemblance of the two processes in such instances need not interfere with the clearness of our first conception of them; nor with our sense of the firm distinction between the separation of a solid mass, already formed, into crystals or coats in its interior substance, and the increase of crystalline or coated masses by gradual imposition of new matter.

Now let me re-state the scope of the questions, for the following out of which I want to collect materials :—

I. I suspect that many so-called "conglomerates" are not conglomerates at all, but concretionary formations, capable, finally, of complete mechanical separation of parts; and therefore that even some states of apparently rolled gravel are only dissolutions of concretionary rock.

Of course, conglomerates, in which the pebbles are fragments of recognizable foreign rocks, are beyond all possibility of challenge; as also those in which the nodules could not, by any chemistry, have been secreted from the surrounding mass. But I have in my hand, as I write, a so-called "conglomerate" of red, rounded, flint "pebbles," much divided by interior cracks, enclosed by a finely crystallized quartz ; and I am under the strongest impression that the enclosed pieces are not pebbles at all ; but secretions — the spots on a colossal bloodstone. It is with a view to the solution of this large question, that I am examining the minor structure of brecciated agates and flints.

II. It seems to me that some of the most singular conditions of crystalline metamorphic rocks are the result of the reduction of true conglomerates into a solid mass; and I want therefore to trace the changes in clearly recognizable conglomerates, where they are affected by metamorphism ; and arrange them in a consistent series.

III. I cannot, at present, distinguish in rocks the faults, veins, and brecciations, caused by slow contraction, from those occasioned by external pressure or violence. It seems to me now that many distortions and faults, which I have been in the habit of supposing the result of violence, are only colossal phenomena of retraction or contraction ; and even that many apparent strata have been produced by segregation. A paper, on this subject, of Mr. George Maw's, put into my hands in May, 1863, gave me the first suggestion of this possibility.

I shall endeavour, as I have leisure, to present such facts to the readers of this Magazine as may bear on these three enquiries; and have first engraved the plate given in the present number in order to put clearly under their consideration the ordinary aspect of the veins in the first stage of metamorphism in the Alpine cherts and limestones. The three figures are portions of rolled fragments; it is impossible to break good specimens from the rock itself, for it always breaks through the veins, and it must be gradually ground down in order to get a good surface.

Fig. 1 is a portion of the surface of a black chertose mass; rent and filled by a fine quartzose deposit or secretion, softer than the black portions and yielding to the knife: neither black nor white parts effervesce with acids : it is as delicate an instance of a vein with rent fibrous walls as I could find (from the superficial gravel near Geneva).

Fig. 2 is from the bed of the stream descending from the Aiguille de Varens to St. Martin's. It represents the usual condition of rending and warping in the flanks of veins caused by slow contraction, the separated fragments showing their correspondence with the places they have seceded from; and it is evident that the secretion or injection of the filling white carbonate of lime must have been concurrent with the slow fracture, or else the pieces, unsupported, would have fallen asunder.

Fig. 3 is from the bed of the Arve at St. Martin's, and shows this condition still more delicately. The narrow black line traversing the white surface, near the top, is the edge of a film of slate, once attached to the dark broad vertical belt, and which has been slowly warped from it as the carbonate of lime was introduced. When the whole was partly consolidated, a second series of contractions has taken place; filled, not now by carbonate of lime, but by compact quartz, traversing in many fine branches the slate and calcite, nearly at right angles to their course.

I shall have more to say of the examples in this plate in connection with others, of which engravings are in preparation.

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## II.—On Subaërial Denudation, and on Cliffs and Escarpments of the Chalk and Lower Tertiary Beds.

By William Whitaker, B.A. (London), F.G.S.,
Of the Geological Survey of England.

[PART II.]

### 4.—*Chalk Escarpments.*

The graceful outlines, smooth curves, and flowing contours of the Chalk hills are well known to southern geologists; indeed these hills are the most marked feature of the south-east of England. Those who hold that their form has been given by the sea, point to the winding ridge, and say how like it is to many a coast with its succession of capes and coves; even so distinguished a writer as Sir C. Lyell remarking that "the geologist cannot fail to recognise in this view (of part of the South Downs) the exact likeness of a sea-cliff."[1] And truly it is so; but let us examine this likeness more closely, and it will be seen that the argument founded on it, plausible enough on the surface, is superficial only, and fails utterly when rigorously tested.

For this purpose let us place ourselves at some spot whence a large extent of these hills may be seen. None perhaps can be better than the hill crowned by Totternhoe Camp, in Bedfordshire, a projecting spur of the lower ridge of the Chalk (for there are two escarpments in that neighbourhood, one formed by the Chalk Marl and the bottom part of the flintless Chalk; the other and larger by the mass of the latter and the bottom part of the Chalk-with-flints). Thence let us look eastward southward and westward along the higher range, of which a long expanse unfolds itself to the view, across the Thames even to the "White Horse Hill" in distant Berkshire. The screen of even-topped combe-cut hills, shutting off all view beyond, with its succession of swelling headlands and in-curved bays, at once impresses the mind with the notion of an old coast-line, and but little imagination is needed to picture the sea beating furiously against the jutting capes, or rippling gently up the sheltered hollows.

But having indulged in a very pleasant day-dream, and transported ourselves for the time to Dover cliffs, Beachy Head, or the great Chalk buttresses of the Isle of Wight, let us descend to sober prose and our mental photograph will quickly fade, and soon be but "the baseless fabric of a vision, leaving not a wreck behind." Reason asks what coast is this ridge like? it is not enough that it should be like a coast, but it should be *like a Chalk-coast*: "it is not a mere resemblance that should correlate different things; there should be a specific character in everything that is to be generalised."[2] The answer comes at once: it is like a coast along rocks of different hardness (the softer yielding to form bays, the harder resisting to form headlands), and not like one along a rock of much the same nature throughout—it is *not* like a *Chalk-coast.*

Now let us examine the great escarpment more closely. Firstly, we shall find that at its foot there are powerful ever-flowing springs, thrown out generally at the out-crop of the Totternhoe stone,[3] which of course contain much carbonate of lime, as is shown by the not uncommon occurrence, further down the streams, of twigs thickly encrusted. Such constant taking away of matter from the Chalk must wear away that rock; and, given unlimited time, is enough to get rid of any quantity of it. This is almost a mere matter of multiplication; if so many tons are carried away in a year, a

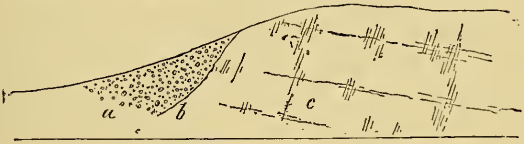
[1] Elements of Geology, Ed. 6, p. 359 (1865). Sir Charles now allows, however, that the likeness is deceptive, see p. 449.
[2] Hutton, "Theory of the Earth," vol. i. p. 489.
[3] The top bed of the Chalk Marl, see Quart. Journ. Geol. Soc., vol. xxii. p. 398.

thousand times as many will be carried away in a thousand years, other things being equal, and so on.

Secondly, if the escarpment were an old sea-cliff weathered down into a slope, it ought to show some such section as that in Fig. 1, in which a *talus* rests against the weathered face of the cliff, only the higher part of the hill being of bare Chalk. But this is not the case; large pits are common along most Chalk escarpments, and they show a more or less clean face of rock from top to bottom. The supposition that subaërial denudation may have cut back the hill, and destroyed the cliff with its *talus* and beach, has been noticed before. I question, too, if there is a known case of an old cliff that has weathered to so long and smooth a slope as that of a Chalk escarpment.

Next let us turn to the country at the foot of the hills, taken up by the flintless Chalk and the underlying beds. What sort of surface-deposit is found there? is it made up of water-worn pebbles like those on our present shores? No indeed, but we commonly find, on the contrary, broken and subangular flints, like those of our old river-gravels, sometimes simply scattered over the surface, at

Fig. 1.—Section of an escarpment on the supposition that it is an old cliff.




*a.* Talus. *b.* Face of old cliff. *c.* Bare Chalk.

others abundant enough to form small patches of gravel. In Buckinghamshire there are thin spots of such far out on the wide plain of the Gault. What can these flints be but the insoluble residue of the great mass of Chalk that has been slowly dissolved away, not pounded and worn by the waves? the remains of which latter kind of process should be looked for rather in such deposits as the old Tertiary pebble-beds of Kent, and the shingle-flats of the south-eastern coast.

It is not at one spot only that these things may be seen, but more or less along Chalk escarpments generally. In some places too a small stream runs for miles at or near the foot of the ridge: thus a branch of the Mole near Dorking, and a branch of the Stour near Ashford.

[Whilst the first part of this paper was in the press I was taking a holiday-ramble in the Isle of Purbeck, and noticed there a good and marked example of the fact that the bottom of an escarpment is sometimes at a higher level at one place than the top at another. The level of the Chalk ridge falls westward from Nine Barrow Down to Corfe Castle by three sloping steps, giving rise to four different levels (not counting the still lower conical hill on which the castle stands), the western of which is lower than the bottom of the escarpment under the higher parts, as shown in Fig. 2.

This is an exceptional case of quick fall in the level of a Chalk escarpment, and I cannot see how such a ridge can have been formed as a sea-cliff, which has of course a level base. To explain away the difficulty of the rise of the base-line by supposing that there have been local sinkings or upheavals, is a groundless and unwarrantable assumption until such changes have been *proved*, not simply imagined.]

Fig. 2.—Rough outline of the form of part of the Chalk ridge in the Isle of Purbeck.


x x. Sea level. *a b.* Top of Chalk ridge.
1, 2. Foot of the ridge. 3. Level of highest part of the foot of the ridge.

## 5.—*Tertiary Escarpments.*

The escarpment of the Lower Tertiary beds is neither so high nor so steep as that of the Chalk; nevertheless it often forms a well-marked ridge with a somewhat winding course, as on the north and north-west of London, from Rickmansworth to beyond Hatfield, along which line the Colne flows south-westward and the Lea eastward at the foot of the hills, receiving on their way streamlets that run down the slopes and carry off the sand and clay of which those slopes consist. Some of these streams are simply the result of the drainage of a clay-country, others start as springs from the Drift gravel which caps the London Clay on the high grounds, and some end their course in swallow-holes in the Chalk.

The thickly wooded hills of "the Blean," between Canterbury and Faversham, show many examples of swallow-holes, the largest of which have been described by Mr. Prestwich.[1] When near the top one sees springs, thrown out from the gravel by the London Clay, and down the slopes there are small water-courses; but outside the close woods, which end mostly at the foot of the hills, the ground is generally dry, the water having sunk into holes at the junction of the Tertiary beds and the Chalk, which may commonly be seen at the re-entering angles of the line of outcrop of the latter formation. From the southern point of these hills to Grove Ferry and the Reculvers, the London Clay, which forms by far the greater part of that district, is wholly cut off by the Stour and the Wantsume channel, not a particle I believe existing on the right side of the river, and the Oldhaven and Woolwich Beds occur only as outliers; in other words, the left bank of the Stour is an escarpment of London Clay, etc.

In many places the outcrop of the Chalk, and of the beds between it and the London Clay is masked by a loam, which is nothing but

[1] Quart. Journ. Geol. Soc., vol. x. p. 222 (1854).

the "rainwash" of the slopes of clay and sand, and is sometimes thick enough to be worked for bricks. If so much has been left, how much more must have been washed away altogether,—all, be it remembered, being the product of mere surface-denudation.

London Clay hills show many traces of landslips, as may be well seen on the left side of the Lea, where some of the sharper slopes are made quite irregular by the many falls.

Whilst, therefore, Chalk is in great part carried away in chemical solution, the clays and sands of the Tertiary beds are wasted by mechanical means.

Where the dip is at a high angle the Lower Tertiary formations have no escarpments, or, at all events, give rise to but a slight feature, as in the Isle of Purbeck, the Isle of Wight, and Surrey; whilst where the beds are flat, or dip at a very small angle, they have a good escarpment, as in Berkshire, Hertfordshire, and Kent. The great difference which the amount of dip has had in causing the denuding powers to form a flat or a slope may be well seen in the Isle of Wight, where the vertical beds of Alum Bay are in a valley between the Chalk ridge and the rising ground formed by the gently inclined higher series of Headon Hill.

West and north-west of London there is a peculiarity in the range and outcrop of the Lower Tertiary beds worthy of notice here. The escarpment trends nearly north-east and south-west along a line through Twyford, Rickmansworth, and Hatfield, roughly parallel to which, and a few miles from it outward, are a number of outliers (like skirmishers thrown out from the main body) ranged along a line from the hills near Wargrave and Beaconsfield, through Chalfont St. Giles, Sarratt, Abbot's Langley, St. Alban's, Digswell, Datchworth, and Bennington. Again, inwards from the escarpment, but also parallel to it and a few miles from it, there are a few inliers along a line through Windsor, Pinner, and Northaw. The outliers I look on as the relics of a former escarpment, and the inliers as the signs of a future one. The outliers mark a line where denudation has been delayed (I do not say stopped); the escarpment perhaps one where it is now delayed; and the inliers one where it will be delayed (of course on the supposition that no great physical change takes place), when the part between them and the present escarpment will be cut off as outliers. Each of these lines is in great part, I believe, through points where a slight change of dip takes place, which may have in some measure enabled the beds better to withstand denudation in the case of the outliers, or may have made them fall an easier prey to it in the case of the inliers, there being an inward dip in the former and an outward dip in the latter. Further out in the Chalk district there are traces of another line of outliers, better marked westward, along a line through Lane End (near Wycombe), Turville Common, Nettlebed, and Woodcot Common (east of Goring). The inner line merges into that of the escarpment near Reading, and further westward the outer line does so too. I have noticed like arrangements in line in Kent, but none so marked as the above, perhaps because the dip is generally less on the northern side of the London basin than on the southern, so that the beds have a greater chance of spreading over a wider tract.

Of course delays in denudation may be owing also to change of condition, climatal or otherwise.

### 6.—*Chalk and Tertiary Cliffs.*

It is usual to talk of cliffs as the work of the sea alone; and those who say that subaërial actions are too weak to do the work of denudation in forming hills and valleys are wont to point to what is now going on along our shores as evidence that the sea and the sea only is nature's great tool for making ridges. I am willing however to meet them on their own ground, thinking that if it can be shown that the sea *alone* does not make the cliffs, but is very largely helped by those atmospheric actions which they despise, their statements as to the powerlessness of those actions will have all foundation destroyed, and will therefore fall to the ground, carrying with them the theories which they support.

Let us examine the Chalk-coast of Kent. The cliffs are for the most part nearly vertical; indeed I can call to mind but one place where this is not the case, the well-known Shakspeare's Cliff, the higher part of which is a sharp slope, whilst near the bottom it is slightly overhanging (on account of a hard bed which stands out). Sometimes they are quite vertical; hardly ever are they undermined. Now if made by the sea alone, which can act only at their base, surely they should mostly overhang; but, in fact, they often project slightly at the bottom by a series of small steps. It is clear therefore that the upper part wears away as quickly as the lower, and as the sea can hardly attack the top of the cliff, one hundred feet or more high, one must look about for some other wearing power that can.

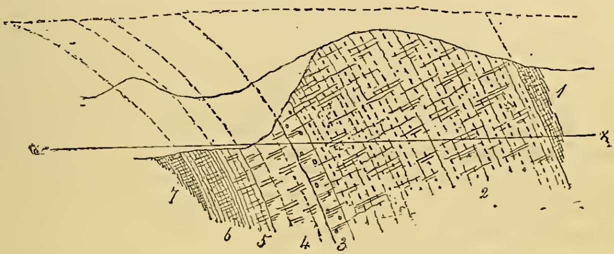
For that purpose let us go to the cliff-top and see what is going on there. We shall find that the action of the weather is nearly everywhere separating masses of Chalk, some of which, from the slow dissolving away of the surrounding rock, stand out for many years as pinnacles or needles, whilst others are soon hurled to the bottom. Where the Chalk is most jointed there of course the power of frost has most chance of showing itself: where too there are large pipes of sand and clay in the Chalk small needles are common along the top of the cliff, as in parts of the coast of Normandy.

When the softer and more yielding beds below the Chalk crop out near the base for some distance, the fall of the cliff sometimes takes place on a very large scale, and "undercliffs" are formed. Thus at Folkestone the porous yielding Upper Greensand has given way to the influence of springs and to the pressure of the great overlying mass of rock, which has in consequence slid down over the moist slippery surface of the Gault. The undercliff of the Isle of Wight is far longer and broader, and the nearly vertical cliff of hard Upper Greensand, which has resulted from its formation, is at a great height above the sea and often a third of a mile distant therefrom, so that no one can well call it a sea-cliff.

In Kent the Chalk escarpment and the Chalk cliff cut one another obliquely, whilst at the western end of the Isle of Wight the two are for a wonder parallel; but alas for the advocates of the marine formation of escarpments! this latter case in no way helps their theory, for putting aside the consideration of the fact that the cliff leaves the Chalk and turns southwards to cut through lower beds, one can see at a glance that the formation of the cliff has in great part destroyed the feature of the escarpment, of which only the curved top remains, as shown in the section below. Moreover

Fig. 3.—Section showing the relation of the Chalk cliff and the Chalk escarpment in the Isle of Wight.

S. N.




Scale about six inches to a mile.

1. Lower Tertiary beds. 2. Chalk with many layers of flints. 3. Chalk with few flints. 4. Chalk without flints. 5. Chalk Marl. 6. Upper Greensand. 7. Gault. x x. Sea-level.

The broken lines show the form of the ground and the continuation of the beds, which must have existed before the sea-cliff was worn back into the escarpment, and which correspond to the same as they now exist in those parts away from the sea.

The dotted lines show the further extension of the beds until cut off by the "plain of marine denudation" made before the exposure of the land to subaërial actions.

the sea has utterly destroyed the Chalk ridge between the Needles and Handfast Point in Dorsetshire. Along all Chalk-coasts, indeed, the antagonism of the two denuding powers is well shown, the sharp cliffs cutting across the gently curved outlines of hill and valley that have been caused by long continued subaërial actions, the sea levelling what these have furrowed.

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Let us now turn to the Tertiary coast of Kent. The foreshore of the Isle of Sheppey (and also of the greater part of the mainland from Whitstable to beyond Herne Bay) consists of a plain of London Clay sloping gently seawards. The cliffs are mostly sharp irregular broken slopes, not altogether cut out by the sea, but formed by the slipping downwards of masses of London Clay and of the overlying Bagshot Sand and Drift gravel, which last two form a more vertical ridge at the top of the slope.

Now it is clear that the waves do not rush up to the top of the cliff and bring down the clay sand etc., but that the fallen masses owe their fall to frost, rain, and heat: the heat of summer to dry up the beds, and by shrinkage to form fissures down which the rain may soak; rain to soften and make slippery; frost to divide mass from mass by its irresistible expansive power. That the slips take place from the top is indeed well known, and good figures of one of them have been given by Mr. Redman.[1] I have myself seen a large and fresh one, and noted the occurrence of a crop of wheat some way down the slope.

The coast from the Reculvers westward for about two miles is of a somewhat different character, by reason of the rise of the sandy beds below the London Clay; but still the waste of the cliff is from the top, masses of the clay being constantly thrown down to the foot. The shape of the cliff is often different, the clay forming a slope at the top and the sands a more or less vertical wall below. Another agent too comes into play here—the wind, which when strong blows away much of the fine loose sand (Oldhaven Beds[2]) next below the London Clay. At Oldhaven Gap there is a well-marked cliff running inward from the shore at right angles, and with a broken slope on the other (eastern) side. This "chine," which is about 300 yards long, and the bottom of which is but little above high-water-mark, has clearly been formed by land-water, although for the greater part of the year the insignificant watercourse along it is quite dry, for the sea has never touched its base, and I believe that it has been cut farther inland within the memory of man.

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The sea, therefore, does not *by itself* destroy the land, but is largely helped by atmospheric actions. The former carries away what the latter bring within its reach. Without the help of rain, frost, etc., the sea would spend its force on compact and therefore on comparatively unyielding rocks: without the help of the sea these subaërial forces would soon mask solid cliffs with slopes of débris, and thus vastly decrease their own destructive power. The two destroying powers working together in different ways, the sea horizontally from below, the other set of agents vertically from above,[3] cause tenfold the destruction of coast that either could do alone.

Most observers indeed are more or less agreed as to the waste of some cliffs from above, though so far as I know, this knowledge of the power of surface-actions on the coast has not been applied to the question of denudation. Sir C. Lyell indeed has said in his last work, that "the waste of the cliffs by marine currents constitutes on the whole a very insignificant portion of the denudation annually effected by aqueous causes . . . . . the action of the waves and currents on sea-cliffs, or their power to remove matter from above to below the sea-level, is insignificant in comparison with the power of rivers to perform the same task."[4]

### 7.—*Comparison between Cliffs and Escarpments.*

From what has been remarked above therefore it is clear that

[1] Proc. Inst. Civ. Eng. vol. xxiii. p. 186, 1865, where, and in an earlier paper by the same author (ibid. vol. xi. p. 162, 1854), the destruction of the South-east coast of England is well treated of.

[2] Quart. Journ. Geol. Soc. vol. xxii. p. 412.

[3] See Jukes, Brit. Assoc. Rep. for 1862, Trans. of Sections, p. 61.

[4] Principles of Geology, Ed. 10, vol. i. pp. 565, 570 (1867).

rivers often run along the foot of Chalk and Tertiary escarpments, whilst, on the other hand, it is very rare for the sea to do so.

Again, an escarpment is remarkable for the comparatively uniform level of its top for long distances, any change therein being by a gentle slope; whilst the height of a range of cliffs is ever varying, and that suddenly and with sharp slopes. Escarpments, too, are nearly always the highest part of a district, the ground falling from them on both sides; cliffs, however, are very rarely so, but are often backed by higher ground; indeed those cases that I know of Chalk cliffs being through the highest ground are just where they cut through the escarpment, as on the north of Folkestone and at Beachy Head. The same kind of reasoning that has been used with reference to the features of the Chalk and the Tertiary beds may be applied to other formations; and how, therefore, an escarpment can be an old sea-cliff passes my understanding, for the two have nothing in common and much in opposition, as may be clearly seen from the following table:—

Comparative Table of the Distinctive Features of Escarpments and Cliffs.

| Escarpments. | Cliffs. |
|---|---|
| (*a*) Run along the strike, or in other words, keep to one formation throughout. | (*a*) Rarely run along the strike, but at all angles to it, and cut through many formations in succession. |
| (*b*) Tops more or less even and nearly flat. | (*b*) Tops mostly very uneven. |
| (*c*) Form the highest ground of a country, overlooking other parts. | (*c*) Rarely through the highest ground of a country, but mostly backed by higher ground. |
| (*d*) Very rarely have the sea at their foot, but often springs and watercourses. | (*d*) Sea at their foot. |
| (*e*) Often run in more or less winding lines. | (*e*) Run nearly straight, or in curves of very large radius, when through homogeneous rock, and when not broken through by valleys. |
| (*f*) No beach at their foot. | (*f*) Mostly a beach at their foot. |
| (*g*) Are now being destroyed by the sea in places where the sea touches them. | (*g*) Are now being made by the sea (aided by atmospheric actions). |
| (*h*) Bases rise towards the watershed and have nothing to do with the sea-level. | (*h*) Bases at the sea-level. |
| (*i*) Those of successive formations run in more or less parallel lines for long distances, with plains, vales, or valleys between. | (*i*) No such parallel arrangement known, long fringes of land divided by belts of sea not being common, except in such cases as Coral Islands, where the features have been caused by growth, not by decay. |

What can be more different than these two? It is for those who say that escarpments are old sea-cliffs to answer the question, and until that has been done they have little reason on their side.

## 8.—*Conclusion.*

All geologists know that rivers have made great deposits, as for instance the Wealden Beds, and therefore I do not see how they can avoid allowing that rivers, etc., have been the agents in effecting a great amount of denudation, The solid matter of the Wealden Beds must have existed somewhere before, and must have been worn away by subaërial actions and carried off by streams (the sea being quite out of the question): more too must have been worn away than was deposited afterwards by the rivers, for much would be carried out to sea to form a marine deposit. Of course freshwater beds are both less common and thinner than marine beds, but so also, as aforesaid, the comparatively trifling denudation that has formed our hills and valleys is of far less amount than that which has planed down vast tracts of country and carried off therefrom a great thickness of rock. Perhaps, indeed, the proportion that the effects of marine denudation bear to those of subaërial denudation is not far from the same as that which marine deposits bear to freshwater deposits.

To those who say that subaërial agents are too small and too weak for the work which has been put to their credit, it may be answered that unlimited time would get over that difficulty; and it should be borne in mind that good evidence has been brought forward that in late geological times our climate was far more severe than now, and that there may have been a far more rainy period before the present order of things was established; or in other words, that the agents in question were far more powerful than they now are in these islands. Great change indeed has taken place in historic times; the felling of forests, the draining of land, the embanking and canalization of rivers, the reclaiming of marshes, and the like human handiworks having had their effect in lessening rainfall and floods, and therefore also the wearing action of surface water.

As astronomy has proved the existence of almost boundless space, so geology needs almost boundless time. The former science gives us our liveliest picture of infinity, and the latter our best idea of eternity. When astronomers talk without any opposition of immeasurable space, surely geologists should be allowed immeasurable time. The last Wollaston Medallist has eloquently said, "The leading idea which is present in all our researches, and which accompanies every fresh observation, the sound which to the ear of the student of nature seems continually echoed from every part of her works is Time! Time! Time!"[1]

Lastly, it seems to me that the discussion on the question of denudation has been argued on a wrong foundation. Surely, if we can explain the facts and appearances we see by actions and operations that can be seen going on at the spot now, we are bound to take such explanation until it can be disproved, or until a better one can be given, and we have no right to call in the aid of other and distant operations, without there is some good sign of their having been once present (thus for instance with regard to many rock-basins now far from glaciers, there are unmistakeable signs of their once having contained ice). As a simple matter of reasoning therefore, apart from all scientific truth, we are bound to accept the theory of subaërial denudation until it can be put aside. Geologists should not call on those who hold it, and who show its agreement with things seen, to disprove other theories; but rather should expect its adversaries to disprove it, and to show firstly, that rain,

[1] Scrope, "The Geology, etc., of Central France," Ed. 2 (1858), p. 208.

rivers, ice, springs, damp, and frost are powerless to wear away rocks and to cut out escarpments valleys and rock-basins; and secondly, that the sea can do and does such work. This, no light task truly, must be done, if it can be done, not by mere assertions of individual opinion, or mere statements based on hasty and prejudiced observations, but by hard work and sound reasoning. Not with us, but with our opponents, lies the *onus probandi.*

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Errors in the First Part of this Paper.

Page 451, line 16 from bottom, for "action" read "actions."

Page 451, line 11 from bottom, for "Portland Stone in part of the Isle of Purbeck" read "Purbeck and Portland Beds in Dorsetshire."

Page 453, line 15 from bottom, after "follow" insert "us."

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## III.—On the "Lingula Flags," or "Festiniog Group" of the Dolgelly District.

By Thomas Belt, F.G.S.

[PART I.]

The strata lying above and below the Lingula Flags have already been well described and illustrated: the Menevian Gronp below, by Messrs. Salter and Hicks, and the Tremadoc Group above, by Messrs. Homfray, Ash, and Salter. The great mass of strata lying between has not fared so well, though several notices of it, to which I shall refer, have appeared. In the present paper I propose to describe these strata in detail; and the remarks I have to offer embody the results of three years' researches, during part of which I have had the advantage of the company and able co-operation of Messrs. Ezekiel Williamson and J. C. Barlow, whose discoveries I shall have to mention in my description of the rocks and their fossil contents. To facilitate the study of the district around Dolgelly, which is exceedingly faulted and complicated, I have carefully mapped out nearly the whole of the rock exposures. This may seem to have been unnecessary, seeing that we have already the Geological Survey maps of the district. But since the officers of the Survey examined and mapped out the rocks of Merionethshire, from fifteen to eighteen years have elapsed, and the maps which then added so much to our knowledge are now far behind our requirements. The whole of the strata lying between the Tarannon shale and the Cambrian grits are there coloured alike. Neither the Arenig nor the Tremadoc rocks are recognised; and we now know that the strata there named "Lingula Flags" include at least three distinct and diverse groups.

In 1847 Professor Sedgwick separated the Tremadoc rocks from the "Lingula Flags," calling the latter the Festiniog Group. Since then Mr. Salter has been the pioneer in their investigation. His discovery in 1863 of *Paradoxides Davidis* in the slates of St. David's gave an impulse to the study of these old rocks, that has resulted in a rich harvest of Primordial trilobites, chiefly through the indefatigable labours of Mr. Hicks. The strata containing these trilobites have been separated from the Lingula Flags by Mr. Salter, under the name of the Menevian Group. The recent discovery by Mr. Hicks of new forms of *Paradoxides* in the purple slates, inter-stratified with the Harlech grits, will probably lead to the classification of the *Paradoxides* beds as Lower Cambrian. The Menevian Group will then form the top beds of the lower instead of the bottom beds of the upper formation and the Lower Cambrian will have a well-defined palæontological limit upwards. Whilst linked to the upper series by such general and far ranging forms as *Conocoryphe* and *Agnostus*, it will be distinctly marked off by *Paradoxides* and other genera that do not transgress the upper boundary of the Menevian beds.

The Lingula Flags above the Menevian Group have been divided by Mr. Salter into the Lower, Middle, and Upper Lingula. In a paper by Mr. Plant, an abstract of which appears in the Quarterly Journal of the Geological Society for November, 1866, the same classification is adopted. Messrs. Salter and Hicks, in the Report of the British Association for 1866, include the Lingula Flags in the Festiniog Group, and characterises them as "hard siliceous sandstone with grey flaky slate, containing *Lingulella Davisii.*" This description only applies to the Lingula Flags of South Wales. In North Wales the arenaceous flags and shales containing *Lingulella Davisii* only form a subordinate part of a series of dark-blue and black, fine grained slates, containing trilobites of several genera.

Even when we have divided the group into Upper, Middle, and Lower, we have still to speak of the Upper division of the Upper, and the Lower division of the Lower Festiniog, as each sub-division contains two distinct sets of strata. Recent discoveries have shown that the group includes at least six zones of animal life, each distinct and separate. I believe that I only meet the strict requirements of the case when I propose to form three groups of the strata now included in one. My proposal is, to restrict the name of the Festiniog Group to the flags containing *Lingulella Davisii* and *Hymenocaris vermicauda,* to which it was originally applied by Sedgwick, and to form the slates and flags lying below them, characterised by typical forms of *Olenus,* into a new group, which might well be called the Maentwrog Group, as the strata included in it are exhibited in great perfection at and around the village of Maentwrog, two and a half miles west-south-west from Festiniog, For the blue and black slates lying above the Festiniog Group, as above limited, I propose the name of the Dolgelly Group, as it is only in the neighbourhood of Dolgelly that both the members of which it is composed have as yet been found. It is well characterised by several aberrant forms of *Olenus,* constituting the genera, or sub-genera *Parabolina, Peltura, Sphæropthalmus,* and *Dikelocephalus* of various authors.

The Maentwrog, Festiniog, and Dolgelly Groups are both lithologically and palæontologically distinct. None of the Crustaceans pass from one group to another, and peculiar genera are found in each. Lithologically, the Dolgelly Group is characterised by soft black slates, with a black streak; the Festiniog Group by hard micaceous flags, and the Maentwrog Group by dark-blue, jointed, ferruginous slates.

Before passing on to a detailed account of these rocks and their fossil contents, and in order to exhibit clearly their position in the Cambrian system, I give below a table of the whole of the Cambrian rocks, showing the proposed classification. and the range of the genera. I have not included *Calymene*, *Homalonotus*, and *Nucula*, recorded by Messrs. Salter and Hicks from rocks at St. David's—believed by them to be of Tremadoc age[1]—as no Tremadoc species have been found, and all the trilobites belong to Silurian genera. They will probably form a Lower Arenig Group.

Table of the Cambrian Rocks showing the Range of the Genera.

| Genera. | Lower Cambrian. | | | Upper Cambrian. | | | |
|---|---|---|---|---|---|---|---|
| | Bangor Slates. | Harlech Grits. | Menevian Group. | Maentwrog Group. | Festiniog Group. | Dolgelly Group. | Tremadoc Group. |
| Paradoxides ...... | | — | — | | | | |
| Anopolenus ...... | | | — | | | | |
| Microdiscus ...... | | | — | | | | |
| Erinnys ............ | | | — | | | | |
| Holocephalina ... | | | — | | | | |
| Conocoryphe ... .. | | - | — | - - - - - | - - - — | - - - — | — |
| Agnostus ......... | | - | — | — | - - - - - | — | — - - - * |
| Olenus ............ | | | | — | | | |
| Parabolina ......... | | | | | | — | |
| Peltura ............ | | | | | | — | |
| Sphæropthalmus... | | | | | | — | |
| Dikelocephalus ... | | | | | | — | — |
| Niobe ............... | | | | | | | — |
| Angelina ......... | | | | | | | — |
| Cheirurus ......... | | | | | | | —* |
| Ampyx ............ | | | | | | | —* |
| Asaphus ............ | | | | | | | —* |
| Ogygia ............ | | | | | | | —* |
| Hymenocaris ...... | | | | | — | | |
| Lingulocaris ...... | | | | | | | — |
| Leperditia ......... | | | — | | | | |
| Protocystites ...... | | | — | | | | |
| Bellerophon ...... | | | | | — | - - - - - | - - - —* |
| Lingulella ......... | | - | — | — | — | — | —* |
| Obolella ............ | | | — | - - - - - | - - - - - | - - - - - | - - - - -* |
| Discina ............ | | | — | - - - - - | - - - - - | - - - - - | - - - - -* |
| Orthis................ | | | — | - - - - - | - - - - - | — - | - - - - -* |
| Theca ................ | | - | — | - - - - - | - - - - - | - - - - - | —* |
| Cyrtotheca ......... | | - | | | | | |
| Conularia ......... | | | | | | | —* |
| Orthoceras ......... | | | | | | | —* |
| Dictyonema ...... | | | | | | | — |
| Protospongia ...... | | | — | - - - - - | - - - - - | — - - - | — |
| Buthotrephis ...... | | | | | — | | |

The Genera marked thus * pass upwards.

[1] Report Brit. Assoc., 1866, p. 184.

*(To be continued.)*

## IV.—Notes on West Indian Geology, with Remarks on the Existence of an Atlantis in the Early Tertiary Period; and Descriptions of some New Fossils, from the Caribean Miocene.

By R. J. Lechmere Guppy, F.L.S., F.G.S.

1. SINCE the researches of Heer into the Miocene Flora of Switzerland have invested the theory of a Tertiary Atlantis with some degree of probability, other observers have come forward with arguments on the one hand which lend support to that hypothesis; whilst on the other hand it has been attempted to prove that the facts (as to the presumed migrations of plants and animals) are to be accounted for rather by a connection between Europe and America through the Asiatic region. My examination of the Jamaican fossils[1] first led me to support a modification of the original view taken by Heer, and in April, 1866, I communicated to the Geological Society a paper bearing on the subject. That paper was read on the 20th of June, 1866, and an abstract of it appeared in the August number of this Magazine.[2] I propose, on the present occasion, to make a few remarks on the probability of the former connection between the eastern and western shores of the Atlantic.

It does not seem to me improbable that we shall ultimately have to admit that the Tertiary Atlantis was, in all probability, only the termination of a pre-Tertiary Atlantis, and that the physical changes produced by the gradual disappearance of the Atlantic land, and the emergence of land in other regions, gave rise to that migration of species, the causes of which we now seek to explain.

According to Dana, the North-American continent has been receiving constant additions during the Palæozoic and Mesozoic periods; but he has not satisfied us as to the origin of the immense amount of material necessary for the formation of so much land; and I would suggest the possibility of that material having been derived, in part, from land which occupied some portion of the present Atlantic area. Such land would have permitted the diffusion of plants, while its shores afforded the means for the migration of marine animals between America and Europe. Then, if the Atlantic continent were of pre-Miocene date, and if its destruction and submergence began in Eocene times, we might be able to account for the facts observed as to the distribution both of Eocene and Miocene Invertebrata and Plants. Since the Eocene period the Alps, in part formed of Nummulitic Limestone, have been upheaved, and it may be assumed that an equivalent amount of depression took place on some not very remote part of the earth's surface. The submergence of the Atlantis continued throughout the earlier Tertiaries, may have left but its higher points, as detached groups of coral islands, in the later Miocene sea. Dana is of opinion that the Pacific land has been depressed 6,000 feet in post-Tertiary times.[3] It is, there-

[1] Quart. Journ. Geol. Soc. vol. xxii., p. 281.
[2] Vol. III. p. 373. Quart. Journ. Geol. Soc. Vol. xxii., p. 570.
[3] Manual of Geology, p. 587.

fore, not so improbable that the submergence of the Atlantic and Pacific continents was, in part, contemporaneous with the upheaval of large areas in Europe and America.[1]

It is possible that we have here an explanation of the comparatively limited development of Tertiary formations in North-America. They are, as we know, chiefly confined to the region about the Mississippi, and to a narrow belt which extends along the Atlantic coast. This small development of Tertiary rocks may be due to the submergence of the area whence the material for the formation of the American continent was formerly derived. A careful study of the physical geology of the whole region under consideration would alone enable us to generalize with safety on this point.

2. A further search in the Lower Miocene beds of San Fernando, in Trinidad, has been rewarded by the discovery of a shell hitherto only known by a few examples, obtained by Sir Robert Schomburgk from a rock in Barbados, and which was described by Professor Forbes. It is possible that we may hence derive some clue to the age of the Barbados older Tertiary, which is as yet undetermined. In order to be clearly understood I shall give a very brief outline of the geology of Barbados.

Two formations are exposed in Barbados. They have been named respectively the Coral formation and the Scotland formation. Of these the former appears by its included organic remains to be of the same age as the Newer Pliocene deposits of the West Indies. All the species are still existing. The Scotland formation contains the well-known microscopic organisms described by Ehrenberg, and called by him Polycystina. In an "isolated rock" in this formation Sir Robert Schomburgk found some fossil mollusca. Of these, three species alone were in a state to admit of description, and they were named by Professor Forbes, who was inclined to regard them as Miocene. From that time (1846) to the present no further examples of these fossils have been discovered. I had the good fortune to find one of them (the *Nucula Schomburgki* of Forbes) in a greenish-gray shale among the middle beds of the Lower Miocene series of San Fernando. The *Nucula* in question is a remarkable species, resembling, especially in the character of its ornamentation, the *N. divaricata* of the Pacific, and the *N. Cobboldiæ* of the English crag. In the San Fernando beds fossils are rare, and difficult of extraction. Several other species accompany the *Nucula* in the bed of shale; but, although enough is seen of them to indicate that they probably belong, in most cases, to undescribed and extinct species, they are rarely in a condition for description.

Our information as to the relation of the "isolated rock" containing *Nucula Schomburgki* to the Scotland formation is not so precise as might be wished; but, assuming it to be a detached pinnacle or boulder belonging to the Lower Miocene it would thus appear that the Scotland formation is newer than the Lower Miocene, and may possibly, considering that it is inferior to the Pliocene, be

[1] Dana, *op. cit.*, pp. 531, 532; and Lyell, Principles, 8th ed., p. 121.

of Upper Miocene date. For although the Scotland formation is different in its general appearance and composition from the Upper Miocene of San Domingo, Jamaica, Trinidad, and Cumana, yet it bears in part a similarity to that of Trinidad, in its included and characteristically abundant minerals; namely, petroleum, coal, and selenite.

It may perhaps be inferred from the discovery of *Nucula Schomburgki* in the Lower Miocene of Trinidad that after the deposition of that formation a depression took place, which led to the existence of a deep ocean over part of the West-Indian area. This is indicated by the Polycystina beds of Barbados, whose fossils resemble those dredged from great depths in the sea.[1]

As the *Nucula Schomburgki* is an interesting form, I have made a drawing of the best-preserved example, and three other fossils from the same bed are also figured herewith, together with some other species of mollusca from Miocene deposits in the West-Indies; and which are not only interesting from their zoological affinities, but may aid in the identification of rocks of the Tertiary period in the Caribean area.

3. In the lists of fossils I gave in my paper on the Relations of the West-Indian Tertiaries, the name *Ancillaria glandiformis* should have been included in the San Domingan and Jamaican lists. I am satisfied from the figures of this variable shell, given by Hörnes, in his Fossil Mollusca of the Vienna Basin, that the *Ancillariæ* in the collection of the Geological Society belong to this species, and also the small and young examples from Jamaica, in the British Museum. Another link is thus added to those which already connect the European and Caribean Miocene. The shell I described in the same paper as *Melanopsis cepula* (not *capula*, which is a misprint), seems to be deserving of generic rank, and I propose to distinguish it by the name *Crepitacella*. The characters are appended hereto. The shell described by me under the name of *Malea camura* occurs in San Domingo as well as in Jamaica.[2]

4. As a further result of my researches, I may here state that I find myself gradually tending towards the belief that the Tamana series and the San Fernando beds in Trinidad must be separated from the other deposits in the West-Indies termed Miocene; and that it would be more correct for the present to limit the term Lower Miocene to the former, and to class the Anguilla and Antigua Beds as the lower members of the Upper Miocene. I propose, therefore, the following classification of the Caribean Upper and Middle Tertiaries:—

1. *Pliocene.*

*a.* Barbados, Guadeloupe, etc.
*b.* Trinidad (Matura Beds).

[1] See Maury, Phys. Geogr. of the Sea (1858), pp. 254, 263.

[2] The shell from San Domingo, in the British Museum, labelled *Venus circinaria*, is not that species, but more probably *Venus rigida* (*V. rugosa*).

### 2. *Upper Miocene.*

*a.* Cumana.
*b.* Barbuda.
*c.* Trinidad (1. Mornga Series: 2. Caroni Series).
*d.* Jamaica (Vere, Bowden and Upper Clarendon Beds).
*e.* San Domingo (Nivajé shale, etc).
*f.* Anguilla.
*g.* Antigua (Chert formation: Conglomerate beds).
*h.* Barbados (Scotland formation).

### 3. *Lower Miocene.*

*a.* Trinidad (Manzanilla Beds).
*b.* Trinidad (San Fernando Beds).
*c.* (?) Barbados (Nucula-rock.)

It will be noticed that I have inserted the name of Barbuda in the list of Upper Miocene localities given above. Having recently examined a small collection of fossils from that island, I have determined the following species from it:—

*Oliva cylindrica*, Sow.
*Nassa solidula*, Guppy.
*Bulla striata*, Brug.
*Tellina biplicata*, Conrad.

All these species occur in the Miocene; and thus Dr. Duncan's conclusion, as to the existence of the Middle Tertiary in that island, is now confirmed by the discovery of these mollusca.

5. Mr. Jeffreys, in his paper on "Dredging among the Hebrides[1] notices that the diffusion of univalves is slower than that of bivalves. This fact may help us to explain why there should be comparatively so large a proportion of bivalves common to the Middle Tertiaries of the United States, and the West-Indies. The species of mollusca I have ascertained to occur in both these areas are as follow:—

*Univalves.*—*Petaloconchus sculpturatus*, Lea.
*Dentalium mississipense*, Conrad.
*Latirus infundibulum*, Lam.
*Bivalves.*—*Artemis acetabulum*, Conrad.
*Tellina biplicata*, Conrad.
*Pecten Mortoni*, Conrad.
,, *comparilis*, Tuomey and Holmes.
*Lucina pennsylvanica*, Linn.
*Ostrea virginica*, Gruel.
*Teredo fistula*, Lea.
*Chama arcinella*, Lam.

Thus we have another fact pointing to the greater facilities which must have existed for migration between the European and Caribean Middle Tertiary seas than between the latter and North America. For, although but few Gasteropoda are common to the European and the Caribean Miocene, yet very many are closely allied, which is not the case with those of America. Further, all those species of mollusca, which Conrad and other authors find to be common to both continents, are bivalves. And there are as many bivalves common to the European and West-Indian Miocene as there are to the latter, and that of the United States.

[1] Ann. and Mag. N.H., 3 ser., vol. 18, p. 387, (Nov. 1866).

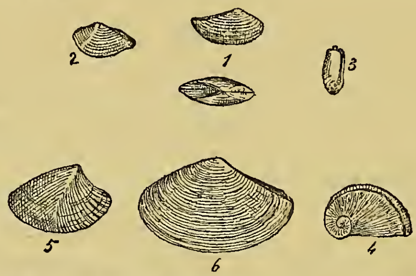
## *Descriptions of a New Genus and Six New Species of Mollusca, from the Caribean Miocene.*

### I.—*Crepitacella.*—gen. nov.

*Shell* turreted, cono-cylindric, last whorl large, rounded; aperture large, with a broad and short anterior canal. Columella twisted; peristome simple, prominent.

*C. cepula*, Guppy, Quart. Journ. Geol. Soc., Vol. xxii. p. 580, pl. xxvi. fig. 14. Upper Miocene, Cumana.

The true position of this shell is probably in the neighbourhood of the family *Buccinidæ*, in which I have provisionally placed it. Its nearest relation known to me is *Cyllene pulchella*, Adams.




Names of New Species Figured and Described.

Fig. 1. *Leda incognita.*
,, 2. *Leda bisulcata.*
,, 3. *Tornatina coix-lacryma.*
Fig. 4. *Stomatia eidolon.*
,, 5. *Nucula Schomburgki.*
,, 6. *Mactra subovalina.*

### II.—*Stomatia eidolon.* (Fig. 4.)

*Shell* depressed, ear-shaped, few-whorled, radiately striate, with a furrow near the outer angle of the whorls; spire small, depressed.

This little shell resembles a *Haliotis* without holes, and for this reason I have placed it in the genus *Stomatia*; for in some respects it resembles a *Sigaretus*, differing from the latter genus in having a groove along the margin of the whorls, as in *Haliotis.*

Lower Miocene, San Fernando, Trinidad.

### III.—*Tornatina coix-lacryma.* (Fig. 3.)

*Shell* small, cylindrical-oval, nearly smooth, but with fine spiral striæ. Spire sunk, the first whorl projecting as a small papillary knob; whorls slightly concave below the superior angle; suture channelled. Aperture long and narrow, widening anteriorly; columella with a callous plication.

This shell recalls the secondary *Acteoninæ.* It is apparently related to *T. coarctata* and *T. canaliculata*, D'Orb., and, perhaps, also to *Bulla Lajonkaireana*, Basterot, of the European Miocene. Only the point of the spire is above the plane of the last whorl.

From the Upper Miocene of Cumana and Jamaica.

### IV.—*Nucula Schomburgki*, Forbes. (Fig. 5.)

(Forbes in Schomburgk's History of Barbados, p. 565.)

This shell varies a good deal in height and width. The lunule is impressed, but not circumscribed, nor is there a circumscribed dorsal area. The shell is thick and nacreous; the teeth of the hinge are pointed.

Lower Miocene, San Fernando, Trinidad.

### V.—*Leda bisulcata.* (Fig. 2.)

*Shell* ovately trigonal, with numerous concentric ribs, narrower than their interstices; with a somewhat sinuous elevated ridge running from the umbo to the pointed rostrum behind; rounded anteriorly with a round groove running from the umbo to the ventral margin near the anterior angle. Umbones close; posterior dorsal area flat, sloping, striate continuously with the ribs of the disc; no very distinct anterior area. Teeth very prominent.

This easily distinguished and handsome little species is related to the recent *L. jamaicensis*. It is without the large well-defined, anterior dorsal area which that species seems to have. It is also allied to *L. ornata*, D'Orb.

Upper Miocene, Jamaica.

### VI.—*Leda incognita.* (Fig. 1.)

*Shell* transversely-ovate, compressed, with rounded concentric ribs; rostrated posteriorly. Dorsal areas broad, distinct, circumscribed by the keels which run from the umbones to the extremities.

Lower Miocene, San Fernando, Trinidad.

### VII.—*Mactra subovalina.* (Fig. 6.)

*Shell* triangularly sub-oval, transverse, nearly equilateral, rather thin, compressed, concentrically striate by lines of growth; posterior slope large, and well-defined by the keel running from the umbo to the posterior end; anterior slope smaller, and less defined, the carination running from the umbo becoming obscure towards the extremity.

This belongs apparently to the group of true *Mactras*, of which the British *M. stultorum* is an example, somewhat allied to the present shell.

Lower Miocene, San Fernando, Trinidad.

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## V.—On the Belgian Tertiaries.

By Dr. A. von Koenen, of the University of Marburg.

SINCE Sir Charles Lyell published his most accurate and detailed paper "On the Tertiaries of Belgium and French Flanders," geologists could only differ in their opinions on the facts mentioned by him. New discoveries have been made in Belgium only in the last few years; besides the splendid cuttings in the ditches for the fortification of Antwerp, about which I am going to speak afterwards, there has been found, near Mons, by sinking a well, a thick bed of lime and limestone at the base of all hitherto-known Belgian Tertiary beds, containing numerous and well-preserved Tertiary marine and fresh-water mollusca. The discoverers, MM. Cornet and Briart, Engineers of Mines, and most zealous geologists, described very carefully the geological position[1] and afterwards the extension[2] of these lowest Tertiary beds in Hainaut. In their first paper they had tried to determine the Molluscan fauna of this basement bed, after Deshayes' works; but, out of 150 species, they could name only 22, and amongst these there are still some very doubtful ones. These 22 species, belonging to beds superior to the "Glauconie inférieure" and to the "Sables de Bracheux" of the Paris basin, they concluded that the new beds at Mons corresponded in age with a part of the "Calcaire grossier," and with the Upper part of the "Sables inférieurs" (Cuise-la-Motte).

Now the Calcaire grossier and the Sables de Cuise contain a very rich and well-known fauna, so that I concluded,[3] from the small number of species identical to them and to the beds of Mons, that they were of different age, rather than of the same, and the fauna of the

[1] Bull. del Acad. roy. de Belg. 2me serie t. xx. No. 11 and t. xxii. No. 12.
[2] See also Geol. Mag., 1866, Vol. III. p. 174.
[3] Zeitschr. d. D. Geol. Ges., xix., pg. 32.

Sables de Bracheux being very small and little known, and bearing a different aspect, it is not surprising that the correspondence in age of the Sables de Bracheux with the lime-beds of Mons cannot yet be proved by Palæontology, whereas Geology indicates it.

Mr. Cornet has written me recently that he has since recognized his error, and that he is going to rectify it. I have thought it desirable to make this statement in order to save the honour of Palæontology, because Mr. Whitaker[1] has cited the paper of Messrs. Cornet and Briart as a proof that it is unsafe to trust to Palæontological evidence.

I wish, in passing, to say a few words on the ferruginous sandstones from Kent, about which Mr. Whitaker l. c. does me the honour to cite my opinion.

The commonest and best determinable fossil, or rather cast, in Mr. Prestwich's collection was *Arca lactea*, Lin., which I mistook at first sight for *A. pretiosa*, Desh., a species peculiar to the Middle and Upper Oligocene beds, but after careful examination, I recognized that it was the recent species, and in this opinion I was confirmed by the superior knowledge of the late Dr. S. P. Woodward. Besides this species, I believe there were *Terebratula grandis*, *Scalaria foliacea*, and *Emarginula fissura*, L., so that I thought it probable that those beds corresponded with the Red Crag, and in this the late Dr. S. P. Woodward, one of the best judges of this matter, was also of the same opinion. Unhappily I made no list of the determinable fossils, but I hope Mr. Prestwich, who so kindly allowed me to make gutta-percha casts from his specimens, will find them out again, and confirm my statement.

Mr. E. R. Lankester[2] has published a paper "On the Tertiaries in the neighbourhood of Antwerp," by which he introduces into English literature the discoveries and observations made by Messrs. Nyst, de Wael, and Dejardin. He adopts the old division of the Antwerp beds, by Nyst, Dumont, etc, into:

| | |
|---|---|
| Système Scaldisien. | Sable jaune.<br>Sable gris. |
| Système Diestien. | Sable vert.<br>Sable noir. |

He calls the Système Scaldisien, Upper and Middle Pliocene; the Système Diestien, Lower Pliocene, not Miocene, (as I had published it two years before), and he tries to prove the correctness of this opinion by the per-centage of recent species in the different beds, and by the resemblance of the fauna of the Système Diestien to that of the Système Scaldisien, and of the Coralline Crag, after the lists published by Mr. Nyst. Now the list of Mr. Nyst of the fossils from the Système Diestien was not intended as a monograph, but purely to illustrate a new locality, so that it is not extraordinary if a number of names are erroneous. On the contrary, it is most natural that Mr. Nyst should have identified the new-found fossils

[1] Quart. Journ. Geol. Soc., 1866, p. 432.
[2] Geol. Mag., 1865, pp. 103-6 and 149-52.

as much as possible with the well-named fossils of his country, in this case especially, with the shells from the Scaldisien. On the other side I must maintain that every Tertiary horizon has as many[1] species in common with the succeeding as with the preceding horizon, that is to say, if they are analogous deposits, and provided there be no sharp lines of division separating them, either into two, three, or four periods, according to the author followed, whether it be Dr. Hœrnes, Sir Charles Lyell, or Professor Beyrich. The division of Professor Beyrich into four periods is in accordance with the geological distribution of the different beds, and has the advantage that the names of the periods, Eocene, Oligocene, Miocene, Pliocene, joined to the words Upper, Middle, and Lower, are sufficient to distinguish all the principal horizons of the Tertiaries.

If, therefore, the Système Diestien resembles the Coralline Crag as much as the Coralline Crag resembles the Red Crag, that is not a reason to put the Système Diestien rather into the Pliocene than into the Miocene. Mr. Lankester proposes to put certain beds of the Vienna basin, which he concedes to be coeval with the Système Diestien, also into the Pliocene; but in doing so, in order not to withdraw one of the Antwerp beds from the others, he tears in two the Vienna beds, which are most certainly identical with the "Faluns de la Touraine," the type of the Miocene, and older than the Subapennine and Crag beds, which are the type of the Pliocene.

I must, say at the same time, that the name of Crag noir ought not to be employed instead of Sable noir or Système Diestien, because these beds do not correspond, either in age, condition, appearance or contents with the English Crag.

The sub-division of the Sable vert ought to be abandoned, because the greenish colour is caused only by the weathering of the black glauconite of the Sable noir, and because the Sable vert lies sometimes below the Sable noir, and contains, moreover, the same fossils, though generally only in the state of casts, the oysters (*Gryphæa navicularis*) alone having the shell preserved. In short, Mr. Lankester very correctly states the difference of the Système Diestien from the Coralline Crag, and its identity with beds generally reputed to be of Miocene age; an identity first announced by me in 1863.[2] But I have since then found that Professor Reuss, of Vienna (one of the best authorities upon *Foraminifera, Anthozoa,* and *Bryozoa*), had already pointed out (in his paper "On the *Foraminifera,* etc., from the Système Diestien and from the Miocene of the North of Germany), the great analogy between their fauna. The identity of the Sable noir with the beds of Recken and Winterswyk in the South-east of Holland has been long ago recognised by Messrs. Nyst and Bosquet. A few miles from Winterswyk, near Dingden[3] (north of Wesel), there appear black marly sands (not passed through by a well-boring, in a thickness of 120 feet), containing a very rich fauna, quite similar to that of the Système Diestien, but containing, besides

[1] About 40 per cent, it appears. [2] Zeitschr. d. D. Geol. Ges. p. 460.

[3] See Beyrich, "Ueber die Zusammensetzung der Norddeutschen Tertiaerbildungen." Abhandl. der Koenigl. Acad. zu Berlin, 1856.

some other species, peculiar to the Vienna basin and to the Faluns, such as *Murex aquitanicus*, Grat., *M. Partschi*, Hœrnes, etc. About 20 German miles to the east from this place, there are, in numerous places, near Berssenbrück, north of Osnabrück, black sandy and marly clay-deposits of about 160 feet in thickness, with the same fossils repeated. About 30 German miles further to the east-north-east, the black clay once more appears, near Lüneburg, with a similar fauna, and again, about 15 miles from this, a yellow marl, with nearly the same fossils, is met with also near Gühlitz, near Terleberg or Wittenberge (on the railway, mid-way between Berlin and Hamburg). This is the farthest known point of this Miocene basin to the south-east. From thence the Miocene beds spread over the western part of Mecklenburg, where they sometimes occur as hard sandstones, with casts of marine shells (Bokup Reinbeck).[1] In the western part of Holstein, Schleswig, and on the Isle of Sylt, black micaceous clay-deposits appear frequently, with a similar but rather poorer fauna, somewhat more approaching that of the Coralline Crag. In the eastern part of Holstein and Mecklenburg, erratic blocks are frequently met with, containing a richer and older fauna, that is to say of Lower Miocene age.

There has been apparently no direct communication with the Miocene sea in Bohemia and Galicia, the extension of which into Upper Silesia has been explained and illustrated by Professor Beyrich, in his most important work already referred to.

So far for the distribution of the Miocene beds in the North of Germany. As to the fauna, there is yet little known; it is described by Professor Beyrich in his still unfinished work, and in some lists by Mr. Semper. I can only assure English geologists that the fauna much more resembles that of the Vienna basin, and of the Subapennine formation, than that of the English Crag, and of the Système Scaldisien, near Antwerp. It seems quite natural that the Miocene of the North of Germany should contain more Subapennine forms than the Vienna basin, because there has clearly been a migration of many species from the North to the South, as is now generally accepted by most geologists.

Another paper, "On the Kainozoic Formations of Belgium,"[2] has been published last year by Mr. Godwin-Austen, against which Mr. Lankester, Mr. Searles Wood, and others have more or less energetically remonstrated in different papers, especially with regard to some points advanced as to the formation of the English Crag. Mr. Searles Wood, with his long years of experience of the Crag-beds, did not think it possible to admit the theories and many of the observations as to the state and condition of the Crag-sea, as explained by Mr. Godwin-Austen. There cannot be any very strong opposition offered to such a high authority; but as I find that Mr. Godwin-Austen has published a number of observations, made at Antwerp, during his short stay, which have not yet been disputed,

[1] See Koch in Zeitschr. d. D. Geol. Ges. vi. pp 22 and 269; viii. p. 249. Meyr in Zeitschr. d. Deutsch. Geol. Ges. iii. p. 411.

[2] Quart. Journ. Geol. Soc., London, vol. xxii. p. 228. 1866.

I venture to offer a few remarks thereon. I have visited Antwerp upon five separate occasions, in three different years, and have always seen new cuttings in the main ditch at the forts, and in the excavations for a new harbour between the town and the Fort d'Austruweel. I have stayed there altogether above two months collecting a large quantity of fossils, mostly from the untouched beds, and as my observations differ in so many parts from those of Mr. Godwin-Austen, I think it necessary to call attention to, at least, the more important ones, on which he bases his theories. It is most unfortunate that he does not follow in his paper the divisions of the Tertiaries of any of the authors who had already described these beds; and that he does not himself explain where he intends to make these divisions, nor the names by which they shall be called. It is impossible, therefore, to say much about this point; but there are certainly more than two Tertiary horizons. The Barton clay does not correspond in age with the "Rupel clay" (which Mr. Godwin-Austen calls Rupellien clay), as stated by him (p. 234, *op. cit.*). The Tertiary beds of Cassel, Luithorst, Freden, and Diekholz, which he puts into the Upper Kainozoic (p. 241), are older than the Faluns de la Touraine, and coëval with the Grafenberg, near Düsseldorf, and the Sternberg sandstones which he puts (p. 237) into the Tongrien; but the Tongrien of d'Orbigny is not well defined. That of Dumont and that of Ch. Mayer is older than all these. The Faluns of Touraine and most of those of Bordeaux are older than the Crag and the Cotentin according to the opinion of all other geologists, whereas Mr. Godwin-Austen says they were synchronous (p. 239), but without giving any reason for this opinion.

This classification, then, of Mr. Godwin-Austen's, invalidates his otherwise valuable map, because so many different periods are confounded together. As to his theories about the condition of the Crag-sea area, and the origin of its deposits, I cannot agree with him at all, because I have observed many important facts differing very much from those stated by him.

For example, he considers the "Sable noir" as coëval with the Coralline Crag, but thinks it impossible to separate these from the Red Crag and from the Scaldisien (called in Mr. Godwin-Austen's paper "Scaldésien"), because this should "contain only dead and drifted shells," (p. 233), "wholly extraneous to it, belonging to all regions of depth, and all periods of the Crag formation" (p. 238),

The difference of the fauna of the "Sable noir" and of the Coralline Crag is explained by him (p. 238) "by the differences which result from depth and condition of sea-bed," and (p. 241) "taken together both form a complete marine fauna, representing a greater range of sea-zones." The Système Diestien was deposited in thirty to forty fathoms (p. 233), in a maximum thickness of four metres (p. 233), The Système Scaldisien was (p. 232) "heaped up under inconsiderable depths of water," and formed about six feet, but at no place exceeded probably eight feet;" it was a dead shell gravel; "not one of the shells had lived where it is now found."

Now I can assure Mr. Godwin-Austen that the thickness of the different beds is much more considerable. The "Sable jaune" attains, near Deurne, a thickness above fifteen feet; the "Sable gris," in the new harbour (or dock?) between the town and the Fort d'Austruweel, as far as I remember, about twice as much; the "Sable noir; attains six metres near the fort (according to the section of Captain Dèjardin).

I have collected in the Scaldisien beds between Deurne and the Fort d'Austruweel the following species of bivalve shells, in a splendid state of preservation, partly even with the ligament preserved :—*Lingula Dumortieri*, Nyst., *Terebratula grandis*, Blum., *Ostrea edulis*,* *Pecten tigrinus*, Müll., *Pecten opercularis*, L., *Modiola sericea*, Goldf.,* *Pinna* sp., *Leda* sp.,* *Nucula* sp., *Astarte Basteroti*, La Jonk.,* *Astarte Omalii*, La Jonk.,* *Astarte Burtini*, N., *Cyprina islandica*, L., *C. rustica*, Wood,* *Isocardia cor*, L.,* *Artemis exoleta*, *Lucina borealis*,L.,* *Axinus sinuosus*, Sow., * *Tellina Benedenii*, Nyst.,* *Solen*, two sp., *Mya truncata?* L., *Panopœa Menardii? Glycimeris angusta*, L., and many others. My collection and my books being packed up, on account of leaving Berlin in order to settle at Marburg, I am obliged to write down from memory only those species about which I am quite sure. I mark by asterisks the species which were rather common bivalves.

I think there can be no doubt, *first*, that these species *have* lived where I found them; *secondly*, that some of them indicate a much greater depth of water than Mr. Godwin-Austen gives credit for in the Système Scaldisien; and, *thirdly*, that they are not washed out from the Système Diestien, in which, with few exceptions, they do not occur at all.

I have indeed seen, near Deurne, some Scaldisien beds, with numerous broken shells, which undoubtedly were "terrains remanies," *but only by former fortification-works*. A dead-shell gravel might also be seen in a few places, but I have never found any shell in it which was not common in the finer sandy beds in the neighbourhood. Some beds near Deurne, several feet thick, consisted only of fragments of *Pecten grandis*, *P. striatus*, *P. opercularis*, etc.; but the shells had been crushed at that very place, the pieces of every shell lying flat together; there was no clay or sand there to protect them against the pressure of the overlying beds. The deepest cutting I have seen was in the before-mentioned harbour (or dock) near the Guano-magazine, north of the town. There was at the bottom, still, fine grey sand with numerous specimens of *Axinus sinuosus*, and *Modiola sericea*, and other shells, always having both valves. Somewhat higher I have found several *Panopœa*, also, with both valves, and still higher the *Mya*, oysters, *Isocardia*, etc., mostly with both valves.

It is very probable that some Scaldisien beds, particularly of the Sable jaune, in the main ditch, indicate shallow water; but others, particularly of the Sable gris, undoubtedly have been deposited in a similar depth as the Sable noir, so that the difference of fauna between the Scaldisien and the Diestien cannot be explained by difference of depth. I do not think that I have collected a single species in the Système Scaldisien, near Antwerp, that does not occur in the English Crag. There is, therefore, no reason to disbelieve the geological and palæontological evidences, that the Système Diestien is older than the Crag, and that the Système Scaldisien is the exact equivalent of the Crag.

If the Sable jaune (or Sable rouge) resembles more in its fauna the Coralline Crag than the Red Crag, to which it is referable, by reason of its being the upper member of the Scaldisien, that may be explained by the different condition and structure of the Red Crag, which was deposited, apparently, in a more agitated or shallower sea.

As to the Système Diestien I have explained my views before. The scheme, therefore, is this :—

| | | England. | Belgium. | Germany. |
|---|---|---|---|---|
| Pliocene | | Red Crag.<br>Coralline Crag. | Système Scaldisien. { Sable jaune. Sable gris. | |
| Miocene | | | Système Diestien and Boldérien } Sable noir and Iron-sands. | Schleswig.<br>Dingden, Berssenbrück, Lüneburg, Gühlitz, etc. |
| Oligocene. | Upper. | | Elsloo, near Maestricht. | Cassel, Freden, Bünde, Crefeld.<br>Sternberg, Wiepke. |
| Oligocene. | Middle. | Hempstead series<br>Bembridge series. | Système Rupélien.<br>Système Tongrien, super. | Hermsdorf, Söllingen.<br>Stettin, Cassel, Bünde. |
| Oligocene. | Lower. | Headon series.<br>Brockenhurst. | Système Tongrien, inf. | Lattorf, Westeregeln, Urseberg, Helmstädt, Bünde. |

In conclusion, I may say it was most instructive to me to see the different species distributed in the different places, and how each had its peculiar locality. Thus, I remember a place where, in the Sable noir, below the *Pectunculus* bed, there were large numbers of bivalve *Panopæa* to be seen, though very difficult to be got out entire. In another place, near the railway, I collected, at least, fifty examples of *Pecten Brummelii*, Nyst., having a diameter of about four inches, a species reputed very rare by Belgian geologists. It is very unfortunate that the fortification-works are now finished. Last year I could not find a single specimen worth picking up. Let us hope that the fortress of Antwerp may soon become too small for the requirements of Belgium, and that there will be new ditches made around the city to yield future collectors additional examples of these beautiful fossil shells and corals.

## NOTICES OF MEMOIRS.

### I.—On the Arctic Shell-clay of Elie and Errol, Fifeshire, viewed in connection with our other Glacial and more recent Deposits. By the Rev. Thomas Brown, F.R.S.E.

[From the Transactions of the Royal Society of Edinburgh, vol. xxii. part iii.]

AFTER describing in detail several sections in the two localities, the author, by combining the information derived from them, gives in serial order the various deposits, and examines the evidence they supply as to climate and the relative height of sea and land. In descending series the beds are—

1. *The Blown Sand and Raised Beaches.*—The blown sand is in some places from twenty to thirty feet thick, and contains several beds of peat of various thicknesses, some of them containing large numbers of land and fresh-water shells of species now living in the district. The so-called raised beach consists of shingle, sand, and shells, arranged in a confused manner. It was probably deposited on the shore while the sand was forming beyond high-water-mark. It is occasionally eighteen feet thick. The evidence that it is a true raised sea-beach is not decisive.

2. *Sands and Clays with Scrobicularia.*—This consists partly of about a foot of fine clay with numerous specimens of *Scrobularia piperata* in the position in which they lived. The tide runs further up the stream than where this deposit occurs, but the level of high-water-mark is at least fourteen feet below the clay bed. In the brick clays between Stirling and Bridge of Allan, in which skeletons of whales have been found, Dr. McBain has obtained specimens of *Scrobicularia* and also at Portobello, and both these clay beds are at the same height above the present level of the sea as at the Elie deposit. Below the clay there is about six feet of alternating sandy and clayey layers, containing the same species of mollusca as occur on the shores of the Forth at present, showing the climate to have been the same as now.

3. *The submerged Forest.*—This is seen on the shore passing out into the sea. It is four feet in depth, and consists of a mass of peat, in which willow and hazel, and especially hazel-nuts, were found, with other seeds, mosses, and abundant remains of *Arundo Phragmites.* These plants indicate a climate identical with the present.

4. *High-level Gravel and Sand.*—The beds of this stage occur at considerable heights all over the surface of the country, and are entirely destitute of fossils. In some of the gravels are found angular patches of fine sand, which the author supposes to have been frozen masses of sand transported with the gravel; and, if so, giving the first indication in the descending series of the glacial cold.

In the Fife deposits there is, below this gravel, an unconformity which Mr. Brown believes to represent the period during which were deposited—1st, the beds of Fort William and Caithness, investigated by Mr. Peach; 2nd, the Clyde beds, described by Mr. Smith; and

3rd, those of Aberdeen, to which Mr. Jamieson has devoted his attention. These indicate an increasing degree of cold which reaches its climax in the next stage.

5. *The Arctic Shell-clay.*—This is a fine clay in which the following shells have been found. The names are given on the authority of Dr. Otto Törell.

*Buccinum cyaneum.*
*Natica grœnlandica.*
*Turritella erosa* (*polaris*).
*Pecten granlandicus.*
*Crenella decussata.*
*C. nigra.*
*C. lævigata.*
*Leda truncata.*
*L. minuta.*
*Yoldia hyperborea.*
*Y.*, nov. sp.
*Astarte compressa.*
*Nucula inflata.*
*Dacrydium vitreum.*
*Thracia myopsis.*
*T.*, nov. sp.
*Tellina proxima.*
*Saxicava rugosa.*

Not only are all these species now found in arctic seas, but the size of those species which have a wider distribution southwards corresponds with the specimens of them now living in the seas of Greenland and Spitzbergen. The Clay bed is more than forty feet above high-water-mark; the shells are evidently in the Clay in which they lived; and as they are all deep-water species, the level of the land must have been at least 150 or 200 feet lower than it is now.

6. *The Boulder-clay.*—This well-known deposit, both at Errol and Elie, is beneath the Arctic Shell-clay; but, from an examination of their relations, the author believes that, as a whole, they were deposited simultaneously, and that the fossils enumerated represent the life of the Boulder-clay period.

The author considers that these Fife deposits may form the starting point for a more rigorous classification of the superficial beds throughout Scotland. W. C.

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## II.—On a New Cephalaspid. By E. Ray Lankester, Christ Church, Oxford.

[British Association for the Advancement of Science. Dundee, Section C. Geology.]

Mr. Lankester exhibited a diagram of the head of a Cephalaspid, fragments of which had been described by Agassiz as *Plectrodus pustuliferus*. It was remarkable for its long cornua, minute pustular ornamentation, and the dentation of its outer margin. It was probably an *Auchenaspis*, but the posterior 'neck-plates' were deficient. Specimens of the head had been obtained by Mr. Lightbody of Ludlow and Dr. Grindrod of Malvern. Mr. Lankester exhibited a diagram of a restored *Cephalapis*, and noticed the existence of a series of scales forming the broad ventral surface of the body and tail of this genus of fishes. He also noticed the thickening of the margin of the head-shield and the ornamentation of a part of its under surface, showing that this particular part of the concave surface was superficial like the whole of the convex surface, and not covered in by a lower jaw or other plates.

# REVIEWS.

## I.—Note on the Surface-Geology of London; with Lists of Wells and Borings, showing the Thickness of the Superficial Deposits. By William Whitaker, B.A. (Lond.) F.G.S. of the Geological Survey of England.

[Extracted from the Appendix to the Report of the Medical Officer of the Privy Council for 1866.]

IT is an encouraging 'sign of the times' when the Medical Officer of the Privy Council avails himself of the aid of the Geologist in making his report on the Health of the City of London.

The newspapers of the last two years have revealed to us many shocking cases of wells in the metropolitan area which were polluted by sewage to an alarming extent. Even where wells are made in porous strata (such as Alluvium, Brick-earth, Gravel, and Sands), the quantity of "Made Ground and Soil," is often equal to half, and sometimes to two-thirds or more, of the entire depth of the well.

Out of a list of 90 wells, of ascertained depth, 5 were between 40 and 50 feet; 21 were between 30 and 40 feet; 24 were between 20 and 30 feet, whilst 40 were only from 9 to 20 feet in depth. When, notwithstanding all the efforts to the contrary, the sewage of a population like London is daily affecting the subsoil to a greater or less extent, it stands to reason that all superficial sources of water-supply within the town-area must be seriously vitiated by ancient cesspools and other unremoved nuisances which yet haunt many of the poorer suburban quarters of our great city.

In addition to the Tabulated List of Wells in London, there are 15 Tables comprising upwards of 206 ascertained Borings along the various lines of the Metropolitan Main Drainage Works. The collecting and tabulating such data as these, whether it be done by the Officers of the Geological Survey, or by the Engineers, deserves the highest commendation.

We earnestly hope the Director of the Geological Survey may have his hands strengthened so that he shall be enabled to send one of his staff to visit every section and excavation of any extent, and carefully to record the details of the same before it disappears for ever behind brick-work, or is covered with vegetation. How many fine opportunities of obtaining sections in difficult districts have thus been lost! In conclusion, we would express our conviction that Geology should not only form a part of the training of every Civil Engineer, but Contractor's Clerks and Assistants have in many instances shown that they could, if properly trained, make excellent geological observers in the field.

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## II.—Elementary Geology and Elementary Mineralogy. By J. R. Gregory. London, 1867.

UNDER the above titles Mr. Gregory has arranged in book-cases a series of specimens of rocks, fossils, and minerals, with a view of affording the student or traveller the advantage of readily acquiring a practical knowledge of the more common forms with which he ought to be acquainted, or is likely to meet with, as well as to form a useful aid to teachers in public or private schools who may desire to impart to their pupils a knowledge of the elements of geology and mineralogy. The geological series comprises two volumes, each containing twelve specimens, neatly arranged and named with their geological position and localities, one of British rocks, the other of British fossils. The mineralogical series is also contained in two cases, one comprising the earthy minerals from which many important and useful preparations are extracted for use in the arts and manufactures; the other contains the mineral ores from which the metals in general use are extracted. Appended to each volume is a brief description of the different specimens, as well as some general and introductory information useful to those commencing the study for the first time. Thus, under "British rocks," the classification and the chief subdivisions are given; and under "Metallic minerals," the principal characters of minerals and terms used in mineralogy are noticed. Each volume is complete in itself, and the cheap price at which they are produced ought to guarantee for them an extensive circulation.

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## III.—The Microscope in Geology.

UNDER this title we find a very interesting article in the "Popular Science Review" (for October, p. 355), by David Forbes, F.R.S., which so entirely relates to our own special study, that we trust we shall be excused for giving an unusually long notice of it: we only regret being unable to present our readers with copies of the two beautiful plates illustrating the "Microscopical structure of Rocks," which accompanies it. After pointing out the indispensable nature of microscopic inquiry, in order to solve the true character of rock-masses, the author proceeds to describe the best method of preparing sections of rocks of the needful transparency for microscopic investigation.

"The examination," says Mr. Forbes, "of such a rock-section enables a mineralogical analysis to be made, even of the most compact and apparently homogeneous rock, and generally leads to the discovery of other mineral constituents previously unsuspected, from their being invisible to the eye, and also, as Sorby has observed, allows those minerals, formed at the time of solidification of the rock, to be distinguished from such as are the products of subsequent alteration.

Arranging rock species according to their structure, it will be found that most rocks fall naturally into one or other of two great classes—

I. Primary or Eruptive Rocks;
II. Secondary or Sedimentary Rocks;

and it will be seen that the microscope is of special value when applied in cases where the external appearance renders it doubtful as to which of these classes a rock may pertain.

The terms *primary* and *secondary* are here used quite independently of geological chronology. Primary rocks (of all ages) might be called "ingenite or subnate rocks" (*i.e.* such as are born, bred, or created within or below),[1] whilst the term "derivate rocks" would be appropriate for the latter, since directly or indirectly they are all derived from the destruction of the former.

## I. Primary or Eruptive Rocks.

This class includes rocks which have made their appearance in many, if not in all epochs, from the most ancient to the most recent, from the old granitic outbursts to the eruptions of the now active volcanoes; and if, as is now generally admitted, the earth be regarded as having been once a molten sphere, the consolidated original crust of the globe would pertain to this class of rocks.

Mineralogically they consist of crystallised silicates, with or without free quartz, and usually containing many other minerals in minor quantities, especially metallic compounds, as magnetite, titanoferrite, iron pyrites, etc, which last are frequently present in so minute a quantity as only to be detected by the microscope.

Whatever be their geological age, or from whatever part of the earth's surface they be taken, the microscopical inspection of such rocks shows immediately that they possess certain general and definite structural characters, distinguishing them at once from all other rocks.

The mineral constituents of such rocks are seen to be developed as more or less perfect crystals, at all angles to one another, thereby indicating that the entire mass must have been one time in a state of liquidity or solution (aqueous or igneous), sufficient to allow of that freedom of motion absolutely essential to such an arrangement of the particles.[2]

The microscopic examination already made of many hundred sections of eruptive rocks, differing widely in geological age and geographical distribution, shows that in all rocks of this class, whether of the most compact, hard, and homogeneous appearance, or occurring in the softest and finest powder, like the ashes and dust frequently thrown out by volcanoes; a similar crystallised arrangement and structure is present and common to them all. Lavas,

[1] These rocks are indiscriminately called volcanic, igneous, plutonic, crystalline, etc. The term crystalline, although characteristic of these rocks, is not exclusively so, and is consequently less appropriate; many normal sedimentary beds, as rocksalt, gypsum, etc., are perfectly crystalline, and others when altered by metamorphic action, become more or less so.

[2] Experiments show that analogous structure can be produced by at least three different methods, all of which, however, agree in the necessity of the mass being in a state of complete liquefaction previous to crystallisation; from—

1. Their solutions in water or other menstrua.
2. Aqueous fusion or melting of hydrated bodies in their water of crystallisation.
3. Igneous or hydro-igneous fusion.

Crystalline structure may nevertheless develop itself by a molecular movement in solid bodies without change of external form or previous liquefaction; as will be hereafter explained, this is frequently the case in nature. The structure so developed is, however, very distinct from the crystallisation after liquefaction, characteristic of the eruptive rocks.

trachytes, dolerites, diorites, porphyrites, syenites, granites, etc., all possess the same general structural features, serving to distinguish the eruptive rocks as a class from all others.

In the examination and discrimination of the minerals which compose these rocks, especially when close-grained, the microscope is quite indispensable, since without it no such enquiry could be attempted. In these examinations the assistance of polarised light is most valuable; but the space, unfortunately, only allows of a mere mention of its application. In distinguishing dolerites from diorites, when fine-grained (as is often of considerable geological importance), the fibrous structure of the hornblende of the latter is generally so well developed, even when present in very minute quantity, as to distinguish it readily from the augite of the former, which possesses no such structure. Even in the case of Uralite, a mineral characteristic of certain porphyritic rocks, which has the external form of augite, although its chemical composition is that of hornblende, the fibrous structure characteristic of hornblende is distinctly visible. The microscopic structure of some minerals, however, varies with their origin; thus Sorby has shown that the structure of augite, and some other minerals in meteorites, is quite distinct from that of the same minerals occurring in eruptive rocks, and demonstrated, in a very striking manner, how the study of such peculiarities is likely to clear up the mystery in which the origin of these bodies is involved.

When, as is often the case, especially with translucent, colourless minerals like quartz, leucite, calcite, felspar, etc., the appearance presented under the microscope is alike, their optical properties and the use of polarised light afford the means of distinguishing between them with certainty; as, also, in the event of one substance being present under two forms, as calcite from aragonite, monoclinic from triclinic felspars, etc. In a similar manner, the structure, whether crystalline or vitreous, is determined, and valuable information obtained, elucidating the mode of formation and origin of the rocks themselves.

The alterations produced in eruptive rocks subsequent to their solidification, by the action of water, atmospheric, or other agencies, are studied with advantage under the microscope.

In a section given, the skeleton of labradorite is seen remaining as evidence of the original crystallised structure, whilst the interstices contain the products of the alteration of the more easily decomposable augite, the structure of which is nearly obliterated, and part of its lime converted into carbonate. The rock in question is the so-called "white horse" of Staffordshire, found imbedded in, or breaking through the Coal-measures, which are frequently burnt or altered at points of contact with this rock, which itself often has the appearance of a whitish clay. The origin of this rock, whether sedimentary or igneous, was disputed until the more recent geological and chemical examinations of it have proved satisfactorily its identity with the Rowley basaltic rock, very similar to that of Poukhill.

Another section of a crystalline slag, produced in silver smelting, is given for the sake of comparison with the structure of eruptive rocks. In formation it is so nearly identical with what is seen in sections of more felspathic basaltic rocks, the mass of which consists of a framework of interlaced crystals of labradorite with the interstices filled up with the other mineral constituents confusedly crystallised, that this section might easily be mistaken for such. The Rowley rag, when fused and very slowly cooled, presents a similar appearance; and, in general, the structure of crystalline slags presents many features in common with that of ordinary eruptive rocks.

Before proceeding to the next class of rocks, the discovery by Sorby of the numerous minute fluid cavities in the quartz of granites should be alluded to, as proving the great value of the microscope in the study of these rocks. The result of this gentleman's researches [1] proves that granites have solidified at a heat far below the fusing points of their constituent minerals, and at such a pressure as to enable it to entangle and retain a small amount ($\frac{1}{4}$ to $\frac{1}{2}$ per cent.) of aqueous vapour, which naturally must have been present during its liquefaction. The presence of these fluid cavities in the quartz of granite was immediately blazoned forth as proof positive of the non-igneous origin of granite; whereas, if Mr. Sorby's memoir had actually been read, it would have been seen that he had found fluid cavities, perfectly identical with those in granite, not only in the quartz of volcanic rocks, but also in the felspar and nepheline ejected from the crater of Vesuvius, and that the presence of fluid, vapour, gas, and stone cavities, are common both to the volcanic quartz-trachytes and to the oldest granites; and the inference drawn by Mr. Sorby, from the results of his researches, is that both these rocks were formed by identical agencies. He therefore classes them together under one head as rocks of similar origin.[2]

## II. Secondary or Sedimentary Rocks.

The rocks pertaining to this class are all, directly or indirectly, formed from the breaking up, or débris, of previously existing rock, and, for that reason, might, as before-mentioned, not inappropriately be termed derivate rocks. When found in the normal state of sedimentary deposition, they may be conveniently subdivided into—

1. Rocks formed of the immediate products of the breaking-up of eruptive rocks.

[1] Quart. Jour. Geol. Soc., vol. xiv. pp. 453–500.

[2] These researches tend to confirm the theory of the igneous origin of granite and eruptive rocks in general. It must not be forgotten that by *igneous action*, as used by the Plutonist, was always understood *the action of heat as developed in volcanoes* (the study of which was the basis of the theory itself), in which the agency of water was always recognized. Nearly half a century ago, Scrope not only insisted on the important part played by water in volcanic action, but specially pointed out the difference between such volcanic fusion and ordinary melting. The term hydro-igneous action might not be inappropriate for such, but hydro-thermalism does not at all express what is intended. The idea of a true dry fusion in nature exists only in the brains of the ultra-Neptunist or lukewarm hydrothermalist.

2. Rocks built up of the more or less rounded or angular débris of previously existing sedimentary or eruptive rocks.
3. Rocks composed of mineral substances extracted from aqueous solution by crystallisation, precipitation, or the action of organic life.

1. *Rocks composed of the immediate products of the breaking-up of eruptive rocks.*—The little attention paid by geologists in general to the study of rocks of this class, has introduced the elements of confusion into many of their enquiries, and frequently has led to very erroneous opinions being formed as to the nature and origin of certain rocks, which could never have been entertained had microscopic investigation gone hand in hand with field observation.

Rocks of this class may either be of subaërial or subaqueous origin; in the former case, for example, volcanic ashes may have been deposited as beds on the surface of the land, and afterwards been covered by lava streams poured out over them; or, from having been depressed below the sea level, may have had sedimentary beds of aqueous origin subsequently superposed on them.

When of subaqueous origin, as is by far the most common case, subaërial or subaqueous outbursts may force into the sea eruptive rocks, which, being at once broken up into a state of division more or less fine, in proportion to the greater or lesser cooling power of the watery mass in immediate contact, may be spread out into beds by the action of the waves: the texture of these rocks may vary from that of the coarsest breccia down to the finest mud, and, as is usually the case, such deposits may present themselves as alternating beds of coarse and fine character. Upon the consolidation of such formations, rocks are formed, identical in chemical and mineralogical composition with the original eruptive rock from which they were derived, and which, particularly when close-grained, often present an external appearance so like the original rocks as to be frequently undistinguishable from them by the naked eye; in such deposits it is often easy to pick out specimens having all gradations in appearance from the above described down to such as would be attributed to the consolidation of mere detrital mud.

No wonder, therefore, if the field geologist finds himself bewildered under such circumstances, and inclined to settle down in the comfortable belief of the transmutation or transition of sedimentary rocks into eruptive, etc.; even the chemist feels puzzled, when he finds that a rock taken out of apparently normal stratified deposits has the same chemical composition with one of undoubtedly intrusive nature. The microscopic examination, however, soon shows that, however similar the external appearance of two such rocks might be, their internal structure is totally different; showing in the primary rock the crystallised structure and arrangement previously described, whilst the secondary rock is resolved into a mere agglomeration of more or less broken fragments of the same minerals constituting the former. In beds formed from the consolidation of volcanic ashes, the microscopic examination occasionally affords evidence as to whether such ashes had been deposited on land, or had fallen into water.

2. *Rocks built up of the more or less rounded or angular débris of previously existing sedimentary or eruptive rocks.*—Where sufficiently coarse-grained, these rocks constitute ordinary conglomerates, breccias, grits, sandstones, etc., and are easily analysed by the eye; but if fine, as shales, slates, etc., the microscope must be appealed to, in order to resolve them into their constituent mineral or rock particles, and by this means it will be seen that even the most compact and homogeneous specimens are a mere aggregate of more or less rounded and water-worn grains of quartz, weathered felspar, mica, chlorite, soft and hard clays, clay slate, oxide of iron, iron pyrites, carbonate of lime, fragments of fossil organisms, etc., arranged without any trace of decided structure or crystallisation, even when the highest powers of the microscope are employed in their examination. The physical structure and optical properties of the mineral components enable them, however, to be recognised with great certainty, even when in grains of less than $\frac{1}{1000}$ of an inch in diameter.

A section is given of a fine-grained (uncleaved) Silurian clay slate from Sorata, in Bolivia, magnified 400 linear. This rock is composed of irregular grains of quartz sand, weathered felspar, and water-worn mica, along with specks of oxide of iron and iron pyrites, all promiscuously mixed.

In the case of roofing slate, however, the microscope shows that the constituents, instead of being distributed at random throughout the mass, possess a definite arrangement, as may be seen in a section of Lower Silurian roofing slate from the Festiniog quarries, where they are disposed in parallel lines, thus constituting lines of weakness or the cleavage of the slate. The researches of Sharpe and Sorby have conclusively proved that this has not resulted from any chemical or crystalline action whatsoever, the particles being in themselves perfectly unaltered; and that the arrangement is solely due to the effects of pressure, applied at right angles to the structure itself, thereby causing an elongation or flattening out of some, along with a sliding movement of other of the particles. The amount of compression to which an ordinary roofing-slate has been subjected in one direction, has been calculated, approximating from the elongation or distortion of the particles, to be about equal to one-half of its original volume.

Besides the cleavage structure, so produced by the compression of rocks whilst in a more or less plastic state, Mr. Sorby has shown that another system of minute jointing may also be present in these rocks, the serrated edges of which, as seen by the microscope, prove it to have been the result of force applied to the rock subsequently to its having been in a perfectly rigid condition.

Rocks of this class, when somewhat close-grained and much indurated, have not unfrequently, from their external appearance, been mistaken for intrusive rocks: thus an Upper Oolitic, highly-inclined shale-bed, was mapped by D'Orbigny as an eruptive greenstone; but the microscopic structure proves the contrary most conclusively.

3. *Rocks composed of mineral substances extracted from aqueous solution by crystallisation, precipitation, or the action of organic life.*—

Under this class are included most beds of gypsum, rock-salt, and other saline bodies, as well as travertine, silicious sinter, flint, infusorial slates and earths, limestones, etc., many of which have been as yet but very superficially examined.

In the microscopic investigation of such rocks as owe their origin to the developement of organic life, very considerable progress has been made, with correspondingly important and interesting results.

As early as 1836 Ehrenberg proved that large rock masses were built up of the carapaces of minute silicious infusoriæ, and more lately Sorby has done good service by his investigation of limestones: these he has proved not to have originally possessed any crystalline structure whatsoever, but to have been deposited as mere mechanical aggregates (aptly termed by him, organic sands or clays) formed of the débris of calcareous organisms, which admit frequently, not only of being recognised, but of having their relative proportions determined. The comparison of the microscopic structure of the organisms in Chalk, with those now forming in the depths of the Northern Atlantic Ocean, indicates that there is an immense deposit now in the course of formation, quite analogous to what had previously taken place in the seas of the Cretaceous period; and the same able observer has shown that the reason why certain calcareous organisms are found so well preserved, whilst others had disappeared or become entirely disintegrated, was from the carbonate of lime in the first being in the form of the stable calcite, whilst in the latter it was present as instable Aragonite.

When a calcareous rock has undergone cleavage, the microscope shows a distortion of its particles and organisms, just as in a cleaved slate, though in a much less degree; the measurement of such distortion serves as a basis for estimating the amount of compression undergone.

With the exception of having briefly referred to the alterations in igneous rocks, subsequent to their solidification, and the cleavage of sedimentary beds, all the classes of rocks treated of have been considered in their normal or unaltered condition. It remains now to direct attention to the use of the microscope in the study of subsequent alteration or metamorphism of rocks.

Many sedimentary beds become more or less indurated, at points where they are cut through by eruptive dykes; thus the Coal-shales and clays of Staffordshire are found altered into a hard rock with conchoidal fracture, or even into porcellanite, when in immediate contact with basaltic dykes. An examination shows no change in mineral or chemical composition beyond the expulsion of the water always contained in such beds, and sections of such rocks are often seen to be quite identical in structure with those of common stoneware made from the same clays, the only difference being that the latter is usually more porous from not having been submitted to the pressure which rocks baked *in sitû* would experience.

The alteration of rocks produced by infiltration may or may not be accompanied by chemical changes. Thus a section of Calcareous grit often shows that the calcite filling up the interstices between the grains of sand has been merely deposited from a solution of carbonate of lime which has percolated through it, and in otherwise unaltered limestones it is common to find microscopic veins of calc-spar, due to minute cracks or fissures, filled up in a similar manner. Frequently however, such infiltration is accompanied by an entire change in the chemical composition of the rock itself; thus the beds of Cleveland ironstone have been proved by Sorby's microscopical researches to have been originally shell-limestones converted into carbonate of iron by the action of ferruginous solutions, the fragments of the original shells being still distinguishable in all stages of conversion; in the same manner he has proved the Magnesian limestones of the Carboniferous and Devonian ages, as well as the Permian dolomites, to have been originally common limestones, or aggregations of organic débris, the particles of which, by the use of the microscope, can be traced back to their original unaltered state, from which they have been changed by the action of magnesian solutions.

The metamorphism of rocks produced by gasolytic action, as, for example, carbonate into sulphate of lime, etc., has, as yet, not been made the subject of microscopical enquiry.

The foliated schists, quartzites, etc., form by themselves a distinct and well-defined class of metamorphic rocks, characterised by structural peculiarities differing from all previously treated of.

This appears to be due to their crystalline development having originated in a solid body, and not from liquefaction; the minerals composing them differ greatly in structure from the same minerals when found in eruptive rocks. Instead of, as in the latter case, presenting themselves in more or less defined crystals, occurring in all positions and at all angles to one another, in the foliated rocks they are developed only in one general direction, not characterised by well defined bounding planes, but forming a string of drawn-out and irregularly bounded crystalline aggregations, presenting a general parallelism to one another, as seen in a section of hornblende schist from Connemara.

The microscopic examination of these rocks proves their original sedimentary origin, often showing the contours of the original sand grains, and, as Sorby has pointed out, the existence of ripple-drift and wave-structure, peculiar to sedimentary rocks alone. These rocks appear to have been micaceous and argillaceous sandstones, the constituents of which have been re-crystallised *in sitû*, owing to molecular action developed in the solid rock.

The quartz of these schists frequently contains numerous fluid cavities, indicating that they have been exposed to a pressure under which the water, always present in more or less quantity in sedimentary rocks, has been entangled and retained during the re-crystallisation of the quartz.

The direction of the lines of foliation or crystalline development is that of the lines of least resistance in the rock, which commonly will be the lines of stratification, but in cleaved rocks will doubtless be those of cleavage. Sorby has alluded to this fact by the names of "stratification foliation" and "cleavage foliation."

In conclusion, the author of this short sketch hopes that it may be the means of attracting attention to the subject, and thereby of causing a hitherto almost unexplored field of microscopic enquiry to be more cultivated; and leaves it to his readers to form a correct estimate of the justness of the sneering assertion that "mountains should not be looked at through microscopes."

## REPORTS AND PROCEEDINGS.

Norwich Geological Society.—At the monthly meeting of this Society, held at the Museum, on the 3rd of September, the President, the Rev. J. Gunn, in the chair, Mr. Bayfield called the attention of the members to a paragraph, announcing the finding of a buried forest when digging the foundations for a dock at Hull. This would seem to be a continuation of the Norfolk Forest-bed. The President then read the following paper "On Recent Formations in the Valleys of Norfolk." The mode in which the valleys in Norfolk have been formed has been satisfactorily ascertained, and the system may be said to have been worked out. In the valley of the Wensum, for instance, we perceive how the Post-glacial and Glacial beds, the Crag and the Chalk, answer to each other on either side, the intermediate portions having been scooped out by the agency of water, aided by ice and snow, in a colder time than the present. The object of my paper is to point out what has almost escaped observation, namely, the contrary process, the filling up of the lower part of the valleys after they have been formed. That they have been scooped out to a much greater depth than the present level of the marshes, and turbaries within them, can easily be proved by sinking or boring. If this were done in the Thorpe marshes, for instance, or anywhere between Norwich and Yarmouth, we should have to penetrate a considerable depth before we reached the Chalk or the older formations. At Yarmouth, at Sir E. Lacon's brewery, the bore was 170 feet deep before the London Clay was reached. A change, or changes of level must therefore be assumed, in order to account for the erosion having been carried down so far beneath the present level of the water, and, afterwards, the deposit of mud and soil, and the growth of peat 20 feet thick, up to the present water level.

In the valley of the Ant I have observed, wherever a section has been presented by the cutting of dykes and ditches, a substratum of light-coloured, tenacious sandy clay, in which the roots of trees are abundant. It appears to have been the site of an extensive forest, which bordered the ancient river. A fine section of this has been lately shown at Stalham, on the making a boat-dyke from the river to Mr. Cooke's malt-house. The alder and birch appeared to be the prevailing trees. The section showed how this bed was cut off and truncated on the river side by the turbary, without its sinking under it; and on the land side how it apparently passed under the warp and a bed of sand. No trace of shells of any description have been found in this clayey bed; and it has long been a question with me as to whether it belonged to recent river formations or to the older beds of the Middle Drift. From observations on this spot, and also in Irstead, where I have excavated to the depth of ten feet, and found what appears to be the same deposit beneath sand and gravel, I incline to the opinion that this bed is of the older series, down to which the valley was sunk, and which formed the land on which the forest grew.

The trees of this forest appear to have been thrown down by winds or floods, and to have become imbedded in the turbary, which is, in many places, twenty feet deep, and which extensively covers this bed. The oak resembles the Irish bog oak ; it will take a good polish, and is very durable, even when exposed to the air.

With respect to fossil remains, I have not succeeded in finding any, except some bones of a large bird (taken from the sand immediately above the Forest-bed, and which might be part of the valley deposits), and also the jaw of a small carnivorous animal.

On this clayey bed rests a turf deposit, of varying depth—shallow at the sides of the valley, and generally deeper in the centre. In this human bones are not unfrequently found (about eighteen fine specimens of old British skulls were taken from a staithe-dyke, opposite to the one I have already mentioned), and bones of the deer, horse, and ox are not uncommon. Hazel-nuts are frequent, and their immature growth seems to mark the period of the year at which they were imbedded.

With respect to the age of these deposits, the clayey bed—if it belongs to the Middle Drift—would precede any deposit in which relics of man have as yet come to light. With respect to the peat formation, it may be regarded as one of the most recent prior to the historic period. The first vestiges of man, as yet fully ascertained, appear in the oldest of the valley gravels and lacustrine beds. From this peat, which in part filled up the valley after it was hollowed out, querns and celts have been taken, and a bronze spear-head (placed in the Norwich Museum by Mr. Cooke) is supposed to have belonged to it.

Besides the growth of peat, that of estuarine and fluviatile mud may be added, which is from year to year accumulating wherever the water overflows the land and leaves its sediment. This, in our Norfolk broads or lakes, is frequently found to be ten or twenty feet in depth ; but, I believe, not an instance can be shown in which shells are absent from it ; and this appears to me to mark the character of the clayey bed as not being a member of the river valley formation, but of the Middle Drift age. I am not, however, confident on this point, for want of sufficient data.

A communication was next read from Mr. Searles V. Wood, junr., having reference to "the deposits of the old estuary of the Yare," described by Mr. Prestwich as covering the London Clay at Yarmouth, and which were penetrated in a well-boring at Lacon's Brewery,—the report of which is deferred.

## CORRESPONDENCE.

### GREAT TRAP-DYKES AND REMAINS OF AN ANCIENT FOREST IN SKYE.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—Having just returned from a trip in Skye, there are two points I wish to draw the attention of your readers to. The ancient forest of the Highlands and the great trap-dykes of the district.

You favoured me last year with the insertion in your MAGAZINE of my views respecting the ancient forest. I subsequently found them, in great measure, confirmed by Mr. Geikie. I sought in vain in the peat-bogs of Skye, in the Sligachan district, amongst the Cuchullin Hills, for remains of this forest; but found them beautifully exhibited at Kyleaton.[1] It is everywhere hidden under beds of peat, until the peat-diggers expose them; then the stools are seen standing up two to three feet high, so hardened by the action of bog-water, that vain is the attempt to cut them, and, as a rule, they are left behind, rooted in the gravel in which they grew—the gravel-bed of Scotland—here covered up with that interloper peat, in which no trees can live. I am therefore confirmed in the view before expressed, that the destruction of the ancient forest is owing to climatal changes of great antiquity. I was desirous of ascertaining the species of fir to which these stools belong. At last the quick eye of my brother, a botanist, saw the cones spread around two of the stools; the peat had preserved them as it preserves the wood, and the roots of bog-plants; they expanded, in drying, like recent cones of Scotch fir. I could discover no difference between them and recent Scotch fir, and therefore consider the trees were of the indigenous conifer of Scotland, now existing. There seems no reason why they should not be preserved in localities where peat did not grow, or where they were not exposed to the violence of the western winds.

Skye, like all other Islands of the western sea of Scotland, as shown by Sir R. Murchison's sketch-map, is chiefly composed of eruptive rocks, which consist of two kinds, the more considerable and ancient, due to that great development which raised the Cuchullins greater hills 3,200 feet at Scuir-na-Gillean, and the much later, or trap-dykes. The first of unknown primeval age, to which we may assume we owe the earliest elevation of the land above the sea; which lifted mountain ranges as well as the younger strata, modified by denudation of the ocean, and no doubt since moulded by atmospheric agencies. These major mountains of Skye are composed of what is called Hypersthene, and are distinguishable from others by their hardness, and by their aiguille points, which nothing alters. They throw down no débris from age to age, but shoot off the rains of the Atlantic at once, as from the roof of a house. The flanks of Scuir-na-Gillean present the appearance of

[1] Kyle-Rhea, or Kyle Akin?—EDIT.

lava-currents, great sheets of which may be seen descending to the sea-shore, where they are sometimes thrown up in rugged masses, as though acted on by the sea-water when in a state of fusion, as may now be seen in Sicily.

Next to these most ancient rocks come the lower hills, whose origin we assign to a somewhat later period, when the volcanic action was dying out: these are composed of materials readily acted on by the atmosphere, and are thus shaven into cones. I must now refer to the trap dykes. Every geologist who has studied the Western Highlands well knows the great area which has been subjected to volcanic action at a comparatively late period. In the low grounds, in the beds of rivers, and on the sea shore, we find trap-dykes, from one inch to several feet in width, passing through the more ancient beds, into which various qualities of trap have been injected. This appears to me to have been the subsiding action of the great elevatory force, and it is interesting to find it extending in Scotland up to the Tertiary period, for Skye offers at Broadford most interesting examples of trap-dykes traversing the Lias limestone.

I will only add, that subsequently to the periods referred to, came that universal surface action by which all Scotland and the North of England have been covered with gravel beds—a subject deserving deep and persistent enquiry. In these beds the primeval forest grew, which, in its turn, has been buried beneath peat or soil, the surface of which is now adorned with the flora of our modern time.

Yours,

THOS. C. BROWN.

FURTHER BARTON, CIRENCESTER,
*7th September*, 1867.

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## THE ORIGIN OF GRANITE.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—I am glad to see "the origin of granite" is likely to crop up as a result of Dr. Sterry Hunt's Lecture "On the Chemistry of the Primeval Earth," which has been so ably commented on in the last number of the GEOLOGICAL MAGAZINE by Mr. David Forbes. There has been so much "Denudation" of late, both marine and atmospheric, that we need not be surprised if a deep-seated rock, like granite, is laid bare, and at last appears on the surface in the field of geological discussion.

At the recent meeting of the British Association in Dundee, Professor Ansted communicated a paper "On the Conversion of Stratified Rock into Granite in the North of Corsica." I took part in the discussion which ensued; but as my remarks, together with those of Sir Charles Lyell and Mr. Geikie, were reported thus—"Some discussion followed the reading of the paper," while those of Professors Phillips and Ramsay were merely noticed, I venture to ask you to have the kindness to permit me to re-state in the pages of the GEOLOGICAL MAGAZINE, as briefly as possible, the substance of what I said on that occasion.

Professor Ansted entered into some wide generalizations favouring the metamorphic origin of granite. I happen to reside in a district where the intrusive character of that rock is particularly well shewn, and I could hardly allow his views to pass unquestioned. There is in this country the largest exposure, and perhaps the greatest variety, of granite in the British Islands, and I trust that a short account of my observations, which have been made with some care, may not be without interest.

There are four large tracts of granite in Ireland—(1) The Leinster district, ranging from Dublin, through Wicklow, into Wexford; (2) the Mourne Mountain district, in the Co. Down; (3) the Donegal district; and (4) the Connaught district. Granite also occurs in smaller masses in other parts of this country.

The Leinster granite (1) is unquestionably intrusive; it penetrates into Lower Silurian Slates, which are everywhere altered into mica-schist as they approach it, and are pierced by numerous granitic dykes. The Mourne granite (2) has a similar character, though the metamorphism of the surrounding rocks is not so extensive as in Leinster: it is supposed to be a newer rock than that of Leinster, being believed to be post-Carboniferous.[1] The Donegal (3) and Connaught (4) granites are of a totally different character. They are essentially of a metamorphic type, being bedded and, in Donegal, interstratified with limestone;[2] they do not intrude into, but form part of the great mass of gneiss, schist, quartz-rock, and limestone among which they occur.[3]

If two geologists were to set to work to investigate the origin of granite, and if one were to locate himself in Leinster and the other in Donegal, the Leinster geologist could bring forward the most convincing proofs of the intrusive character of granite, while the Donegal observer could produce equally conclusive arguments in favour of its metamorphic nature.

I am at a loss to understand how any one could explain the Leinster granite by the metamorphic theory, yet the Donegal rock appears to be but an instance of an advanced or perfected stage of that metamorphic action which is less fully developed in the varieties of gneiss. Any geologist who has examined gneissose districts may

[1] Jukes, "Student's Manual of Geology," pp. 93 and 313. I think, however, further proof is required as to its being of the same age as the rock which alters the Carboniferous Limestone near Carlingford: it rather differs in appearance and mineral composition from the Leinster granite, containing other micas, and notably by the occurrence in some places of albite (Haughton, Quart. Journ. Geol. Soc. vols. xii. and xiv.), though I believe that this feldspar is not so important a constituent as has been supposed.

[2] Brit. Assoc. Report, 1863; Scott, Journ. Geol. Soc. Dublin, vols. ix. and x. See also Haughton, "On Granites of Donegal," Quart. Journ. Geol. Soc., vols. xviii. and xx.

[3] There can be little doubt that some intrusive granites do occur in Donegal and perhaps largely in Connaught: we require further information on this point; a red patch on a map, lettered G for granite, does not teach us much.

["Stratified eruptive rocks." See Forbes, "The Microscope in Geology," in this number, p. 515.—Edit.]

remember to have seen true gneiss which, in a hand specimen, it would be impossible to distinguish from granite.

Now I ask—Are we to suppose that, notwithstanding the vast difference between their modes of occurrence in the field, the granites of Leinster, and the granitoid rocks of Donegal must have had a like origin, merely because they have a *somewhat* similar mineral composition, both containing quartz, feldspar, and mica?

But have these rocks an identical mineral composition? So far as my experience goes, most assuredly not. They vary in appearance, texture, and mode of aggregation of the component minerals; the quartz has a different look, difficult to describe, but once seen and observed, not easily to be forgotten; but above all, they differ widely in their feldspathic constituents, for while the intrusive granites are orthoclasic or, as in Down, sometimes albitic (and, let it be remembered, albite is as highly silicated as orthoclase), and the uncrystallized feldspathic paste is always highly silicated, the granitoid rocks on the other hand contain, notwithstanding the presence of free quartz, a large proportion of basic feldspars, of which oligoclase is the most recognizable, and the feldspathic paste is basic also, approaching oligoclase or anorthosite[1] in composition.

During a recent visit to Scotland I had these views fully confirmed by the facts which I observed there. The intrusive granites of Arran are extremely like those of the Mourne district, while many of the Highland rocks appear to pertain to the metamorphic type. As my visit was very hurried, I cannot now commit myself to details; neither shall I say anything of the intrusive and metamorphic characters of the hornblendic series of rocks, such as greenstones, syenites, and hornblendic schists.

The views now put forward are only suggestive: my field of observation has been too limited to warrant my entering into generalizations, but I trust they will tend to elicit further opinion on this important subject. So long as our knowledge is added to, it matters little whether these views are corroborated or refuted by such investigators as Forbes, Haughton, Hunt, and Sorby, men who combine the highest chemico-mineralogical attainments with great knowledge of physical geology, accomplishments which unfortunately do not often co-exist in the same individual.

In conclusion, I think the last passages of Mr. Forbes's paper (Geol. Mag. Vol. IV. pp. 442—444), deserve the serious attention of every one who may be inclined to go in for the metamorphic origin of *all* granite.

I am, Sir, your obedient servant,

W. H. Stacpoole Westropp.

Blackrock, Dublin, *October 5th*, 1867.

Since writing the above, I have looked into Haughton's Manual of Geology, and find that I have been anticipated in suggesting a two-fold origin for granite. In that work (p. 45) the terms hydro-metamorphic and pyro-metamorphic are proposed. I fear that the

[1] Geol. Report, Canada, 1854; and Bigsby, Geol. Mag. Vol. I. p. 157.

latter word smacks of the old "dry fusion" theory, though, as every one knows, Professor Haughton's speculations are anything but *dry*.

FORBES.—CHEMISTRY OF THE PRIMEVAL EARTH.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—Under this heading, page 434 of your October number, are these words, "Hutton, the propounder of the plutonic theory of the world's origin, which assumed the world to have been at one time a sphere of molten matter solidified by refrigeration."

I think that there must be some great mistake here. I do not think that Hutton would attempt to lift the veil of Isis, or to account for the "*world's origin*" at all, or for the "*origin*" of anything whatever, animate or inanimate; not even for the "*origin*" of the smallest particle of matter. His word is "no sign of a *beginning*, no prospect of an end."

I have, indeed, never had access to Hutton's work; but I have by me Playfair's illustrations of it, Edinburgh, 1802, and he totally repudiates the idea of the original fusion of the globe, either igneous or aqueous, partial or entire. The igneous theory he imputes (while he controverts it) to Buffon. Page 136, section 132, and note xxv. Playfair accounts for the orange shape of the globe by a most beautiful theory of his own, entirely dependent on Hutton's doctrines, and therefore entirely dependent on rain and rivers.

The principles which poise the *universe* are as simple as they are sublime; and it is not only, as Professor Jukes remarks in your last number (p. 144), that "the form of the ground" depends on rain and rivers, but, as Playfair says, the statical figure of the globe itself,—the spheroid of equilibrium depends on rain and rivers, on causes now in operation. Those who have not access to Playfair's work may see his beautiful theory as to this clumsily explained by me in the eleventh chapter of "Rain and Rivers."

I have the honour to be, Sir, your most obedient and most obliged servant,

GEORGE GREENWOOD, Colonel.

BROOKWOOD PARK, ALRESFORD,
*4th October*, 1867.

THE CHEMISTRY OF THE PRIMEVAL EARTH.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—I hope the space at your disposal will admit of the insertion of a few remarks in reply to Dr. Sterry Hunt's letter, on page 478, and in defence of my report of his lecture "On the Chemistry of the Primeval Earth:" (GEOL. MAG., p. 357).

Dr. Sterry Hunt's communication must not be allowed to mislead you or your readers into the belief that I am responsible for the twenty *errata* which have been tabulated in the two published lists, (pages 432 and 478), for, in fact, *only four* of these mistakes have originated with me. Of these four I am perfectly willing to bear the blame. The first occurs in the passage (page 361) relating to the fusing point of certain bodies being augmented by pressure. In taking down this sentence from the lecturer's lips, I was in some doubt as to the words used, and I recorded those which I understood him to utter. You, however, have set the passage right by means of a very simple alteration. My second error was the substitution of the word *decomposed* for *recomposed.* This obviously arose from similarity of sounds. On page 367, the letter "p" is inserted in Professor Thomson's name, but I find that Dr. Sterry Hunt has himself committed the same mistake in the report of his lecture in the *Chemical News.* My fourth error is the substitution of the word *ault* for *coal.* This occurred in transcribing my notes.

Of the other *errata,* three are what are familiarly termed "printers' blunders." They consist of the substitution of the words *seven* for *several, orchid* for *orchard,* and *mutation* for *nutation.* These might have been avoided if I had seen a proof before the Magazine went to press.

The remaining thirteen corrections are, in reality, emendations of the lecturer's own words, and departures from the actual language of the lecture. These errors are, for the most part, only such as are common to unwritten discourses; but they cannot, as Dr. Sterry Hunt would imply, be with any fairness classed under his description of "mistakes into which the reporter has fallen;" and I must beg leave to protest against being held responsible for the lecturer's own inaccuracies of expression.

If Dr. Hunt prefers the version of his lecture given in the *Chemical News,* it cannot be because it approaches more nearly to what he actually said than the version which you have published. If the *Chemical News* report was founded upon shorthand notes at all, the author has performed the work of revision so vigorously that the original transcript has disappeared.

I am, Sir, obediently yours,

The Shorthand Writer.

London, *October* 17*th,* 1867.

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## SHELLS ON THE GREAT ORMESHEAD.

*To the Editor of the* Geological Magazine.

Dear Sir,—Owing to my absence from Cambridge, I have only lately seen Mr. Maw's letter, in the August number of the Magazine. The shells which I found at Gwydfyd were by no means in such numbers, or in such a condition, as to suggest to me the idea that I was on a kitchen-midden. If that be the case, they are very different to those in the kitchen-middens on the N.W. side, and, though I cannot speak positively, I am disposed still to adhere to my original opinion. Yours very truly,

T. G. Bonney.

St. John's College, Cambridge.

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## NOTE ON THE CONTENTS OF THE POCKETS IN THE CARBONIFEROUS LIMESTONE AT LLANDUDNO.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—An examination of the contents of the pockets in the Carboniferous Limestone near Llandudno has brought to light some few fossils that may tend towards solving the problem of the origin of these curious accumulations. A reference to Mr. Maw's paper on the same subject in Vol. II., No. 4, of the GEOL. MAG., will give a clear description of the general character and position of the deposits. Those which I examined are three in number: one near the Little Orme, at Nant y Gamer, and two on the Great Orme, close to Wyddfyd Farm. At the former locality there are two large pockets known; one of these, the upper one, is now nearly emptied and is abandoned, the other is an open pit of considerable size, reached by an adit driven in the hill-side through the Boulder-clay drift and the limestone rock beneath. This pit contains, immediately beneath the drift and sharply contrasting with it, some ten yards of beautifully white sand, mixed in places with equally white clay; the clay is also here and there variegated with red; it forms the floor of one side of the pit, and its thickness has not been ascertained. In the sand there is in one place a thickish kind of vein, consisting for the greater part of oxide of manganese; it is amorphous and pulverulent; this is said to extend beneath the floor to a depth not yet known. On looking over the clays and sands in this pocket I found traces of fossils, chiefly in the former; portions of Encrinites were tolerably plentiful, apparently derived from the Carboniferous Limestone, the other fossils were not so distinct, but may be parts of Producti; they were very fragile. The white clay was in places filled with pieces of white chert, and some of the fossils may have come from this, as I have no doubt this chert and that also at the base of the Boulder clay on the shore, is derived from the Limestone, although I could find none *in situ* in the neighbourhood. Some of the Limestone forming the walls of the now abandoned pocket is very curiously banded with white and red; it is rather shaly or fissile, and is also here and there slightly silicious; it contains many crinoidal and other fossil remains. How far back towards the old pocket the lower one may extend is not yet known; it is not improbable that the two may be connected.

On examining the deposits of fire-clay with sand and chert at Wyddfyd Farm, I found in the sand, or rather sandy clay, which overlies the thick clay, very numerous pieces of chert, some of large size; these undoubtedly belong to the Carboniferous Limestone, for they are crammed with casts of Encrinites, and resemble closely what in Derbyshire are called "Screw-stones." The chert is whitish or drab, but is often very much decomposed and yellowish, and crumbles very readily into a kind of sand. Is it impossible that the sands in the pockets may thus have had their origin? The sand a little beyond Wyddfyd Farm contains very many joints of Encrinites, besides traces of other fossils. One piece of sand, I found, has a tolerably distinct impression of a fossil shell in it, which may perhaps be sufficiently distinct to enable its name to be ascertained. Fragments of Carboniferous Limestone were not uncommon in this sand-pit. From its position it is not easy to say for certain whether it overlies or underlies the clays at Wyddfyd Farm. It has been dug into to a depth of some eight or nine feet. I have sent specimens of all the above-mentioned deposits, in the hope they may throw some little light upon their origin.

J. M. Mello.

St. Thomas' Parsonage,
Brampton, Chesterfield.

## MISCELLANEOUS.

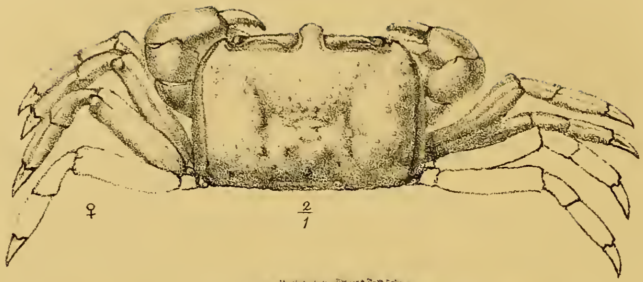
Discovery of a Mew Mineral ("Crookesite").—Whilst examining the seleniferous minerals from the Skrikerum mine, in Sweden, M. Nordenskiold has discovered that thallium exists in small quantities in eucairite ( (Cu Ag) Se) and berzelianite (Cu Se). Continuing his researches among these selenides, in Mosander's collection, he has found a mineral which contains from seventeen to nineteen per cent. of this metal. It occurs in small opaque masses, having a metallic lustre and lead-grey colour, mixed with the grains of eucairite and berzelianite. From these it is easily separated, and on analysis gives the formula (Cu, Tl, Ag) Se. Density = 6·9. No crystalline faces yet observed. Before the blowpipe it fuses easily into a shining greenish-black enamel, and the flame is coloured intensely green. Insoluble in hydrochloric acid, but nitric acid dissolves it completely. M. Nordenskiold has named this new mineral "Crookesite," after the well-known discoverer of thallium. But few specimens have been yet found of Crookesite, but M. Nordenskiold hopes to obtain more by carefully searching the Skrikerum mine, which has been for some time abandoned.—T.D.

A King-Crab in the Upper Silurian.—Among the fossils exhibited by Mr. Robert Slimon at the meeting of the British Association in Dundee, and collected by him at Lesmahagow, in Lanarkshire, was a minute form of Crustacean, nearly allied to *Belinurus*, in which all the body segments appeared to be free and unanchylosed. In calling attention to this beautiful little fossil, Mr. Woodward pointed out the great interest attaching to its discovery, as being the oldest representative of the *Xiphosura*, or King-Crabs, known, carrying this division back in time from the Coal-Measures to the Upper Silurian.

Erratum in Mr. Forbes' Article in the October Number.

On p. 443, in footnote, in line 21 from foot of page, for "before," read *after*.

1.



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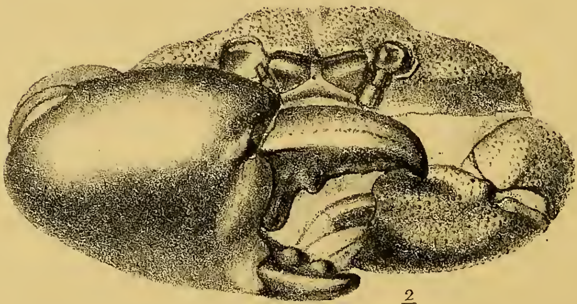

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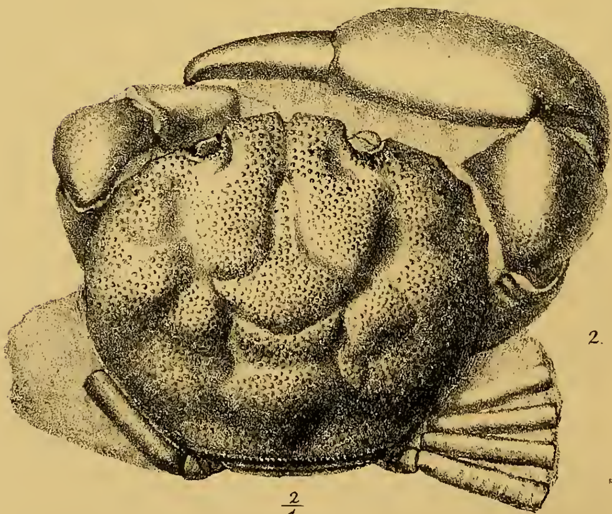

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A. T. Hollick del. W West imp.

*New Genera of Crustacea from the London & Plastic Clays.*

THE

# GEOLOGICAL MAGAZINE.

No. XLII.—DECEMBER, 1867.

## ORIGINAL ARTICLES.

### I.—On a New Genus of Shore-crab, *Goniocypoda Edwardsi.* from the Lower Eocene of Hampshire.[1]

By Henry Woodward, F.G.S., F.Z.S., etc.

(PLATE XXI. Fig. 1.)

ONE of the characteristic features of the warmer and intertropical regions of the globe, is the presence in abundance of those highest forms of Crustacea, the Shore- and Land-crabs.

Along our own coast, the common shore-crab, *Carcinus mœnas,* prevails; on the coast of Spain the genus *Grapsus* is equally abundant; whilst in the Eastern seas the shores are tenanted by *Gelasimus, Macrophthalmus,* and *Ocypoda.*

Among the Decapodous Crustacea which have rewarded the labours of the palæontologist, and furnished materials for Monographs by Professors Bell, Reuss, A. Milne-Edwards, and others, no fossil remains of the Quadrangular Crabs have hitherto been recorded as occurring either in this country or on the Continent.

So long ago, however, as 1822, M. Desmarest[2] had figured and described one species of *Grapsus,* five species of *Gonoplax,*[3] one species of *Gelasimus,* and one of *Gecarcinus,* which were probably all from India and China (although the history of some was unknown); for fossil crabs of these species are still sold in the Bazaars of the East as a medicine.[4] It is highly interesting, therefore, to record the occurrence, in the fossil state, of a true shore-crab, near to *Ocypoda,* from the Red Marl of the Plastic-clay, of High Cliff, Hampshire.

These Plastic or mottled clays and sands, which lie immediately below the London Clay, contain many subdivisions representing repeated changes in the conditions under which they were deposited,

[1] This new species was noticed by the author at the Dundee Meeting of the British Association.

[2] Brongniart and Desmarest, Histoire Naturelle des Crustaces Fossiles. 1822.

[3] Prof. Dr. A. Reuss. Zur Kenntniss fossiler Krabben in Denkschriften der K. Akad. d. Wissensch. Mathem. natur w. cl. xvii. Bd. Vienna, 1859. Taf. xx. and xxiii., p. 82 has figured and described four species of *Macrophthalmus* from the East Indies and Molucca.

[4] See Notes on Chinese *Materia Medica,* by Daniel Hanbury, F.L.S. (Reprinted from the Pharmaceutical Journal, February, 1862, and other numbers), p. 40. "*Shih-heae,*" Fossil Crabs of the Post-Tertiary period, obtained from the Island of Hainan and on the opposite shores of Kwang-si.

sometimes—as their contained fossils prove—marine conditions prevailed, at another freshwater, at a third estuarine. But whatever these conditions were, the contained organic remains indicate a warmer climate than is enjoyed by us in the same latitude at the present day.

The Crab which forms the subject of these remarks was collected by Mr. B. Porter, and now forms a part of the geological collection in the British Musuem. It is preserved in a small slab of Red Marl or Clay, having the dorsal aspect exposed to view. The counterpart or intaglio is also preserved, and affords some additional details.

*Diagnosis of the genus Goniocypoda.*—Carapace quadrangular, nearly one-third broader than long, tumid, borders rounded, surface granulated sparingly, regions of carapace but little distinct from each other; lateral border of carapace entire, deep, forming nearly a right angle with dorsal surface, posterior border straight, anterior angles curving inwards and terminating in the external orbital angle: rostrum small, square: front border of carapace nearly straight and occupied by the orbital fossæ; eye-stalks long: fore-arms short, feeble; thigh of walking-legs broad and flattened, and slightly serrated at distal end: feet formed for running. (The Abdomen and antennæ, if present, are concealed in the matrix).

I have carefully compared this Eocene Crustacean with *Grapsus, Gonoplax, Macrophthalmus, Gelasimus*, and *Ocypoda*. It differs from *Grapsus* in the absence of dentations on the latero-anterior border, in the greater lateral breadth of the carapace behind, and in the greater length of the eye-stalks. It approaches *Grapsus* only in the form of the limbs, and the smallness of the hands. *Goniocypoda* is distinguished from *Gonoplax* by the more rectangular form of the lateral and posterior borders, and by its short, somewhat thick hands and chelæ.

From *Gelasimus* and *Gonoplax* it also differs, in having the latero-anterior angles of the carapace curved in towards the external orbital angle. Compared with *Macrophthalmus* the relative proportions of the length and breadth of the carapace are much the same; but *Goniocypoda* differs from *Macrophthalmus* in the same point as it does from *Gonoplax* and *Grapsus*; namely, in the absence, in the fossil, of dentations along the latero-anterior border.

The form of the rostrum closely corresponds with *Macrophthalmus* and *Ocypoda;* and in both genera the orbital fossæ occupy the whole breadth of the front of the carapace; they are much curved in the two recent genera, but nearly straight in the fossil. The carapace in *Ocypoda* is almost equilateral, in *Goniocypoda* it is one-third broader than long.

*Goniocypoda Edwardsi* (Pl. XXI. Fig. 1.)—This neat little crab, is smaller than the *Macrophthalmus dilatatus* of De Haan, the carapace being eight lines in greatest breadth, and five lines only in length: the rostrum is only one line in width, and projects the same distance in front, being bent downwards as in *Ocypoda:* the eye-peduncles are two lines in length, and are but slightly curved: the external orbital angle is marked by a strong incurving spine, which also forms the latero-anterior angle of the carapace.

As is the case with all land- and shore-dwelling crabs the carapace is much swollen, especially in the branchial regions: the cardiac region is marked by four faint tubercles, the gastric by two lateral depressions marking the line of separation between the gastric and branchial regions; with these exceptions and a few scattered granulations on the surface, the carapace is destitute of any well-marked surface-features or divisions into regions. The fore-limbs are nearly equal in size, the arm is almost entirely concealed beneath the carapace, and is very short; the fore-arm is tumid, and is not ornamented with spines along its border: the hand is short and smooth; the fixed ramus and moveable finger being furnished with three or four small teeth along their edges. Three of the true walking legs are preserved on the left and two on the right side; outlines of the absent limbs are given in the figure. As before stated, in form, these limbs closely resemble those of the *Grapsidæ*.

I have failed in my attempt to work out the underside by reason of the exceeding fragile nature of the fossil; but I have no doubt the specimen here described and figured was a female; indeed there is evidence of the first wide abdominal segment behind the posterior border of the carapace. The smallness of the hands would also confirm this view, as in most, if not in all the quadrangular crabs, the male has one or both hands large and well-developed, whilst those of the adult female remain small and feeble.

From the nature of the fossil, I am necessarily unable to offer more than a very incomplete description of *Goniocypoda*, but I think the occurrence of such a rare Crustacean novelty is a sufficient excuse for placing it on record, in the hope that more perfect remains may thus be brought to light.

I have designated it *Goniocypoda Edwardsi*, after MM. Drs. Henry and Alphonse Milne-Edwards, who have by their labours done so much to advance the study of recent and fossil Crustacea in Europe, and for whom I entertain personally so high an esteem.

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## II.—On *Necrozius Bowerbankii*, a new Genus of *Canceridæ* from the London Clay.[1]

By Professor Alphonse Milne-Edwards, D.Sc., M.D., etc., etc.

(PLATE XXI., Figs. 2 and 3).

On the genus *Necrozius*.—This new genus is very near to *Ozius*, and is still more near to a small genus, established a few years since by M. Stimpson, named *Spherozius*. Like this last-named form, the carapace of *Necrozius* is remarkable for its globular form, its width scarcely surpassing its length. The curve of the buckler is slight in a transverse direction, but is great from back to front, the anterior

[1] Translated from the "Histoire des Crustacés Podophthalmaires Fossiles," par Alphonse Milne-Edwards: (Reprinted from the Annales des sciences Naturelle. Tom. xviii., 4te series, pp. 297). Paris, 1865.

border being much curved down. The latero-anterior borders are continuous, almost without interruption, with the latero-posterior, which latter are swollen. The frontal border (rostrum) projects a little, and is slightly depressed in the centre. The basal joint of the internal antennæ is large, and it is articulated obliquely beneath the front (rostrum). The basal joint of the external antennæ is short, not reaching to the front as in the *Pseudozius* of Dana, and in *Spherozius* of Stimpson; the articulation is free and is not lodged in the internal obital cavity. With *Ozius* on the contrary, this basal joint is fully attached to the front.

I have unfortunately been unable to examine the endostome, so that I could not determine the characters shown by the absence or presence of the tubercles (*crêtes*) which, in *Ozius*, are confined to the neighbourhood of the expiratory canal of the branchial chamber. The labial border was also concealed by the matrix, as are certain parts of the specimen between the hands, so that I have been unable to see if the border was complete, or sloped off as in *Ozius*.

The anterior feet are very strong, and unequal in size, the smallest being only half the size of the largest, their proportions and appearance enabling one at once to distinguish the crustaceans of this section.

The walking feet are cylindrical; they are not tuberculated, and in this latter respect they resemble those of *Ozius*, *Spherozius*, and *Pseudozius*. The abdomen in the male, as in the three preceding genera, is composed of seven segments, all of which are free.

This genus, as we have already said, is very near to *Spherozius*. The basal joint of the external antennæ in *Ozius* reaches the front; in *Pseudozius*, *Spherozius*, *Necrozius*, it is distant from it. *Pseudozius* has a rather elongated carapace, while in *Spherozius* the carapace is more globular. This last genus differs from *Necrozius* in having a more swollen carapace, and the front is continuous, without interruption, by an insensible curve with the superior orbital border; in *Necrozius*, on the contrary, the internal orbital angles are well marked.

*Necrozius Bowerbankii, Alph. Milne-Edwards.*—This pretty species is from the London Clay of the Isle of Sheppey, which has furnished so many interesting crustaceans.[1] It formed a part of the rich collection of Dr. J. S. Bowerbank, who, with his accustomed scientific liberality, obligingly placed it at my disposal.[2]

This crab appears to be extremely rare, for Professor Bell does not notice it among the Crustacea of the London Clay, and I have never seen but this single specimen, perfectly preserved it is true, although I have examined the collections of the British Museum, the Museum of Practical Geology, and many others almost as rich.

*Description of the Species.* — The carapace is closely covered on all the salient parts with minute rounded granulations. The

[1] [The specimen here referred to, and which is figured in our plate (Plate XXI. figs. 2 and 3), was obtained some years since by Dr. J. S. Bowerbank, F.R.S., from the London Clay, Holloway, when the Great Northern Railway was in course of construction. Two less perfect specimens have, however, since been obtained from Sheppey.—H.W.]

[2] [The type-specimen here figured is now in the British Museum.—H. W.]

furrows which separate the various parts are smooth. These latter, without being very salient, are plainly indicated. On the gastric region, the epigastric lobes are not distinct from the protogastric; the mesogastric stretches from a point between these to the middle slope of the front. The metagastric lobe is distinct from the urogastric. The branchio-cardiac furrow is strongly marked. The cardiac region is rounded and gently sloped off in the rear. The hepatic regions are separated from the branchial by a shallow depression; the latter are rather swollen, and show an ill-defined lobule near the urogastric lobe.

The latero-anterior borders of the carapace are thick; they exhibit in the midst of the granulations which cover them, three or four little tubercles scarcely larger than the granulations themselves.

The external orbital angle does not project in the form of a tooth. The orbits are very small and point directly forward. The superciliary arch is well marked, and has no fissure. The front (rostrum) juts forward straight and is furrowed down the centre. The pterygostomian regions are finely granulated.

The anterior feet are unequal, the fore-arm shows a small blunt projection within, on the outer side it is smooth: the large hand is smooth both above and below, and is not tuberculated; the fingers are short and thick, the thumb is ornamented near its base with a strong tooth, the fore-finger has two rounded teeth. The small hand is finely granulated or rather roughened, the fingers are slender and longer in proportion than those of the large hand. The walking feet are smooth, having neither granulations nor tubercles. The various parts of the sternal plastron are granulous. All the rings of the abdomen are free, as we have already said, in describing the characters of the genus.

EXPLANATION OF PLATE XXI. Figs. 2 & 3.

Fig. 2. Dorsal aspect of *Necrozius Bowerbankii*, A. Milne-Edwards; twice nat. size.

„ 3. Front view of same, showing the Orbital and Antennary fossæ and the chelæ; twice nat. size.

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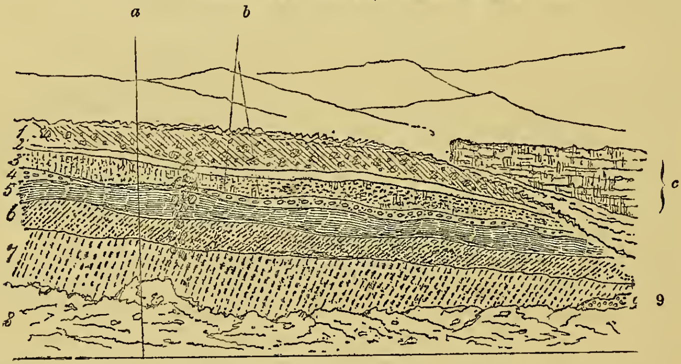
## III.—The Kitchen Middens at Llandudno.

By the Rev. J. M. Mello, M.A., F.G.S., etc.

A WEEK or two spent last month at Llandudno has given me the opportunity of examining the deposits on the Great Orme's Head, described by the Rev. T. G. Bonney in the August number of the Geological Magazine, and supposed by him to be the remains of a Kitchen Midden. The present communication is intended merely as a supplementary note to his paper. It appears that the beds, containing recent shells and bones, had been previously observed, and their true character ascertained, since the Rev. W. S. Symonds remarks, in some notes on the Geology of the district, "The beds of mussels and other shells on the Great Orme, which, at one time I imagined to have been elevated in raised beaches, Mr. Darbishire believes to be derived from old shell-heaps, the accumulations of former inhabitants."

The beds in question appear in the face of the low cliff, which terminates a somewhat steep *talus*, covering the base of the Carboniferous Limestone escarpment of the Great Orme, close to Pen Morfa. Part of the *talus* has been carried away by the sea, and the present cliff is only a foot or two above high-water-mark.

FIG. 1.—CLIFF AT PEN MORFA, GREAT ORME'S HEAD.




1. Surface soil with angular blocks of limestone, *Helices* and other shells, etc., 1½ to 2½ feet.
2. Calcareous dust and tufa, about 10 inches.
3. Sandy soil and limestone fragments, with shells of *Mytilus edulis*, *Patella vulgata*, *Littorina littorea*, etc., bones, teeth, charcoal, etc., 1 foot.
4. Sand with pebbles and angular limestone fragments, 6 inches.
5. Reddish clay, 8 or 9 inches.
6. Sand } 3 to 4 feet.
7. ,, darker }
8. Talus of all the above.
9. Pocket of shells of *Mytilus edulis*.

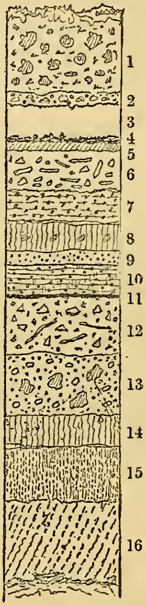
*a*. Line of section. *b*. At the spots indicated below, in bed No. 3, two jaws of a small sheep were found. *c*. Wall at Pen Morfa.

The general appearance of the face of the cliff is given in the accompanying sketch (Fig. 1), which, though not drawn to scale, represents with sufficient accuracy the different beds as they occur. These are more minutely shown in the section given in Fig. 2; it is taken about 20 yards from the beginning of the Midden, or from the first rise of the cliff at Pen Morfa. The beds occur as follows:—

1. Surface soil with angular fragments of limestone, etc., with some *Helices*, about 1 ft.
2. Bed of *Patella vulgata*, with a few bones, 4 in.
3. Calcareous dust, like decomposed tufa, about 9 in.
4. Dark-coloured tufa, ½ in. to 1 in.
5. Dark Carbonaceous layer, 1 in.
6. Soil, with *Patella vulgata*, *Littorina littorea*, *Mytilus edulis*, etc. and bones, 3 in.
7. Sooty layer, with fragments of charcoal and burnt bone and shells, 3–4 in.
8. Bed of burnt clay, with calcined pebbles, 3 in.
9. Whitish sand, 1 in.
10. Dark-coloured loam, with fragments of charcoal and burnt shells, 2 in.
11. Thin layer of Carbonaceous matter, with burnt bone, ¼ in.
12. Dark earth, full of fragments of charcoal, *Mytilus edulis*, *Patella vulgata*, *Littorina littorea*, and numerous bones, 8–9 in.
13. Sandy bed, with limestone fragments and rolled pebbles, 10 in.
14. Reddish clay, 2–3 in.
15. Sand, 6 in.
16. Sandy argillaceous bed, the base obscured by a talus of fragments, etc. from above.

The entire length of the Midden is about 80 yards, thinning out at that distance into a dense bed of *Patella* near the surface. How far back from the shore it may extend is not so easy to ascertain; a bed of *Littorina* and *Patella* crops out on the surface, about 56 yards from the commencement of the Midden, and 20 feet above the beach; at some six feet from the edge of the cliff, where it is exposed at about three feet from the edge, the bed is six inches below the surface and two feet thick. I found no bones here, but several fragments of charcoal. In the cutting by the side of the pathway, near the gate beyond the Dean of Christ Church's house, a bed of *Patella* and *Littorina* occurs about 50 or 60 feet from the beach. Beside the shells mentioned above, I found in bed No. 12 several oyster shells, two specimens of *Purpura lapillus* and some fragments of *Cardium edule.* The early inhabitants appear also sometimes to have caught a crab, by way of a treat, as part of a claw was in this bed. Amongst the bones which I obtained were several that had been burnt; others seem to have been split for the sake of the marrow. These burnt bones and shells, also calcined, together with the large quantity of charcoal disseminated throughout these beds, seem to put beyond question their being the remains of an old Kitchen Midden, but I am inclined to doubt its very great antiquity, many of the shells and bones, even in the lowest bed, presenting a very fresh appearance, and the latter seem, in many instances, to have lost none of their gelatine; however, that may prove nothing. Bones were tolerably numerous in bed No. 12, but no very large ones were met with. I found several small jaws of lambs or small sheep; also fragments of jaws of the ox and deer (species ?), two small skulls of some little rodent, many leg bones, also vertebræ and knuckle bones of different small animals;—what these may be I am not enough of an osteologist to say. No traces of implements appear in these beds, unless one small bone-fragment, which looks as if it might have been used as an arrow-head, should prove one. Bits of burnt clay, like those mentioned by Mr. Bonney, were very numerous in parts, and the layer of burnt clay, with calcined pebbles, looks very much—from the layer of charcoal on its surface—as if it had been burnt *in situ.*

Fig. 2—Section of Cliff, about 20 yds. from its commencement, at Pen Morfa




(*talus*).

Farther along the coast, close to a boat-house, near the ruins of Glogarth Abbey, a bed of *Littorina* and *Patella* appears in the cliff, which is here but a few feet in height; the bed looks as if it had been mostly destroyed, perhaps by the sea; in it I found a few bone-fragments and teeth, and some bits of charcoal: the shells in this bed were very friable, far more so than in the other Midden, owing possibly to their greater antiquity, or, may be, to their being nearer the surface, and thus more exposed to atmospheric influences. I examined as closely as possible the mussel-beds in the sand which caps the Boulder-clay that appears on the coast higher up Conway Bay, thinking they might perhaps turn out to be artificial accumulations; but I could discover no admixture of bones, or even of other shells with them, with the exception of one or two specimens of *Patella* and *Littorina.* These mussel-shell beds occur in the loose sand, with no rock for their attachment, and are about 20 feet above the beach in some places. I could find nothing in the pocket of *Mytilus* near the great Midden save those shells, and they mostly had their valves in approximation and undisturbed; they are apparently unconnected with the Midden. A general, though somewhat hasty search round the greater part of the Orme failed to reveal any further traces of Middens, although remains of raised beaches here and there, containing a few shells, such as *Patella, Littorina,* etc., may be seen in many places, and at very considerable heights above the present sea-level. Some fissures also in the Limestone rocks can be traced in the face of some of the quarries, which have been filled up with rolled pebbles; these are now cemented into a firm conglomerate by the infiltration of carbonate of lime. I could find no shells or other organic remains in the contents of these fissures, though *Patella* and *Littorina* are to be found in the *talus* close by.

[NOTE.—All the bones sent me by the Rev. J. M. Mello, from the Kitchen Midden in the Great Orme's Head, were very much broken (old fractures); but I was enabled to identify *Bos longifrons*; jaws, etc., of a small-horned sheep; Leg-bones of *Canis lupus*, or *Canis familiaris*; tooth and vertebræ of pig; and fragments of bones of bird.—H.W.]

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## IV.—ON THE "LINGULA FLAGS," OR "FESTINIOG GROUP" OF THE DOLGELLY DISTRICT.

By THOMAS BELT, F.G.S.

[PART II.]

THE accompanying section shows the succession of beds from the Harlech grits, near the sixth milestone on the road from Dolgelly to Trawsfynydd, across their strike in a south-easterly direction, to the lower ash-bed of the Arenig group at the farm of Blaenau, five miles north-east from Dolgelly. In this section all the beds occur in regular sequence, although they are invaded by many intrusive masses and dykes of diabase;[1] only the larger of which are shown in my section, as it would be impossible, on so small a scale to depict the innumerable protrusions of this rock that occur in the district. The section crosses, at Moel-Cors-y-garnedd, the southern flank of the mountain Rhobell-fawr, which is the largest mass of diabase in Wales. All along the eastern side of Rhobell-fawr the strata are completely inverted, as shown in diagram, so that the Festiniog beds (5 and 6) lie above the more recent Dolgelly beds (7 and 8), from underneath which the Tremadoc beds (9) come up, overlying the beds of slates and ashes belonging to the Arenig Group (10 and 11).

[1] I follow Mr. David Forbes in calling these rocks diabase; they are the "Greenstones" of the Geological Survey.


Section from Afon Eden to Blaenau, five miles N.E. from Dolgelly.

I shall now describe the strata lying between the Menevian and Tremadoc beds in ascending order.

MAENTWROG GROUP.

*Lower Maentwrog Beds* (No. 3 in Section).—The blue black slates of the Menevian group, which everywhere around the Merionethshire anti-clinal overlie conformably the Harlech grits, are followed by a series of sandy and slaty beds. The lowest of these are grey and yellowish grey, fine-grained, pyritic flags, with hard felspathic bands and rusty partings. Alternations of more arenaceous and gritty beds are not unfrequent, and beds of yellow grey shale also occur. Some of the beds are ripple-marked and traversed by worm-tracks, but neither Trilobites nor shells have been found.

These arenaceous and shaly flags are about 400 feet thick, and are succeeded by bluish grey, blue, and blue-black, jointed, fossiliferous slates, alternating with bands of slightly arenaceous, grey and yellow grey flags. The slates contain *Olenus gibbosus*, Wahl; *Agnostus nodosus*, Belt; and *A. pisiformis*, Lin., *var. obesus*, Belt. Fragments of these fossils were first found by Mr. Williamson, near Cefn-deuddwr in 1864; but it was not until Mr. Barlow found them in great abundance near Dolmelynllyn in 1866 that I was able to determine their specific distinctness, and to separate the beds containing them from those above, with which they had been until then confounded.

The fossiliferous beds, and also the underlying arenaceous and shaly flags, may be well studied on the range between the Eden and the Mawddach, a little above the junction of these rivers, but the best locality for the fossils is that discovered by Mr. Barlow, near Dolmelynllyn, in the Mawddach, opposite the fifth milestone on the Trawsfynydd road.

The fossiliferous beds are about 300 feet thick, making the total thickness of the Lower Maentwrog beds about 700 feet.

*Upper Maentwrog Beds* (No. 4 in Section).—The last beds are overlaid by yellow and bluish grey fine grained flags, sometimes a little arenaceous, but never so coarse as some of the gritty beds lying below. They are often finely laminated and flaky, especially towards their upper limit, where *Agnostus pisiformis*, Lin., is not uncommon. The top beds are very fine grained and flaky, and of a bluish or brownish grey colour. There are about 600 feet of these fine grained flags.

From the bluish grey beds there is a gradual passage upwards into dark, dull blue slates, much jointed and weathering to a rusty colour. There are occasional intercalations of bluish and yellowish grey beds; and where sections of the rocks are exposed in the beds of streams, thin alternations of blue, yellow, and grey layers give them a banded appearance. This part of the series is at least 1200 feet thick, and may be more. The rocks are so much faulted that it is impossible to obtain more than an approximation towards correct measurements.

Throughout the blue beds *Agnostus pisiformis*, Lin. is found, but most abundantly at the base and in the upper beds. Above Dolgoed, in thin shaly slates, it occurs in thousands, all drawn out and distorted by slaty cleavage; but the best specimens have been found on the left bank of the Mawddach below Hafod-fraith. In the Lower beds, at Cae-gwernog above Llanelltyd, where it was first found by Mr. Salter in 1864, and near Dolgoed, *Olenus truncatus*, Ang. accompanies the *Agnostus*, but it does not follow it into the higher beds, where it is replaced by a closely-allied species, *O. cataractes*, Salter, of which I have obtained fragments from the rocks by the roadside, a little north of Llanelltyd, and in the blue slates below Hafod-fraith.

The total thickness of the Upper Maentwrog beds in the Dolgelly and Maentwrog districts is about 1800 feet.

*The Maentwrog Group*, comprising the Upper and Lower Maentwrog beds, contains altogether, in the district under consideration, about 2500 feet of strata, and is, as has been already mentioned, well defined, both lithologically and palæontologically. The beds are everywhere much jointed and weather to a rusty colour, and form hills covered with angular ferruginous débris, so that even at a distance the experienced eye can distinguish them from the hard, shelving flags of the Festiniog Group, or the low rounded hills formed from the much softer slates of the Dolgelly Group.

In the Dolgelly district the slates and shaly flags of the Maentwrog Group occupy all the ground between the Menevian beds and the river Mawddach, from a little above Barmouth up to Llanelltyd, where they cross the river and occupy both its banks as far as Tyddyngwladis Mine. A little below the Tyddyngwladis lode they are thrown entirely to the eastern side of the river, partly by intrusions of diabase and partly by faults. Between Cwmhesian Mine and Hafod-fraith they again cross the river and range northward, towards Trawsfynydd.

In the Maentwrog district these beds are finely developed, and splendid sections of them are shown in the Waterfall Valley, and in the valley running from Tafarn-helig to Caen-y-coed. In the Caen-y-coed quarries (now abandoned) the topmost beds are well exhibited, and from this locality the finest specimens of *O. cataractes*, Salter, have been obtained by Mr. Homfray, who has also found with it, fragments of a crustacean allied to *Hymenocaris*.

The rocks of the Maentwrog Group are of little economic importance. Some rough slates and slabs have been worked in them at Caen-y-coed and above Llanelltyd, but the fine-grained beds are too much jointed, and the coarse-grained too rough for profitable working. The gold-mines of Hafod-y-morfa, Cefn-deuddwr, and others of less importance have been opened in these beds. The auriferous quartz veins also contain ores of copper, lead, and zinc, but only in small quantities.

### Festiniog Group.

*Lower Festiniog Beds* (No. 5 in Section).—Lying conformably upon the Upper Maentwrog beds are a thick series of micaceous, grey flags. The Lower beds are bluish grey and only slightly arenaceous and micaceous, and contain *Lingulella Davisii*, McCoy, in abundance, and also numerous worm tracks. Thin, hard felspathic layers alternate with thicker and more shaly ones. These are succeeded by thick beds of yellow and yellowish grey arenaceous flags, containing also hard felspathic layers. The arenaceous beds are often coarsely and strongly cleaved, and the cleavage planes filled with iron rust, so that, but for the uncleaved interbedded felspathic layers, it would be most difficult to determine the planes of bedding, and those of cleavage might easily be mistaken for them. *Lingulella Davisii* occurs only sparingly in this part of the series. The thick-bedded arenaceous flags are followed by thinner-bedded grey and yellowish grey flags, much finer grained than those lying below them, and crowded with the shells of *Lingulella Davisii.* In these beds in 1865 I found, near Penmaen-pool, the only specimen of a true fucus recorded from British Lower Silurian or Cambrian rocks. It branched dichotomously over the face of a slab about four feet long and three feet broad. It belongs to the genius *Buthotrephis*, but the species has not yet been described.

The highest of the Lower Festiniog beds are bluish and brownish grey fine-grained flags. They too are crowded with *Lingulella Davisii*, and contain also *Hymenocaris vermicauda*, Salter, which has been found near Penmaen-pool, on Mynydd-gader and on Moel Hafod-Owen, but only sparingly. The Lower Festiniog beds are about 2000 feet thick.

*Upper Festiniog Beds* (No. 6 in Section).—Lying on the last-named beds is a band of tough blue grey flags, not more than fifty feet thick, but containing an assemblage of fossil remains, nearly distinct from those in the beds below, and quite so from those above. A species of *Lingulella*, probably a variety of *L. Davisii*, but only one-third the size of that species, still occurs, and is accompanied by *Hymenocaris vermicauda.* Along with these occur, for the first time, *Conocoryphe micruua*, Salter, and *Bellerophon Cambriensis*, Sp. n. I have found this band, with its characteristic fossils, at Gwern-y-barcud; in the Mawddach near Craig-y-dinas, and on Mynydd-gader.

*The Festiniog Group*, as above defined, comprises the Upper and Lower Festiniog beds, and is a little more than 2000 feet thick. The river Mawddach cuts through the whole of the beds between Rhiufelyn and Hafod-fraith. From thence they range across the east-end of Moel Hafod-Owen and by Pen-y-bryn, skirting the igneous rocks of Rhobell-fawr, where, however, only the lower beds are seen, as the upper ones have been thrust a mile and a half over to the eastward, by the intrusion of the diabase, and are seen on the east flank of Moel Cors-y-garnedd completely inverted, so that they overlie the newer Dolgelly and Tremadoc beds, as shown in Section, page 537. From Pen-y-bryn the lower beds, much disturbed by intrusive rocks, run south-westerly past Glasdir-isaf and Llyn Cynwch to Tyddyn-bach, but are not well seen, excepting on the west bank of the lake, where good specimens of *Lingulella Davisii* abound. The whole of the beds, having escaped from the disturbing influence of the Rhobell-fawr igneous rocks, cross the Wnion near Glyn Maldon, and then by Gwern-y-barcud and Tyn-y-craig, range to Coed-y-garth, and into the estuary of the Mawddach. To the south of Dolgelly, at Pandy and Bryn-rhug, they are brought in by a branch of the great Bala fault, and are there much disturbed and altered by intrusive igneous rocks.

Very durable building stones and some good rough flags are obtained from these strata. In the neighbourhood of the intrusive diabases the lower beds are often largely impregnated with iron and copper pyrites, and have been mined for the latter with some success at Glasdir. The numerous quartz veins intersecting the same beds in the neighbourhood of Dol-y-frwynog all contain a little gold, but have nowhere on this horizon been worked with profit.

### Dolgelly Group.

*Lower Dolgelly Beds* (No. 7 in Section).—The next beds in ascending order are hard, blue slates, characterized by containing, in great abundance, a small species of *Orthis*, and *Parabolina* (*Olenus*) *spinulosa*, Wahl. *P. spinulosa* was first found in the Dolgelly district by Mr. Williamson, in loose boulders, in the valley of the Mawddach, below Rhiw-felyn. In consequence of this discovery we searched the rocks in the neighbourhood together, and soon found, not only the above fossils *in situ*, but, above the strata containing them, the Upper Dolgelly beds crowded in some parts with Trilobites of various genera. Shortly after, I found the lower beds with *Orthis* and *P. spinulosa* at Gwern-y-barcud, and more lately, have detected them on Mynydd Gader, at both places lying conformably upon the Upper Festiniog beds. I have also recognised them on the eastern flank of Moel Cors-y-Garnedd; but there, through the inversion of the strata, they lie below instead of above the Upper Festiniog beds. Since their discovery, the lower beds have been well searched for fossils; but the only species found in addition to the two mentioned above, have been some specimens of a *Lingulella*, and a single fragment of a species of *Agnostus*. In a loose stone, which probably came from these beds, Mr. Hicks, of St. David's, found a species of *Protospongia*. It adds to the probability that the specimen came from the Lower Dolgelly beds—that I have found two species of the same genus in Lower Tremadoc beds—so that it must have existed from the Menevian epoch, where it first appears, up to the time of the deposition of the Tremadoc strata.

I think that the Lower Dolgelly beds are about three hundred feet thick; but they are so much jointed and faulted that I have nowhere been able to get a trustworthy measurement of them, and my estimate of their thickness is little more than a guess.

*Upper Dolgelly Beds* (No. 8 in Section).—To these beds I have already alluded, when mentioning the discovery of the last. They are soft, black slates, much jointed and often intensely cleaved. They generally contain numerous fine grains of pisolitic iron. Near the junction with the lower blue beds some bands of blue slate occur, interstratified with the black, but higher up they are entirely black. With the exception of a thin layer of black slate in the Festiniog Group, and which has been noticed but at one spot, the Upper Dolgelly beds are the only black slates in the district, although the term has been applied to the dark blue rocks of the Menevian and Maentwrog Groups. These, however, are never black, and when scratched show a white streak. The Upper Dolgelly beds are not only black, but their streak also is black. A careful examination of all the rocks of the Dolgelly district enables me to state that, with the trivial exception mentioned above, there are no other beds with a black streak. It is only since I established this fact that I have been able to map out the beds in the highly disturbed district to the east of Rhobell-fawr, and on Mynydd Gader. Geologists who have attempted to unravel the intricacies of such a disturbed country as that around Dolgelly, where the strata are faulted and contorted, altered by intrusive igneous rocks, and often so shattered and cleaved that it is useless to search for fossils, will appreciate the value of the discovery of a test which enables us to identify a well-defined set of strata however it may be fractured and cleaved.

The Upper Dolgelly beds are characterized by a great many Trilobites, none of which are found in the strata above or below. The species found in the Dolgelly district are *Conocoryphe* (*solenpleura*?) *abdita*, Sal., *C. Williamsonii*, sp. n., *C. longispina*, sp. n., *Peltura scarabœoides*, Wahl., *Sphœrophthalmus bisulcatus*, Phil., *S. humilis*, Phil., *Agnostus princeps*, Sal., *A. trisectus*, Sal., and *A. obtusus*, sp. n. Besides the trilobites, a few shells belonging to the genera *Orthis*, *Lingulella*, and *Obolella*, are found. The *Orthis* is *O. lenticularis*, Dalm., according to Salter; but the others have not been described. The *Lingulella* is, however, very like *L. Davisii*, McCoy, from the Festiniog beds.

Near Tremadoc the following additional Trilobites have been found in strata at or about the same horizon as the above:—*Conocoryphe invita*, Sal., *Dikelocephalus* (?) *celticus*, Sal., and *D.* (?) *discoidalis*, Sal. The Upper Dolgelly beds are about three hundred feet thick.

The *Dolgelly Group*, comprising the Upper and Lower Dolgelly beds, is altogether about six hundred feet thick. A very fine section of the beds is exposed along a brook falling into the Mawddach at Rhiw-felyn. From thence, with many dislocations, they curve round the eastern side of Rhobell-fawr to Blaenau. Half a mile south-west from Dolgelly the black beds are well developed up the ravine through the grounds of Bryn-y-gwin to Bran-y-gader. where they are overlaid by Lower Tremador beds, with *Dictyonema fenestrata*, Sal. On Mynydd Gader they overlie the Upper Festiniog beds, and are followed conformably by Tremadoc strata containing *Asaphus innotatus*, Sal., *Niobe Homfrayi*, Sal., *Conocoryphe depressa*, Sal., and two species of *Protospongia*.

The Lower beds are not known to exist except in the Dolgelly district. They will, however, probably be discovered around Tremadoc, as in the Jermyn Street Museum there is a tail of *Parabolina* *spinulosa*, Wahl. (labelled *Olenus serratus*, Sal.), from Carreg-wen, near Tremadoc.

The Upper beds have long been known as the Malvern shales, and I should have preferred to call the group the Malvern Group, if the lower beds had been found in that locality. It is, however, appropriate that the Dolgelly district, where alone the whole of the Cambrian rocks known in Great Britain are represented, should give a name to one of the groups.

(*To be continued*).

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## V.—Notes on the Geology of South Beds. (No. II.)

By J. Saunders, Esq.

SINCE my former communication on this subject, which appeared in the Geological Magazine for April last, (p. 154) I have had several opportunities of re-visiting some of the cuttings, on the Midland Railway, therein referred to, respecting which some doubts were expressed in reference to the age of the deposits exposed to view, and, as they are now completed, more precise observations can be made than when they were only just commenced. The cutting, south-east from Westoning, (which, in an Editorial note, was suggested might be of Tertiary age) exposes a dark heavy clay, which, upon the most rigid examination, furnished not the least trace of rolled fragments of Chalk or flints, or any other substance so frequent in the Tertiary clays of this neighbourhood, which would lead to the inference that it had been deposited subsequently to the Cretaceous era. It, however, contains what would strongly indicate that it is coæval with the Greensand, namely, a continuous band of coprolitic nodules, averaging about a foot in thickness. This layer passes through about one-third of the cutting, and may be traced from its commencement on the north-west side of the hill, passing along the face of the cutting with a gentle dip, until it reaches the level of the line, when it passes out of sight, nor does it re-appear on the south-east side of the excavation. The fossils associated with the nodules are *Lamna*, *Belemnites*, *Parasmilia*, and *Terebratulæ*, all of which are abundant in the coprolite beds at Hexton and other places in the immediate vicinity. Both above and below the coprolites the clay is identical in character, and must have been deposited contemporaneously with its associated nodules, and, as far as I can judge, it is the equivalent of the bed *h* of the section given by Mr. W. Whitaker, in the Quart. Journ. Geol. Soc., vol. xxi., 1865, pp. 399, "On the Chalk of Bucks." About the middle of the cutting is a considerable accumulation of light-brown coloured drift-sands, that lie in a basin-like hollow, that has been eroded from the summit of the hill.

The cutting at Harlington, at the north-west side of the hill, facing the Kimmeridge Clay and Greensand strata, exposes a thick bed of heavy dark clay, containing a profusion of selenite crystals, with occasional fragments of rolled chalk, indicating that it has been formed principally from the disintegration of the Kimmeridge bed. It furnished several fossils identical with those observed in this formation at Ampthill, at which place also selenite crystals form a considerable portion of the mass of the upper beds. This bed of dark clay is succeeded by others of a lighter colour, containing a greater proportion of rolled Chalk and flints, until at the south-east side of the hill—or that facing the Chalk escarpment—the beds are composed almost entirely of sand and water-worn fragments from the Upper Cretaceous beds.

The cuttings between Luton and New Mill End, running parallel with Luton Hoo Park, exhibit some fine specimens of "Chalk-rock" which are interesting, as few continuous sections of this remarkable formation are visible. The first cutting, about a mile from Luton, is entirely in "Chalk-with-flints," which is here very massive. In the second cutting we have the first occurrence of the "Chalk-rock," where are exhibited in descending order :—

Chalk-with-flints, 10 feet to 15 feet.
Chalk-rock, about 2 feet.
Lower Chalk, without flints, 10 feet to 15 feet.

So excessively hard is this "rock" that it stands out in striking prominence on the sides of the excavation, it having been impracticable to level it to the same plane as the softer strata above and below. It does not occur in unbroken continuity, but is considerably dislocated at several places, and sometimes, for a few yards, two beds lie parallel to each other at a distance of several feet.

Contrary to the general character of this bed in other localities—as observed by Mr. Whitaker and others—it is here very rich in fossils ; but, the matrix being so excessively hard, they are with great difficulty extracted. It has a metallic ring when struck with a hammer ; it abounds in green-coated nodules, and is not uniformly compact, but in places can be very easily pulverized. Perforations are occasionally to be seen passing almost through its entire thickness, which have been subsequently filled with dark-brown clay. The Brachiopods, Echinoderms, etc., are always in good preservation, but the more delicate shells of the univalves have perished, leaving casts of their external ornamentation, and a spiral mould of their interior. The *Ammonitidæ* and *Nautili* have also experienced a similar decay, and, when broken, show the internal divisions of their *septa*. From my experience in this district I consider that the fossils from this bed have a greater resemblance to those of the Lower Chalk, than to the Upper, or Chalk-with-flints. The following are the principal genera obtained from the section :—

| | | | |
|---|---|---|---|
| *Ventriculites.* | *Cidaris.* | *Terebratula.* | *Ammonites.* |
| *Cephalites.* | *Cyphosoma.* | *Rhynconella.* | *Nautilus.* |
| *Parasmilia* | *Serpula.* | *Pleurotmaria.* | *Lamna.* |
| *Holaster.* | *Spondylus.* | *Turbo.* | *Ptychodus.* |

Of some of these genera there are several species which await the skill of the Palæontologist to determine.

In the third cutting the Chalk-rock occurs at a less elevation, so that a smaller section of the Lower Chalk is seen beneath it; and in the fourth cutting, immediately adjoining the village of New Mill End, it occurs at the bottom of the excavation, which in the deepest part is about ten or twelve feet. This formation also occurs in the immediate vicinity of Luton, on the opposite side of the valley of the Lea. It has been met with in two Chalk-pits now closed, in one of which, near the London Road, it was customary to sink a shaft down to this bed, and then excavate a considerable chamber beneath, the Chalk-rock forming an excellent roof to the workings.

Through the kind assistance of R. Etheridge, Esq., Palæontologist to the Geological Survey, I am enabled to add the following species, from the Totternhoe stone, to the list published in the April Number of the Geological Magazine (p. 159):—

| | |
|---|---|
| *Rhynchonella plicatula.* | *Exogyra.* |
| ,, *Cuvieri.* | *Palæastacus.* |
| ,, *octoplicata.* | *Plesiosaurus campylodon.* |

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## VI.—On the Glacio-Marine Denudation of certain Districts.

By Miss Eyton.

Having been for the last twelve months engaged in a careful study of the post-Tertiary geology of the eastern part of Shropshire, I have at length arrived at the conclusion that the denudation of the New Red Sandstone in this neighbourhood, and consequent excavation of the Tern basin, has been effected partly by glacial and partly by marine agency; the grounds upon which this conclusion is based being:—(1) An attentive consideration of the general form and outline of the basin; (2) A particular examination of the drift beds contained therein.

First, with regard to the general outline. The district drained by the river Tern, forms a basin of extensive area, but with a comparatively narrow outlet. The area is almost entirely of New Red Sandstone, chiefly the Lower Bünter beds, bounded on the east by the basaltic rock of the Wrekin range of hills, and by the long line of low Coal-measure hills extending through Ketley, Donnington Wood, and Lilleshall, in the direction of Staffordshire. In fact, as will be seen by consulting the Ordnance map, the outline of the basin is here co-extensive with the line of fault separating the Bünter Sandstone from the Coal-field. On the opposite side of the latter there occurs another great fault, dividing the Coal from the Permian beds, and by sinking a shaft through the latter, the Coal was again found on the lower side of the fault. It is extremely probable that the same experiment might be attended with similar success in the Tern basin. Indeed, there can be little doubt that, before the period of volcanic convulsion, which occasioned the faults, both the Permian and lower Bünter beds covered the whole of the Shropshire Coal-field, and it is probable that even since that period they have been largely denuded by glacial and marine agency; so that, if we are indebted to the god Pluto for having opened to us his stores of subterranean wealth, his brother deity, Neptune, may claim a share of our gratitude for having, by more gentle means, removed some of the obstacles to its acquisition.

The western boundary of the basin is formed by the basaltic ridge of Haughmond Hill, which, with its opposite neighbour, the Wrekin, form the barriers on either side of the outlet. After this ridge is passed the basin widens considerably, and the outline is, in places, broken. It is, however, perfectly distinct in the Sandstone Hills of Grinshill, and in the neighbourhood of Hawkestone.

In the lowest part of the area there lies an old lake basin, some seven miles in length, by four in width, now called the Wealdmoors,[1] and it is upon the evidence of this basin that the glacial theory principally depends. I am at a loss to conceive any other denuding agent than ice, with sufficient force to act upon so large an extent of surface in a circular direction. It must be remembered that the Wealdmoors certainly existed as a lake at the period of the Low-level drifts, and, consequently, that the excavation must have been effected previously to that period; that is to say, either during the period of marine submergence, or before it. Now the action of the sea is always in straight lines: it may form cliffs, terraces, or lines of shingle, but it is incapable of working in a circular direction, save in the exceptional case of a whirlpool, or a concentration of local currents, flowing from various directions; and to produce either of these, there must be some local cause, as sunken rocks, of which there is no trace in this instance. I infer, therefore, that the depression in question was produced by a mass of frozen matter, which, being heaviest in the centre, was continually pressing the lower fragments outwards, and from which small streams of water were continually flowing at the lowest point of contact with the earth. If, as Mr. E. Hull has demonstrated,[2] a valley within a valley is a proof that the outer one is of marine origin, I think a basin within a basin may be taken to show the same with regard to ice. The Wrekin must certainly have once formed an ice-shed. Between the Ercall and Lawrence's Hill, in the Wrekin chain, there occurs a deep rift, now occupied by a small mountain stream, but when we consider the hardness of the rock through which the channel is cut, it seems scarcely possible that such a rivulet could have effected it. Besides, the chasm is strewn with large masses of rock, firmly fixed in the mud and gravel, brought down annually by the stream, and overgrown with vegetation; evidently the remains of a far older drift. Other ice-rifts occur in this chain of hills. On the face of Haughmond Hill, towards the Severn, are four or five distinct furrows, or grooves, apparently ploughed into the hill by masses of frozen matter precipitating themselves into the valley below.

I have not yet succeeded in finding any beds of ascertained glacial drift in the basin itself, but there are traces of its existence in the

[1] See Geological Magazine for January, 1867, for a detailed account.

[2] Modern views of denudation. Popular Science Review, Oct., 1866.

large granite and limestone boulders, which are scattered at different levels over the surface of the land. And this is easily accounted for when we consider that, during the succeeding period of submergence, all the lighter material would be washed away by the waves, to reappear in the form of marine drift, the heavy boulders alone remaining in, or near, their original sites.

It is, however, certain, that if the Tern basin was originally excavated by ice, the sea must, at least, have done much towards shaping and modifying its outline. To the eye of a geologist, looking from the centre of the depression above alluded to, it is easy to re-picture the time when the whole of the surrounding country, with its rich pastures, its towns and rural homesteads, and its busy working population, was a vast bay or inland sea, resembling the Irish Loughs of the present day, having its outlet into the Severn sea at the northern extremity between the two before mentioned basaltic barriers. The coast line, though not in all places equally distinct, may yet be traced almost continuously; and nowhere more clearly than in the terrace of Haughmond Hill. Had the denudation of the Sandstone been entirely effected in this locality by ice, it would have left its marks, in the shape of furrows and striæ, upon the hill-side; but none such exist. On the contrary, the hill forms a terrace extending in a direct line, with smooth and rounded outlines, such as could only have been formed by the continuous and gradual action of the waves, wearing away the softer rock which then concealed the face of the hill, leaving bare the basaltic ridge. The same observations apply wherever trap intrusions occur, as at Lilleshall and Wrockardine Hill.

But it is in the Drifts that we find the strongest evidence of the sea's presence. The lowest of these consists of a bed of loose coarse-grained sand, partially filling up the hollows over nearly the whole extent of the basin, and sometimes appearing upon the sides and summits of the lower elevations. I infer that this bed is of marine origin, since the uniform action of the sea could alone have distributed it so evenly and generally over so large a surface. When microscopically examined it is found not to consist chiefly of the denuded sandstone, but of minute rounded fragments of quartz, syenite, and greenstone. It has not hitherto yielded any organic remains.

Reposing conformably upon this, and extending along the base of the Wrekin chain, and of the Carboniferous hills, is a line of marine drift clearly indicating an old sea-board. This drift consists of clay, mixed with rounded shingle, slightly bedded. An admirable section is exposed to view in the clay-pit worked by Mr. More, of Ketley Brook. The face of the bank, which is here rather steep, has been cut away, so that the position of the beds, shingly-clay resting upon sand, is visible. A curious sub-atmospheric effect occurs here, which, although foreign to the present subject, is so remarkable as to be worth mentioning. The rain, penetrating the upper bed, has formed small streams trickling through into the sand, and carrying particles of the clay with it, to which the sand adhering, columnar masses have been formed of a substance as hard as the hardest sandstone.

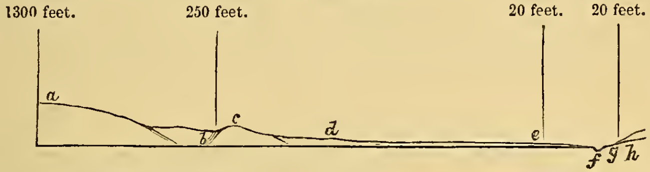
This bed is some hundred feet, more or less, below the level of the Glacial chasms I have spoken of; but we often find, mixed with the round shingle, angular *débris* which may have been washed down by former streams now vanished, or by melting snows. I am inclined to believe the latter, and to see in these drifts a line of partition above which we may find the remains of an ancient frigid zone; while below them we find traces of a gradually increasing temperature. Specimens of *Turritella communis*, *T. incrassata*, and a small *Tellina*, have been found in different localities along this line. This bed occurs at about the same elevation and in the same position as those drifts which mark the old coast-line along the eastern base of the Malvern Hills, and I am satisfied with their correlation. Thus the Tern basin was contemporary with, and, in fact, formed a part of, the ancient Severn sea.

Proceeding lower in the descending scale, we find that the river Tern, a small sluggish stream, whose course lies exclusively through sandstone and Lias, and which overflows its banks at every heavy rain or thaw, so shallow is its channel, is yet bordered at a height of about eighteen or twenty feet by banks of shingle, consisting of such a heterogeneous mixture of materials that it is out of reason to suppose them all to have been collected by the river, although they may have been re-assorted and placed in their present position by a former and more powerful stream. Grey granite, which must have been carried southward from Cumberland, with occasional fragments of pink and micaceous granite, and flints much chipped and rolled, enter into its composition. All these appear to have undergone a process of scratching and grinding, more forcible than anything the river could have effected, and must, I think, be the remains of an old glacial drift, brought here by the waves and afterwards arranged and placed by the ancient stream and its tributary brooks.

And here we find the agency of the latter at work. Passing down from the hills through the high-level drifts on their way to the plain, they would convey by their rapid current, much of the material to the river, separating the shingle from the commingled clay and silt in preparation for the sorting and bedding process, to which it is next subjected. Taking into consideration the hardness of some of the material, and the immense amount of attrition which it must have taken to bring some of the pebbles to their present form, there seems no alternative but to suppose it the result of some such process.

I have thus endeavoured to describe the means by which some of the more extensive depressions which vary the surface of our country have been formed. The same observations will generally apply to those wide and deep valleys through which no river of any size has its course, as the vale of Church Stretton, in Shropshire, and of Todmorden in Yorkshire. Nature has her factories and her mining operations as well as man, only they are upon so vast a scale and the interval of time consumed is so immense, that our insect eyes are often as incapable of discerning, as our minds of grasping, the facts which she lays before us. It is only by a long and close process of reasoning that we can arrive at the solution of a single problem.

SECTION OF THE TERN VALLEY SHOWING THE RELATIVE POSITIONS OF THE DRIFT-BEDS.




(*a*) Summit of ths Wrekin.
(*b*) High level drifts, on Red Sandstone.
(*c*) Protrusion of Basaltic rock.
(*d*) Sand.
(*e*) Clay under peat, lake basin.
(*f*) Present river-level.
(*g*) Low-level drift.
(*h*) Bank of river valley.

The accompanying diagram shows the relative positions of the Drift-beds I have described. Although not, perhaps, strictly correct, it is so nearly so as to afford a sufficient guide to any geologist desirous to examine these beds.

## NOTICES OF MEMOIRS.

### GEOLOGICAL PAPERS READ BEFORE THE BRITISH ASSOCIATION, AT DUNDEE.

### I.—NOTICE OF AN "ESKAR" AT ST. FORT, FIFESHIRE. By Dr. ROBERT CHAMBERS, F.R.S.E., F.G.S.

ESKARS, though of frequent occurrence in Ireland, and very numerous in Sweden, where they are recognised by the plural word "ösar," are comparatively rare in Scotland. One of a very striking character occurs about three miles inland from Newport, on the road from Dundee to Cupar-Fife, and on the estate of Mr. Stewart, of St. Fort. It is fully a mile long, and in some parts half a mile broad; rises from thirty to forty feet above the neighbouring ground, and is, unfortunately for the geologist, wholly covered with trees. Its surface is rough and uneven. Several good sections, produced by the cuttings for the road to Kilmany, show it to be composed of gravel chiefly rounded, including many large pieces, some of which are of Primitive rocks. The skirts of this "eskar" melt into a vast gravelly tract of cultivated ground, undulating towards Balmerino, but in other directions forming flat surfaces on a higher level. Elsewhere there are gravel mounts of less elevation, with rounded tops. The whole are manifestly relics of a vast sheet of alluvium at between eighty or ninety feet above the present level of the sea, extending southward into the valley of the Eden, and thence eastward by Kincaple and Strathtyrum to St. Andrews. The history of this great sheet of alluvium is probably connected with

Glacial action in the Tay, in the upper part of which, about Weem, there are decided moraines. In most of the great outlets from the Alpine regions of Scotland—as, for example, the valleys of the Spey, the Findhorn, and the Ness—there are smaller sheets of gravelly alluvium gathered about the places where the valleys open into the low country. In the case of the alluvial sheet here described, there has been sufficient denudation and outsweeping to account for the sand-banks which so largely encumber the mouth of the Tay, and give so much trouble to the mariners of Dundee.

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## II.—On the Old Sea Cliffs and Submarine Banks of the Firth of Forth. By D. Milne Home, F.R.S.E., F.G.S.

In describing the line of old sea-cliff along both sides of the Firth of Forth, which had been formed before the last change in the relative levels of sea and land, Mr. Home stated that its height at the lower parts of the estuary was about thirteen or fourteen feet above the present level of the sea, whilst near Stirling it was about thirty-one feet, and to the west about thirty-five or forty feet. He also specified two higher and older cliffs at heights of about sixty feet and one hundred and thirty feet respectively. Skeletons of whales and seals had been found at heights varying from eighteen to twenty-three feet above the present level of high-water-mark, and sea shells were found in two conditions—viz., first, in undisturbed beds, now fourteen and fifteen feet above high-water-mark, entire and perfect; and, secondly, in beaches, where they were broken. He explained the origin of the Estuary of the Firth, by the great east and west fractures in the country adjoining, to the north and south. He said that in the Fife Coal-field, the downcasts were almost all on the south side of the fractures, and amounted altogether to nearly 2,000 feet; and in the Coal-field of the Lothians, Linlithgow, and Stirlingshire, the downcasts were, on the other hand, to the north, and even to a greater extent, thus producing a trough or hollow, now filled by an arm of the sea. The rocks in this hollow were covered by various drift deposits, the oldest being Boulder-clay, and, over it, stratified clay, sand, or gravel. The gravel was generally on the top, which was accounted for by the water of the Estuary shallowing, whereby the currents became more powerful, and thus gravel was laid down where only mud or sand could be laid down before. Mr. M. Home next proceeded to describe a long ridge of gravel running four or five miles through Callendar Park, by Polmont eastward towards Linlithgow. He stated that its height was from thirty to sixty feet, and, judging from the materials composing it, he considered it had been formed by sea-currents. He said that these gravel ridges were very numerous in our open valleys, and that their direction or course was invariably parallel with the axis or sides of the valley. Though he had not seen the ridge of gravel at St. Fort, described in Dr. Chambers's paper, he could not help thinking it was to be accounted for in the same way, viz., by marine currents, and not as an effect of ice action. He exhibited some Admiralty charts, showing the submarine banks and spits existing in the English Channel, all of which were in like manner parallel to the sea-coast. If this bank was formed in that way, the sea must have stood at least 350 feet higher than now, and, in that view, an explanation was afforded of several phenomena in the district, such as the smoothed appearance of the hard whinstone rocks of Stirling, Craigforth, Airthrey, Castleton, and Logie. He thought it however probable that ice then floated on the sea, otherwise he could not account for the position of some enormous boulders to the east of Stirling. In the opinion recently expressed, that the last change of relative levels between sea and land had occurred since the occupation of this country by the Romans, he could not concur. Several facts militated against it. If the sea covered the extensive plains to the west of Stirling, up to the old sea-cliff shown on the map, it would have been impossible for the Romans to have had their road, which had been discovered across the moss of Kincardine; or to have had their fort on the banks of the river below Stirling. Moreover, the caves hollowed out by the sea at Wemyss, in Fife, before the last change of the relative levels, must then have been occupied by the sea, and therefore the remarkable sculptures found on their walls, lately described by Sir James Simpson, must have been executed since the Romans left our island, a notion which, he believed, all archæologists would repudiate.

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## III.—On Carboniferous Fossil Trees Embedded in Trappean Ash in the Isle of Arran.—By E. A. Wünsch, Esq.

The beds in which these trees occur have hitherto been classified as trap dykes or eruptive sheets of trap rock, but a summer's residence in the island has enabled Mr. Wünsch to discover the true character of the rocks. The beds referred to extend in a north-easterly direction, at an angle of about 37° from high, down to low-water mark, and, doubtless, to some distance below it, with the stems of trees embedded at right angles to the plane of stratification, having retained the original position in which they once grew, and having subsequently been upheaved on the flanks of the granitic nucleus of the island. As many as twelve or fourteen trunks have been observed on different occasions and within a circumscribed area. The stems of the trees are perfectly cylindrical, from 15 to 20 inches in diameter, with their roots extending down into the subsoil—one of them, a *Sigillaria,* must have been a hollow cylinder, through the interior of which several vigorous young shoots had made their way at the time it was suddenly buried by a shower of ash. Another tree must have been perfectly hollow, filled up with *débris* of vegetables and with fir cones. Mr. Binney, who has undertaken to make a more minute examination of the plants, has found specimens of *Sigillaria, Lepidodendron*, and a species as yet undescribed. The ash itself is very much indurated, having, in fact, very much the appearance and hardness of ordinary trap rock. So far as known, the trees referred to are the only instance of Carboniferous trees preserving both their original outline and position and their internal structure.

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## IV.—On the Age of the Arran Granites. By Dr. J. Bryce, M.A., F.G.S.

THE author began by stating that all the extraordinary phenomena of the geology of Arran arose from the abnormal position of the Granitic nucleus of the north end of the island, which, instead of forming an anticlinal axis, as is usually the case, had broken through the slate band close to its outer edge, within a few yards of the Old Red Sandstone. Within the area of this nucleus are two granites—a fine and a coarse—and beyond the limits of the nucleus, two separate granite tracts—both of the fine-grained variety—one at the outer edge of the Old Red, and the other amid slates and limestones abounding in fossils. The chief question of interest now in regard to the geology of Arran lay in the age of these granites, and the relative position of the two rocks forming the granite nucleus. Dr. Bryce explained that Glen Iorsa, instead of being occupied by the fine variety, as was supposed, exhibits only the coarser kind, while the fine granite occupies the heights on either side, and forms the surface over all the higher interior parts of the nucleus; and, on the south-east of the area, it runs out against the slate, into which it sends veins in the same manner as the coarser kind does on the flanks of Goatfell. He had come to the conclusion that this finer variety was the later of the two, and overlaid the coarser kind, while the two outlying granites of Ploverfield and Craigdhu were of the same age as the fine variety of the nucleus. He adverted to the singular fact that while granite fragments were absent from the Arran conglomerate, small lumps of the Craigdhu granite had been injected into the adjoining conglomerate—probably in a plastic state—quite an exceptional case in the geology of Arran.

Professor Ramsay said that since he first knew the island of Arran, his opinions regarding it, in some respects, had been considerably altered. Since the publication of his book, now long out of print, some things which were there stated in regard to the special Geological features of certain parts of Arran, he certainly did not now consider correct. If he were to write about the granite formation of Arran in particular, there was scarcely a word in that book that he would repeat; he would withdraw every word he had previously said. And if he were now to express his opinion on the granite of Arran, he believed he would be regarded as so heretical by Dr. Bryce and others on the platform, that he thought, for the sake of the harmony of the meeting, the less he said on the subject now the better.

Professor Ansted expressed his opinion that the granite deposits in Arran were not erupted rocks, and said that the evidence in very many cases of granites not having been erupted in the ordinary sense of the word, was so great as to be entirely incontrovertible. There was no such thing as eruptive granite, properly speaking.

Granite was originally a stratified rock, merely changed by intense heat and pressure, and could not, therefore, be said to be eruptive in the usual sense.

Mr. E. A. Wünsch said that he had accompanied Dr. Bryce in his researches, but had arrived at very different conclusions. The position maintained by Dr. Bryce that there were two granites of different ages—the fine grained erupted through the coarse grained—was utterly untenable. All the granites of Arran he believed to be of one age, and the difference in grain was merely owing to the difference in texture of the different strata previous to being metamorphosed into granite.

The President also expressed an opinion that granite is not erupted rock in the ordinary sense of the term.

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## V.—On the Trap and Granite in the Island of Mull. By His Grace the Duke of Argyll, K.T., D.C.L., F.R.S.

BEN CRAIG, one of the lower shoulders of Ben More, exhibits very clearly the passage of a rock, which looks like pure trap into regular granite. At the base of the shoulder of the mountain, which may be about 2000 feet high, it is a mass of fine-grained compact granite. At the top it is a mass of tuff which weathers white, and has a fracture like some kinds of trap. At an immense elevation this tuff contains many crystals of felspar, very distinctly separated. A little lower down these crystals become more frequent, a granitic rock appears, and then comes the regular granite. His Grace could detect no distinct separation. The top of the mountain is very white, the rock very shattered, some of it very light, with one or two dykes passing through this trap-like mass. The dykes are of a closer texture, with white crystals unlike the surrounding mass. The whole structure of Ben More, in Mull, is full of interest. The summit peak is of stratified rock—mica slate—and all the lower shoulders are granite, or igneous rock *becoming* granite.

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## VI.—On the Cambrian Rocks of Llanberis. By George Maw, F.L.S., F.G.S.

A CUTTING on the branch railway from Carnarvon, now in course of formation, has exposed the structure of the Lower Cambrian beds, the most complicated part of the series. Underneath the beds worked for slates in the Dinorwic and Glyn Quarries, there occurs a considerable thickness of a trap-like rock, obscurely banded with dark olive green and dull buff, which rests unconformably on the upturned edges of a still more ancient slate rock. Many of the dark-green bands, interstratified with the workable slates of the higher series, and which have been grouped with the Cambrian grits and pebble-beds, contain isolated fragments of altered slate, and wherever they are in contact with the blue or purple slates, a thin course of altered green slate occurs at the junction. Towards the lower part of the upper series in the Glyn Quarries, the green matter occurs as thin bands, in contact with which the slate has been altered to a pale green in the same way as that adjacent to the intrusive dykes of greenstone. The dark green bands were found on analysis to exhibit a totally different composition to that of the slaty matrix, and appeared to have been derived from a different source. With reference to the condition of fusion, under which the dykes of greenstone were intruded, judging from the kind of alteration produced in the adjacent slate, the heat could not have been sufficient to effect a purely vitreous liquefaction of the traps; and experiments proved that the slaty matrix was fusible at a temperature at which the greenstone remained refractory.

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## VII.—On the Alteration of the Coast Line of Norfolk. By J. Wyatt, F.G.S.

THIS paper described the result of observation on the changing coast line of Norfolk. The author showed that the geological changes in this part of the island were not all to the loss of the nation, proving that in West Norfolk there was a continual addition to the area. A secondary object of the paper was to enforce the necessity of accurate records of the changes of coast lines, and the author suggested that this should be undertaken by a responsible department of the Government, who should combine the two systems adopted by the Ordnance and Admiralty Surveyors,

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## VIII.—Report on Dredging among the Shetland Isles. By J. Gwyn Jeffreys, F.R.S., F.L.S., F.G.S.

THIS, the fourth report by Mr. Jeffreys on dredging in the British seas, as usual contains observations of much interest. Five species are added to the list of British Mollusca, namely, *Terebratella Spitzbergensis*, Dav.; *Rhynchonella psittacea*, Gm.; *Leda pernula*, Müll.; *Siphonodentalium Lofotense*, Sars.; and *Cadulus subfusiformis*, Sars.; and more information is gained on the geographical distribution and habits of the Mollusca. A list of species obtained from a depth of 170 fathoms is given, of which sixteen were living, and thirty-eight dead. The shells were of the usual tints; the notion that colour is absent, or fainter in shells from deep water appeared to be quite unfounded. Relics of the Glacial epoch occurred in 170 fathoms, and higher, up to 80 fathoms; they were—*Pecten Islandicus*; *Tellina calcaria*; *Mya truncata*, var. *Uddevallensis*; *Saxicava rugosa*, var. *Uddevallensis*; *Mölleria costulata*; and *Trochus cinereus*.

In dredging at a depth of about eighty-five fathoms, on a soft, sandy bottom, twenty-five miles north-north-west of Unst, the canine tooth of an animal of the weasel tribe—probably a ferret—and the shoulder-blade of a bat were brought up. The author is indebted to Mr. Boyd Dawkins for an examination of these remains.

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## REVIEWS.

I.—Histoire Elementaire des Mineraux Usuels par Jean Reynaud. 2me edition. 3 planches. 8vo. pp. 312. Paris: L. Hachette & Cie. 1867.

THIS little book is one of the series called the "Bibliothéque des Mervielles." It is quite an elementary treatise, as stated in the title, on the common minerals, and has been written in the hope of popularizing the study of mineralogy amongst those who have not the leisure to penetrate deeply into the science, but desire to know a little of what is daily going on around them. Being only addressed to those who have no previous knowledge of the subject, the author has, as far as practicable, avoided all technical language; nor does he enter into theories, only treating of the minerals generally met with in every-day life, and these more with regard to their commercial uses than their physical laws.

With this object in view, he has divided all minerals into five great classes, viz.:—les Pierres, les Terres, les Combustibles, Minerais métalliques, et les Eaux minérales. The substances comprised in these divisions he has taken in the order of their relative importance to man in the arts and manufactures, only describing those that are at present useful, and passing over those whose interest is purely scientific.

Each division of the book is commenced with a short introductory chapter, the first of which, for instance, describes what is usually understood by the word "rock," gives an account of *pierres en general,* of the principal elements of which the most abundant rocks are composed. Next follow chapters on granite, including its varieties, syenite, etc. on porphyry, limestones, sandstones, etc., at the end of which are given short notices of the less important siliceous, carbonaceous, and other minerals, such as lapis-lazuli, malachite, or fluor, describing their appearance, composition, properties, uses, durability when used as building materials, localities, method of working, and their histories, where they have been known to, and used by the ancients. The last chapter of this division is devoted to precious stones.

The second division, "les Terres," comprises soils, brick-earths, china-clay, etc.

"Les Combustibles" are, of course, coal, peat, bitumen, and sulphur.

"Les Minerais métalliques" describes the ores and other of the principal metals, with the methods of reducing them.

The last division treats of "les Eaux Minérales," and the substances held in solution by them.

Three chromo-lithographs accompany the text, and, considering the price (1*s.* 8*d.*), we must not be too critical of the details.

This book being of so elementary a nature, we cannot expect it to have many readers in this country, but we hope that it may have a large circulation in France, for we feel sure that if any one reads it through, they will be tempted to go more deeply into this interesting study.

## REPORTS AND PROCEEDINGS.

Geological Society of London.—The opening meeting of this Society took place on November 6, 1867. Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The only communication read was "On the Amiens Gravel," by A. Tylor, Esq., F.L.S., F.G.S., which, with the discussion which followed, occupied the entire evening. The author referred first to the prevalent views respecting the gravels of the Valley of the Somme, namely (1) that there are two deposits of distinct age—the upper and the lower valley gravels; (2) that the former of these is the older; (3) that the Valley of the Somme has been excavated to the depth of forty or fifty feet since its deposition; (4) that both gravels contain bones of extinct animals and implements of human manufacture, the lower gravels, however, containing the greater number of species of mollusca, and the upper the greater number of flint implements; and (5) that the height (70 feet) of the gravels at St. Acheul above the present level of the Somme is much beyond the limit of floods, and that, therefore, they could only have been deposited before the river-channel was cut down to its present level. He then pointed out that the general effect of these views is to refer back the remains of man found at St. Acheul to an indefinite date separated from the historical period by an interval during which the valley was excavated.

In former papers Mr. Tylor stated his belief that the upper and lower valley-gravels of the Somme are continuous and of the same age, which he considered to be close to the historical period. In this paper he stated facts, which appeared to him to demonstrate the truth of his views, and described a number of sections near Amiens, in which the levels were laid down from an exhaustive survey by M. Guillom, Chief Engineer of the Northern Railway of France.

The conclusions he had thus been able to arrive at are the following:—(1) That the surface of the Chalk in the Valley of the Somme had assumed its present form prior to the deposition of any of the gravel or loess now to be seen there; (2) that the whole of the Amiens valley gravel is of one formation, of similar mineral character, contains nearly similar organic remains, and belongs to a date not much antecedent to the historical period; (3) that the gravel in the valley of the Somme at Amiens is partly composed of *débris* brought down by the river Somme and by the two rivers the Celle and Arve; and partly of material from the higher grounds washed in by land-floods; (4) that the Quarternary gravels of the Somme are not separated into two divisions by an escarpment of Chalk parallel to the river, as has been stated; (5) that the evidence of river-floods extending to a height of at least 80 feet above the present level of the Somme is perfectly proved by the gradual slope and continuity of the gravels deposited by them; and (6) that many of the Quarternary deposits in all countries, clearly posterior to the formation of the valleys in which they lie, are of such great dimensions and elevation that they indicate a pluvial period just as clearly as the

Northern Drift indicates a Glacial. This Pluvial period must have immediately preceded the true Historical period.

Geological Society of Glasgow.—1. The annual address in connection with the opening of the winter session of this Society was delivered on October 31st, 1867, by Professor John Young, M.D., F.R.S.E., the President. The subject he had chosen from his own observations was "The evidence of zoological continuity in the past." In speaking of the terms 'high' and 'low' as applied to organisms—terms used too often very vaguely—the lecturer put several cases. Amongst others, the comparison of the lamb and the human infant immediately after birth, which shows a superiority on the part of the former, and raises the question, as regards the invertebrated animals, as to the period of life which supplies data for the decision as to rank. In dealing with the origin of species and the evidences of zoological continuity, Dr. Young stated that, from the earliest times, there must always have been suitable localities for some forms of life. The lecturer passed in review the fossils of the Palæozoic and Triassic strata, and showed that, so far as the structure of their hard parts is concerned, it cannot be affirmed as an absolute truth in all cases—though there is great probability in some—that there has been progress from the earlier to the more recent forms. The fish and labyrinthodonts were the groups chiefly referred to, and in these, especially in the former, it was pointed out that structures once relied on as proof of embryonic condition had since (as the heterocercal tail of fishes) proved to be the rule in many, if not all, living genera. Dr. Young then described at some length the structure of the amphibians, or frogs and salamanders, with their allies, and indicated the points on which they resemble fish on the one hand and reptiles on the other. The amphibians were selected because the classification of the series shows a gradation of structures generally parallel to the development of the tadpole into the frog. He then pointed out that the labyrinthodonts belonged to the lower divisions of the amphibians, but that at their first appearance in the Coal they present two forms of very unequal development as regards their skeleton, just as at the present day amphibians co-exist of all degrees of development. It was next shown that functionally the sharks are, in many respects, better endowed than a large section of the amphibians. The latter, however, are ranked higher than the former. In the lower members, however, of a class there is no degradation in the sense of backward progress, where structural inferiority is found, it is an arrest of development; where the parts are fewer, it is because the functions are more limited. There are but two ways of the origin of living things; not speaking of the first origin of all, but of the appearance of new forms in a series already existing. The one of these ways is that of a relation by descent, with modification; the other is the organization of inert matter. The one is within the limits of science, the other is wholly beyond the pale. We must either believe in the hypothesis of special creation, or in that of zoological continuity. The former involves so many contradictions, and is after all so utterly barren, that we are compelled to seek for some theory which shall show that the classification of animals depends on the right understanding of laws continuously operative throughout all time. Descent, with modification, is the probable origin of our present faunas, but that descent must be compatible with the continuance, unaltered for a shorter or longer period, of some at least of the plans of structure; must have been so far under external influences that the causes of change have been at all times variable in amount and in extent of action; otherwise, at present, we should see around us only the higher forms, the lower having succumbed to a universal law of change. The spirit of this view is contained in a pregnant sentence by one of our highest authorities in Botany, who has contributed much by his writings to the philosophic cultivation of Natural History. Dr. Hooker, in his Flora of Tasmania, says "The degree or amount of variation may be assumed as differently manifested at different epochs in the history of the group," and goes on, "as all the highest orders of plants contain numerous species, and even genera, of as simple construction as any of the lower orders are, it follows that the physical superiority which is manifested in greater extent of variation, in better securing a succession of race, in more rapid multiplication of individuals, and even in increase of bulk, is in some cases of a higher order than that represented by mere complexity or specialization of organ."

2. An ordinary meeting of this Society was held on November 7th, Professor Young, M.D., F.R.S.E., President, in the chair. The following papers were then read:—

I. On the Order of Succession among the Silurian Rocks of Scotland. By Archd. Geikie, Esq., F.R.S., Director of the Geological Survey of Scotland. The Silurian rocks may be regarded as the framework of the country. They spread over the Southern uplands, and then, sinking under the central valley of the Lowlands, rise up on the farther side in a metamorphosed form, and stretch far and wide as the gneisses, schists, limestones, and quartz rocks of the Highlands. It is, of course, in the unmetamorphosed or southern belt that the order of succession among the Scottish Silurian rocks must first be studied. The contortions in this southern belt obscure the relations of the beds; but viewed on the great scale, a longitudinal axis is seen to traverse the chain in a N.E. and S.W. direction, crossing Annan valley, a little south of Beattock. This central portion must therefore be of older date than those towards the margins where Upper Silurians are found on the north at Lesmahagow and the Pentlands, on the south in Kirkcudbright. Pending the detailed mapping of the country, the succession seems at present to range from Llandeilo Flags, represented by the beds along the axis, to the Lower Llandovery, to which certain Ayrshire beds seem to belong. The hard grey grits, greywacke sometimes conglomeratic or brecciated, blue, red, or olive shales, and occasional but inconstant bands of limestone, which make up nearly the whole of the Southern

Uplands, are, in default of more detailed palæontological data, most safely referred to the Caradoc and Llandeilo rocks of Wales.

In the discussion which followed, Mr. E. Hull, F.R.S., drew attention to the poverty of the Scottish Silurian rocks in Limestones, as compared with those of the Border districts of England and Wales, where calcareous strata are more fully developed, and remarked that there was an apparent similarity in the distribution of calcareous strata of the Silurian and Carboniferous rocks of the two countries. In the latter case, the Carboniferous limestone was most fully developed in central England, attaining in Derbyshire a thickness of over 4000 feet, and gradually thinning away northward into central Scotland. On the other hand, the sedimentary materials augment in bulk towards the north-west, and in north Lancashire attain a thickness of about 18,000 feet. Mr. Hull thought it probable that the Silurian sedimentary strata would be found to augment in bulk in a northerly direction, and in the inverse ratio of the calcareous beds of the same formation. He believed that the cause in each case (Silurian and Carboniferous) was the same, and that these changes might be explained on grounds which Bischof had hinted at in his "Chemical Geology"—that the existence of sediment in the ocean is inimical to the formation of limestones. Applying this doctrine to the cases of the Silurian and Carboniferous formations, and supposing the source of the sedimentary materials to have lain in the region of the North Atlantic (then a continent), the explanation of the tailing out of the calcareous beds towards the north and north-west might, he thought, be found.

II.—On the Upper Silurian Brachiopoda of the Pentland Hills, and of Lesmahagow in Lanarkshire. By Thomas Davidson, Esq., F.R.S., etc. Mr. Geikie had determined that the Upper Silurians form the fundamental rocks of the Pentland chain, and are covered unconformably by the Old Red Sandstone, by felspathic traps of Old Red age, and by lower Carboniferous sandstones; while their geological position was equivalent to the Ludlow rocks of England. After the examination, however, of several thousand specimens of the fossils, Mr. Davidson was of opinion that both the Ludlow and the underlying Wenlock rocks were represented in the Pentland Hills. The specimens of Brachiopods occur principally in the condition of external casts and internal impressions—the shell itself being rarely preserved. These observations were followed by a full description of the species, about twenty-six in number. The remaining portion of Mr. Davidson's paper consisted of a description of two species of Brachiopoda, *Lingula minima*, Sowerby, and a *Rhynchonella*, discovered by one of the members, Mr. Robert Slimon, in the Upper Silurian rocks of Lesmahagow. It was of great importance that the fossils from the lower Palæozoic series of Scotland should be correctly described and illustrated; and with a view towards furthering that object, he had gladly acceded to the request made him by the President and by some members of the Society that he should prepare for the Palæontological Series of the Transactions a series of descriptions and illustrations of our Scottish Silurian Brachiopoda. J. A.

Norwich Geological Society.—Monthly meeting, September 3rd (continued). The Rev. J. Gunn, M.A., F.G.S., President, in the chair. The President read a letter from Mr. Searles V. Wood, jun., having reference to the so-called deposits of the old estuary of the Yare. Mr. Wood said, "I have been induced to doubt whether the beds described by Mr. Prestwich, as covering the London-clay in Sir E. Lacon's boring at Yarmouth, be what he calls them, viz., the deposits of the old estuary of the Yare. There may be nothing in my doubts, but I will explain them. The depth to which these deposits descend is 171 feet, the upper fifty feet being, according to Mr. Prestwich, blown sand. Now as the town of Yarmouth stands only from ten to fifteen feet above the present level of the Yare, this depth of 171 feet would, on Mr. Prestwich's view, imply that the estuary of that river was originally 28½ fathoms below the town of Yarmouth, *and was completly silted up* to the marsh level. Such a depth, however, I find to be three times the deepest point inside the sands forming the Yarmouth Roads, and more than twice the average depth of the North Sea, which only exceeds seventeen or eighteen fathoms in a few deep places far out towards Holland. Moreover, it is double the greatest and three times the average depth *of the estuary of the Thames, where it is fifty miles across from Harwich to the North Foreland.* It exceeds the depth of the English Channel, between Sussex and France, and only one narrow submarine channel in the Straits of Dover equals it. Moreover, if the thickness of the Crag and Chillesford beds on the east side of Norwich be added to the base of Corton cliffs, it would only take off from this 171 feet, at the most, 21, leaving 150 feet to be added to the thickness of the London-clay, which the boring showed to be 310 feet under the 171. This would make the thickness 460 feet for the London-clay, or more than its maximum known thickness in its thickest part, viz., South-east Essex. Under these circumstances I cannot help having a suspicion that the so-called estuary beds are the prolongation of the Cromer beds, which, in the form we see them at Hasbro', seems to resemble the beds pierced in the 171 feet boring, or rather in the lower part of that boring, say the lower 120 feet. If there be anything in this, the only way to determine it would be to put down a borer from the base of Corton cliff, and learn whether these beds are present there below the red loam sand and Boulder-clay of that cliff. Of course we can suppose the Yare estuary excavated to this depth, with a proportional increase in the depth of the adjoining North Sea; but when we recollect the rapid way the coast wastes, it is difficult to suppose that the cliffs forming this estuary on either side of the Yare, now represented by the hills north and south of the river (which are only six miles separated), would not have been wasted by the agency of deep waters of such an estuary during the long period required for silting up 171 feet, so as to push them back to a much greater width than they now possess. If the Yare has thus been silted up, why have not the other rivers of the east coast?" The President said Mr. Prestwich came to the conclusion he did by examining the shells; if he had seen the *Tellina obliqua,* or any of the Norwich Crag shells, he would have known them instantly. For his own part, he thought Mr. Wood's difficulties were easily answered. The water-level was always permanent, that of the land was not. The land was upheaved to a great extent, and then the valley was scooped out, and subsequently going down again, was silted up. Mr. Harmer said Mr. Wood's difficulty was that a vast period of time must have elapsed while the 170 feet was being silted up. The President remarked that it must be considered they were speaking of a time when rivers were stopped up with ice, and when tons of materials were rapidly brought down the streams, much more rapidly than now.

The President then read a report "On an Excursion to Corton and Hopton." The very contradictory opinions expressed in the Geological Magazine respecting the number and position of the Boulder-clays in Norfolk and Suffolk appear to render it desirable that the geologists, who maintain such different views, should for a time rest their pens and use their eyes. In accordance with this impression, an excursion of the Norwich Geological Society was fixed for September 19th, and the members met on the beach at Corton, in Suffolk. It was very satisfactory on the day of excursion to find the beach cleared of shingle, and the "red loam," as Mr. Wood calls it, exposed about two miles in extent. Six small boulders of granite and trap-rock, besides flints, several of them polished and scratched, were taken out of it. The bed varied in thickness from four feet to twelve feet, and was at very different levels, sometimes dipping below the beach, and in one instance, near Hopton, upheaved about ten feet. It is unstratified and, in the opinion of the members present, corresponds with the Lower Boulder-clay at Happisburgh in every respect except colour. The position is precisely the same between the laminated series and the Middle Drift. The extensive beds of gravel above may suggest the cause of this change of colour.

On this excursion not only was this Boulder-clay seen to be exposed at the base of the cliffs, but in many places four and five feet, and in one place, where an upheaval had taken place, about fifteen feet of the laminated series. The forest bed, also, was seen peeping out. Besides the beds beneath the Lower Boulder-clay, the Middle and the Upper Drift were seen to advantage, and large masses of *septaria* in the Upper Boulder-clay. What was most unexpected was the range and depth of the Post-glacial sands and gravels above the Upper Drift, which promise the discovery of flint implements, and other relics of the early occupation of man.

Geologists' Association, University College, London.—The session commenced on Friday, the 1st, with a paper by the Rev. Thomas Wiltshire, M.A., F.G.S., "On the Chief Groups of the Cephalopoda." The author having given a definition of the forms of life to which the term Cephalopoda is restricted, proceeded to divide the class into the two great orders of the *Dibranchiata* and the *Tetrabranchiata*: the common Cuttle-fish and the Pearly Nautilus being taken as types of these orders, various facts in connection with their organization and habits were mentioned, and allusion was made to some of the other genera now existing in the present seas. These remarks served as an introduction to the description of the fossils belonging to the same class. The Belemnites, the Ammonites, and the Nautili, with their sub-genera were explained. The old traditions relative to the two former were not forgotten, and the knowledge of more modern times brought to bear upon the subject. The paper closed with some remarks upon the existence of the Nautili group in the more ancient deposits, and upon the importance to be attached to the zones of all these fossils in connection with agriculture and mining operations.—*Land and Water*, November 9th, 1867.

Bristol Naturalists' Society.—At a meeting of this Society, held on October 24th, Major Thomas Austin, F.G.S., in the Chair, Mr. W. W. Stoddart, F.G.S., read a paper "On the Lias series of Bristol." In describing the Cotham Grove quarry, the author stated that the beds attained a thickness of fourteen feet five inches, of which about half belonged to the so-called "Sutton series." This series was placed by Mr. Tawney[1] in the Rhœtic formations when he first described the beds as developed at Bridgend, Glamorganshire; subsequently, Mr. Bristow[2] has referred them to the zone of *Ammonites planorbis* in the Lower Lias, with the appellation of Lias conglomerate, in explanation of their characteristic structure. This section at Cotham decidedly proved the latter opinion to be correct, as the fossils of the *Planorbis* zone were found both above and below the horizon of the Sutton fossils. Details of the various strata were given; the Sutton series comprised twelve beds of limestone, separated by bands of clay containing encrinital joints. The sixth bed from the top contained the most characteristic fossils in the greatest numbers, namely, *Lima Dunravenensis*, *L. gigantea*, *L. tuberculata*, and *Pecten Suttonensis*; *Plicatula intusstriata*, met with in the series at Bridgend, was here absent. Underneath the Sutton series were beds containing *Ammonites Johnstoni*, *Pholidophorus*, *Modiola minima*, *Myacites*, *Monotis*, etc., and at the base the Cotham marble. Mr. Stoddart added that Mr. Etheridge and Mr. W. Sanders were satisfied of the correctness of his views.

Palæontographical Society.—A general meeting of this society was held on the 31st of October, when Dr. James Scott Bowerbank, F.R.S., was unanimously elected President in the room of Mr. Hamilton, deceased, who had filled the post of president for 20 years, and Professor Phillips was chosen to fill the vice-presidentship, vacated by Dr. Bowerbank. The election of Dr. Bowerbank to the presidental chair of this society will be gratifying to every one who knows how very much geological and palæontological science owe to him. Many a man, now eminent in science, has been heard to attribute his first feelings of interest in scientific pursuits to Dr.

[1] Quart. Journ. Geol. Soc., vol. xxii. p. 69.
[2] Geological Magazine, *ante*, p. 216.

Bowerbank's patient and generous teaching, and his subsequent rise to Dr. Bowerbank's kind introductions and encouragement. The society itself may be said to owe its formation to him, for when it was proposed to figure the fossils of the London clay, he asked the pertinent question, "Why not figure the whole of the British fossils?" The idea was seized and acted on, and the works which the Palæontographical Society publish annually are sufficient proof of the value of the suggestion.—*Land and Water*, November 9, 1867.

## CORRESPONDENCE.

### THE VALLEY OF THE OUSE AT BUCKINGHAM.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—In a paper by Mr. Searles V. Wood, junr., in the last number of the Quarterly Journal of the Geological Society, there is the following foot-note (p. 309):—

"The section of the valley at Buckingham, given in the Memoir of the Geological Survey at sheet 45, appears to me quite at variance with the actual structure of it. So far from there being any evidence of the existence of an actual valley in this part prior to the Glacial period, the mode in which the valley of the Ouse is cut through the Glacial-beds shows the valley to have been wholly formed since the deposition of the Glacial-clay."

Will you allow me to call attention to a few facts which seem to have escaped Mr. Wood's notice when he wrote the above?

The section to which Mr. Wood alludes was drawn from the following evidence:—First, a quarry on the Stony Stratford-road, just outside Buckingham, on the eastern side of the valley, showed the following section:—

Drift-gravel,
Cornbrash,
Great Oolite.

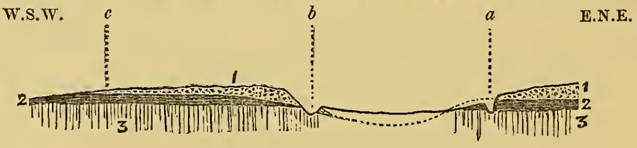
Secondly, a quarry behind Buckingham Workhouse, on the opposite side of the valley, showed Drift-gravel resting directly on Great Oolite, *without any Cornbrash between.* Thirdly, at the Buckingham cemetery, a little further to the west, we have a section exactly like the first, namely, Drift-gravel, resting on Cornbrash, with Great Oolite below.

Now these three sections seem to me to show conclusively that, before the deposition of the Drift-gravel, a valley must have run between the first and third, at least, as deep as the thickness of the Cornbrash. I believe the central quarry showed that the hollow had also cut down into the Great Oolite; but I have not my note-book now with me, and cannot speak certainly on this point from memory. These little points of evidence are so minute that no one can be blamed for overlooking them; but even if they had not been forthcoming, I do not think Mr. Wood's reasoning very convincing, when he argues that, because the river has cut a valley through the Glacial-beds, therefore there could have been no valley there before.

Errors of omission are pardonable enough, but such a bit of logic as this he must allow me to cry out against.

I add a sketch section, which will perhaps make my meaning clearer.

SECTION ACROSS THE VALLEY OF THE OUSE, AT BUCKINGHAM.




1 Drift Gravel.
2 Cornbrash.
3 Great Oolite.

*a* Quarry on Stony Stratford Road.
*b* Quarry behind Workhouse.
*c* Cemetery.

Dotted line—supposed outline of surface before the deposition of the Drift Gravel.

Yours obediently,

A. H. GREEN.

MONK BRETTON, BARNSLEY,
*Nov.* 18*th*, 1867.

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## AGE OF THE THAMES VALLEY DEPOSITS.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—Mr. Searles Wood, jun., in his essay on the structure of the Post-glacial deposits of the south-east of England, published in the last Quarterly Journal of the Geological Society, Vol. xxiii. p. 394, has made some remarks relative to a paper of mine, on the Lower Brick-earths of the Thames Valley, which ought not to pass without notice. Into the merits of his arc-theory, in explanation of the inequalities of the present surface of the ground, I do not intend to enter, nor into the question of the supposed existence of the faults in certain gravels and brick-earths. What immediately concerns me, is the assertion that the Thames gravel, *x* 4 of section twelve, of his essay, p. 409, overlies the mammaliferous brick-earths of Stonehams pit near Crayford, and his inference therefrom that there is no parallel between the brick-earths of Grays and those of the great pit near Crayford, which was stated to exist in my essay. In coming to my conclusion, so far from neglecting the evidence of super-position, I have gone over the ground repeatedly with Dr. Spurrell and Mr. Flaxman Spurrell, who have obtained a magnificent collection of mammals from it, and know it better than perhaps anyone else, and I have failed to detect the slightest proof of the Thames gravel in question actually overlying the brick-earth. Professor Morris also is fully pursuaded of the exact parallelism in in point of time between the brick-earth at Crayford and that at Gray's Thurrock. I see therefore no reason for modifying my belief on that point. Mr. Wood assumes that the deposit on the south of Dartford Heath, and at Hill House, is of the same age as the fossiliferous beds at Crayford; but he adduces no proof of it whatever. Whether they be or not is perhaps an open question, but the fact that the brick-earths in the railway-cutting, immediately to the north of Mile End Terrace, and not more than half a mile from

Hill House, contain nearly all the testacea now living in our rivers, and none of those extinct in Britain, and no bones of mammals, proves them to be much newer than the neighbouring deposits containing older forms of life.

Again, the principal object of the essay seems to be to demonstrate the Post-glacial age of the valleys in the south-east of England, and especially that of the Thames. That demonstration has altogether eluded my grasp. An appeal to the author's elaborate maps, in the rooms of the Geological Society, supplies proof that is directly subversive of his theory, The whole question lies in a nutshell. Do you, or do you not, find Boulder-clay *in* the basins drained by the rivers of which he writes? Is it present in those of the Roding and Blackwater? A glance at Mr. Wood's map of the area drained by the former, shows that he recognizes that it is so found. In reference to the latter river I have to correct a mistake. Mr. Wood wrote to me for proof of its occurrence in the basin of Blackwater; and, unfortunately, without dreaming that my hurried note would be quoted in print, instead of referring to my note book, I ran my finger up an affluent of the Blackwater, instead of the main stream, and wrote Ingatestone and Mountnessing,—a mistake that Mr. Wood has italicised and noted with a mark of admiration. I ought to have written Witham Station. So far, indeed, as Mr. Wood's maps go, the Boulder-clay occupies any level, irrespective of inequality of surface, and therefore they prove that the hill and valley system "was sketched out" before the deposit of the overlying Boulder-clay. Of course, in many places, the Boulder-clay has been denuded by the present streams, and areas of London clay, of variable extent, have been exposed. If Mr. Wood restricts the term valley to the hollow in the immediate vicinity of a stream, and does not mean the area below a line drawn from one watershed to another, he is merely disputing about terms. If the excavation of the Thames Valley, using the term in the latter sense, took place in Post-glacial times, the deposits contained in it must also be Post-glacial, and the evidence of fossils characteristic of Pliocene mammals in France and Italy, is useless in classification. To say the least, no evidence has yet been adduced in support of this hypothesis, that is based merely on a belief that the entire valley-system of the South-East of England originated in centres of arc-like or curvilinear disturbance." W. Boyd Dawkins.

11th November, 1867.

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## DR. A. VON KOENEN, ON THE BELGIAN TERTIARIES.

*To the Editor of the* Geological Magazine.

Sir,—In the November number of the Geological Magazine, M. von Koenen, in dissenting from my way of viewing the Belgian and East Anglian Kainozoic formations, represents me in a manner to which I may reasonably object. My paper having been published in the Journal of the Geological Society I should be sorry should its members be misled.

M. von Koenen starts with what is calculated to produce an erroneous impression. At page 504 he says, "Mr. G. A. has published a number of observations made at Antwerp *during his short* stay." Of himself he says, by way of contrast, "I have visited Antwerp on five separate occasions, in three different years;" but had he read my paper with more attention than he has, he would have seen that I had been there repeatedly; and what is more to the point, that I had seen the sections at Edeghem in 1861 (p. 234), when the extent of open work was much more favourable for geological observations than in 1865.

He complains (p. 505) that I do not follow the divisions of any of the authors who have described those beds; if this means that I have not used such terms as Oligocene, Miocene (GEOL. MAG., p. 507), it is true, but it was not from ignorance; rather from an old conviction that such a system of nomenclature was based in vague, mistaken, and theoretical views. He is incorrect, however, when he states that I have disregarded old names. I took, what I still consider to be, the natural division of the Belgic Kainozoic beds—that of M. Dumont and M. Nyst. The natural system in geology and palæontology is that which describes old sea-beds and their contents, according to the guidance which the naturalist and hydrographer have derived from the dredge and sounding lead; in place of this, the artificial systematists have endeavoured to set up what are merely convenient Museum arrangements.

Some of M. V. Koenen's sentences are contradictions rather than objections, p. 505, "Barton Clay does not correspond in age with Rupel Clay." Waiting for better evidence to the contrary, it seems to me that the approximation of the purely marine clays of Rupelmonde to those of Barton is closer than that which can be established between any two deep sea mud-beds of the English and Belgic Nummulitic formations. It may be, and must be, that a freshwater formation in one place is the equivalent of a purely deep-sea series in another, the Physical Geologist may some day arrive at their arrangements, but not so the Cabinet Conchologist. Another short phrase used by M. Von Koenen at p. 505, is also calculated to mislead: "The Tertiary beds of Cassel, Luithorst, Freden, and Diekholz, which he puts into the upper Kaniozoic, are . . . . . coeval with the Grafenberg and Sternberg Sandstones which he puts into the Tongrien." Put in this way, it certainly represents me as writing nonsense, but I wrote nothing of the kind. The reference given is to a note, in which I state "that the map of the Crag Sea has been drawn so as to include the Upper Kainozoic formation near Cassel, etc." There is an extension of sea-bed thus far into Hesse with the following fauna:—

*Solen ensis, Mactra triangula, Corbula nucleus, C. revoluta, C. cuspidata, Tellina distorta, Astarte incrassata, Cyprina Islandica, Venus plicata? Cardium papillosum, Isocardia cor, Arca diluvii, A. noæ, Nucula sulcata, N. margaritacea, N. minuta, Calyptræa vulgaris, Bulla utricula, B. ovulata, B. lignaria, B. Lajonkaircana, B. acuminata, Eulima subulata, E. nitida, Natica castanea, Turritella communis, T.*

*carinifera, Siliquaria anguina, Cerithium vulgatum, Lima perversum, L. trilineatum, Buccinum macula, Pleurotoma rugulosum, Mitra eburnea, M. plicatula, Dentalium strangulatum.*

There is a sufficiency of Lusitanian features in this assemblage to make it referable to that older condition of the North Sea known as the Crag Period; instead of associating such a fauna with that of Sternberg and Grafenberg, one object of my paper was to show that there was no blending.

The mystification as to Cassel arises from the same cause as it did at the Bolderberg; there is an admixture of fossils, but it is purely accidental, owing to the lowest beds of one series (Kainozoic) having been superimposed upon the uppermost beds of another (Tongrien). This last has not been misunderstood by M. D'Orbigny (see Von Koenen, p. 505), in whose geological scheme it is the latest and uppermost marine assemblage of the great Nummulitic Period, and of its Germanic sea area.

M. D'Orbigny's only misconception consists in his placing his "Tongrien" as a "sous-étage" of the "Falunien." Into this he was misled by the German authors. It is an error which may be turned to good account by others, as showing how unsafe it is to methodise from a bag of fossils gathered from the remanié beds of one locality.

Yours truly,

ROBERT GODWIN-AUSTEN.

CHILWORTH MANOR, GUILDFORD,
*November* 19*th*, 1867.

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## MR. WHITAKER ON "SUBAËRIAL DENUDATION."

*To the Editor of the* GEOLOGICAL MAGAZINE.

DEAR SIR.—I most unwillingly request of you to allow me space to reply to some observations of my colleague, Mr. Whitaker, contained in his paper "On Subaërial Denudation," published in the number for October last; and calculated to convey a very erroneous impression of my views on this subject. Owing to a variety of circumstances, I had not read this paper, nor was I aware that any personal allusion to myself was contained therein, until a friend called my attention to the passage a few days since. In that passage I find myself represented (p. 453) as "*a strong believer in the sea, and nothing but the sea,*" as objecting to reasoning on logical principles, and the writer concludes with the following:—"One should not be surprised at the advocates of the marine formation of valleys and escarpments looking down on logic, and scorning syllogisms, . . . . unless *they follow and overcome those prejudices* which contracted views of nature and magnified opinions of the experience of man may have begotten," etc. What may be the meaning of "following" and "overcoming" a prejudice, is a question which may well be left to those who alone are conversant with logical reasoning.

If my critic had only taken the trouble to refer to my paper in the GEOLOGICAL MAGAZINE (Vol. III, p. 474) on "The Denudation of the Valleys of Lancashire," and to another paper to which reference is there made in the *Popular Science Review* (for October, 1866), which he was bound to do before he undertook to give an exposition of my opinions, he would scarcely have represented me as being "a believer in the sea, and nothing but the sea" as an agent of denudation. So far from this being the fact, I state in the former paper, with regard to the scooping out of the valleys of the Lancashire Hills, that they have been formed by rivers "in the great majority of instances" (page 474), and again (in page 477), I add, "the more I consider this subject, the more I am satisfied, that in the great majority of instances *in this region,* the extent and limits of river action are capable of the clearest demonstration. Most of the valleys are really double valleys, the smaller being alone due to river denudation," and the evidence of this lies in the fact—that the larger, or primary, valleys are filled with terraces of Marine Boulder-clay, and are really plains of marine denudation in their earlier stages.

In the paper in the *Popular Science Review,* I adopt a two-fold view of denudation, under the heads of "Vertical Denudation," and "Horizontal Denudation;" the former term including the formation of "channels and furrows, either branching or lying along parallel lines, as in the case of mountain chains," by the action of frost, rains, rivers, and glaciers. Under the term "*horizontal*" denudation, I include the formation of plains and terraces by wave action, either of the sea, or large lakes.

If my critic had glanced at the same paper he would also have seen that I adopt, though with some hesitation, the views of Professor Ramsay, Dr. Foster, and Mr. Topley, regarding the subaërial denudation of the Weald; and, without any hesitation, those of Mr. P. Scrope regarding the formation of valleys and escarpments in the region of Auvergne; and after this statement I am quite ready to leave it to the judgment of your readers whether or not I am to be regarded as "a believer in the sea and nothing but the sea."

A believer in the sea I certainly am; both in its power of forming valleys and escarpments, and this from the evidence of my own eyes. I have seen along the coast of Cantyre, channels several hundred feet in length, with steep walls scooped out of tough gneissose rock by wave action, and caves hollowed out of porphyry and other rocks, like part of a railway tunnel, many yards in length, and I care for no *à priori* arguments which are intended to prove that after such exhibition of the power of wave action to cut narrow channels in the rock, the formation of valleys by such an agent is an impossibility. Knowing the variety of agencies which nature employs in the formation of the features of the earth's surface, and believing that each special district requires the application of special principles, I altogether repudiate *as of universal application* some of the general axioms laid down by Mr. Whitaker with such show of authority; knowing from my own experience that some of them are contrary to fact. I shall just remark on one or two of them here. He says:

(1) "Escarpments always run along the strike, whilst sea-cliffs rarely do so." The "rarely" is a saving clause, as there are many

examples; but has it not occurred to the author, that towards the close of the Drift period, most of the principal escarpments of the centre and north of England which run along the strike, must have been sea cliffs when the land was from 200 to 400 feet lower than it is.

(4) "If escarpments have been formed by the sea, there ought to be at their foot some resultant, a beach or other marine deposit; but this is not the case (except where masses of Boulder Drift end near the bottom of a ridge)," etc. To this I reply that these "masses of Boulder Drift" are very often level terraces of marine origin, and to all intents and purposes sea-beaches, or beds; but besides this, there *are* true sea-beaches at the foot of escarpments, as for example, in the Vale of Gloucester, at the foot of the Cotswold Hills.

I would also remark, that it is surprising to me, how any one who believes in the formation of Professor Ramsay's "Planes of Marine Denudation," can question the power of the sea to produce escarpments, as some escarpments are only the lines along which the sea left off its work in the formation of such planes.

In conclusion, I will only express a very strong conviction that we shall never arrive at true views of the operation of nature in sculpturing the surface of the earth, unless we take into considera- the effects of all possible agencies, and give them their due place in the great work. I remain, yours truly, EDWARD HULL.

3, HAMILTON PARK TERRACE,
GLASGOW, 18 NOV., 1867.

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## ON CLIFFS AND ESCARPMENTS.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—I know very little about escarpments in the soft newer formations, but as I have seen a fine cliff cut by the Atlantic in the hard, older rocks that occur in the west of Ireland, and also in the Boulder-drift, perhaps I may be allowed to make a few remarks on Mr. Whitaker's notes on cliffs in his "Comparative table of the distinctive features of Escarpments and Cliffs."[1]

| "CLIFFS." | REMARKS. |
| --- | --- |
| (*a*) "Rarely run along the strike,[2] but at all angles to it, and cut through many formations in succession." | (*a*) It rarely happens that a sea-cliff can keep to the out-crop of a bed, for it is highly probable that the beds were not raised to their present position horizontally. However, it does occur sometimes, although the beds may not be perfectly horizontal; as, for instance, on the westerly coast of Aranmore, Galway Bay, where a bed of shale for miles forms the base of a perpendicular cliff: also on the coast of Clare, where a thin bed of limestone in the Coal-measure shales acts in a similar way. At the base of a drift-cliff, there is often a bed of stiff clay; just as it will often occur at the base of a drift-cliff formed by a stream. |

[1] GEOL MAG. November, 1867. Vol. IV. p. 491.
[2] Ought not this to be out-crop, or basement?

| "CLIFFS." | REMARKS. |
| --- | --- |
| (*b*) "Tops mostly very uneven." | (*b*) In the west of Ireland the tops of the escarpments are also "mostly very uneven," except, perhaps, some of those limestone escarpments in the Barony of Burren, Co. Clare; but these are very similar to the cliffs now being formed by the sea in the limestones along that coast. |
| (*c*) "Rarely through the highest ground of a country, but mostly backed by higher ground." | (*c*) If (for argument sake) we allow that *all* cliffs were formed by the sea, it would be nearly impossible that the present sea-cliffs should run through the highest ground of the country. For if the land rose gradually the sea-action would form a slope, a period of rest being necessary for the formation of cliffs; and, therefore, to allow of the cliff being in the highest ground, each succeeding rest must, at least, be of twice the duration of the previous one. However, in spite of these conditions, many of the headlands extending into the Atlantic *slope from the cliff inland.* |
| "ESCARPMENTS." | |
| (*d*) "Very rarely have the sea at their foot, but often springs and watercourses." | (*d*) Most, if not all, of the drift-sea-cliffs have springs at their base; so have the previously mentioned cliffs in Aran-more and Co. Clare. There are, also, usually springs at the base of a cliff which rise from a horizontal, or nearly horizontal, master-joint. |
| (*e*) "Often run in more or less winding lines." | (*e*) The sea-cliffs on the west of Ireland are very irregular, never in anything approaching a straight line or a wide curve. |
| "CLIFFS." | |
| (*f*) "Mostly a beach at their foot." | (*f*) On the west of Ireland there is rarely a beach at the base of a cliff, except, perhaps, when it is of Boulder-drift, and even then not always. |
| (*h*) "Bases at the sea-level." | (*h*) Not always. If there is a horizontal, or nearly horizontal master-joint, either above or below the sea-level, the cliff is nearly sure to spring from it; or it may spring from a soft bed that occurs under similar conditions. |

From the above remarks may it not be suggested that sound conclusions cannot be drawn from observations made only among peculiar rocks. If an observer will compare the work done by the two dissimilar forces—marine and subaërial (including ice) denudations—he will be surprised to find the results so very similar in appearance. However, he should always bear in mind that the subaërial agencies may work alone, when the marine agencies must always be helped from above.

Yours, etc.,
G. H. KINAHAN.

CONNEMARA, *Nov.* 10*th*, 1867.

## LYELL, JUKES, AND WHITAKER ON SURFACE-GEOLOGY.

*To the Editor of the* GEOLOGICAL MAGAZINE.

SIR,—Since I last wrote very briefly on the origin of escarpments,[1] you have admitted into your pages two articles, one by Mr. Whitaker, and one from Professor Jukes, which, were they to remain unnoticed, might leave the controversy too one-sided, more especially as the first-named author has spoken in very strong and persuasive terms (coupled with a grace and elegance which remind one of the illustrious Playfair), which are calculated to mislead those who have not studied the other side of the question.

*Lyell's Recantation.*—Let me first call attention to a change of opinion in the great founder of inductive geology—Sir Charles Lyell, as announced by Mr. Whitaker. Ordinary coast-action, Sir Charles now believes, will not account for the parallelism of the Chalk and Greensand escarpments, or for both following the strike of the strata. But to reject coast-action as the main or primary cause of these escarpments is not entirely to give up the marine theory; for they may have originated in longitudinal cracks during axial elevation, and may afterwards have been deepened and widened, and their inner sides planed down by currents maintaining a general uniformity of direction, but at intervals deflected and reflected so as to hollow out the curvilinear "coves" by which the "capes" are separated.[2] But suppose it could be shown that powerful currents, operating at a considerable, not "too great" a depth, are incapable of scooping out the depressions bounded by escarpments, it would not be more inconsistent with uniformity to suppose a cyclically-recurring intensification of the action of currents, caused by sudden upheavals of strata, than to admit "occasional strides, constituting breaks in the otherwise continuous series of (organic) changes."[3]

*Whitaker on Chalk Escarpments.*—Mr. Whitaker and other subaërial geologists, though they have thrown difficulties in the way of the marine theory, have brought forward very few facts in support of their own views. The main force of what they have advanced lies in a few words—Because sea-coast action could not have done it, therefore it has been done by rain and frost. To state that a river *sometimes* flows near the base of an escarpment, coupled with the admission made by Messrs. Foster and Topley, and implied by Mr. Whitaker, that escarpments are not river-cliffs—that springs are often found at the base of escarpments—and that time will accomplish anything . . . cannot be regarded as evidences, unless it can be shown that these agents are now actually giving rise to phenomena similar to those requiring explanation. An escarpment is a *steep, continuous* slope. Continuity, both longitudinally and transversely, are its essential characteristics. Springs, at intervals, cause landslips which *break* this continuity, and therefore tend to destroy escarpments. Rain-streamlets (where they are not prevented by a covering

[1] GEOL. MAG. May, 1867.
[2] See reference to escarpments under the Atlantic, *ibid.* p. 236.
[3] Lyell's Antiquity of Man.

of turf) furrow their faces, and tend to disfigure a smooth slope by a series of unsightly gutters. Frost cannot act effectively where an escarpment or slope does not already exist. Mr. Whitaker, to a certain extent, seems to admit this, when he speaks of "outliers" as "relics" of a former escarpment, and "inliers" as signs of a future escarpment. He invests subaërial agency with a power of beginning, by making something very unlike an escarpment, and ending by ruining an escarpment—the escarpment being only a stage of maximum development. Somewhat like Professor Babbage and his calculating engine, he makes his machinery capable of performing a miracle at a certain stage of its working, so as to give a result the opposite of that preceding and following. The fact would appear to be, that the action of the atmosphere, instead of forming a slope, tends directly to make a pre-existing slope less *escarpmental.* It has never been satisfactorily shown how, on a plane of marine denudation, the atmosphere could *begin* the work of escarpment-making.

*Removal of Detritus.*—Mr. Whitaker admits the absence of a *talus* from the face of Chalk escarpments, and states that the solid chalk comes up to the surface. But this is the case, not only with the slopes but with the *base* of many Chalk escarpments; and it may be asked, if rain has washed away the soluble chalk, what has become of the insoluble flints? Is it reasonable to suppose that rain and frost, which act intermittingly, or by successive stages, can leave no sign of their action? Col. Greenwood (the father of modern subaërialism) admits that one rain leaves soil on its path to wait for the "next rain." The entire absence of detritus implies a cause equal in force and volume to a "sweeping" removal of the mass of chalk necessary to leave an escarpment. Uniformly-cut, and cleanly swept surfaces of chalk are common not only on the face and at the base of escarpments, but on the sides of gently swelling eminences, and on the level summits of table-lands, or "planes of marine denudation." There are many short Chalk escarpments, and parts of long escarpments, where the ground at the base is a plain, and where there is no stream to carry away the detritus which must result from the action of rain and frost, if they act at all. The streams in the neighbourhood of other escarpments are so sluggish, and choked with vegetation, that they tend rather to raise than lower the level of the area through which they flow. Mr. Whitaker admits that the formation of some escarpments is "delayed," and that rains, during a "former order of things," must have been more powerful than now. Why, then, not allow the advocate of marine denudation to suppose the action of currents formerly more energetic than at present? He appeals to the destruction of forests and other changes introduced by man as diminishing the fall of rain; but it is obvious that the denuding action of rain is much increased by the removal of trees,[1] and the cultivation of the soil.

*Inclined Escarpments.*—Mr. Whitaker refers to escarpments, the base of which at one place is higher than the top at another; but

[1] See Lyell on North American forests.

such cannot be escarpments running along the strike in the same set of beds (according to Mr. Topley they cannot be escarpments at all), and if not due to the sea they cannot be the effect of atmospheric action—which "always follows the strike." Escarpments consisting of different beds at the lower from those at the upper end, can easily be explained by supposing the sea to have acted at different levels. A longitudinally-sloping cliff, of the same kind of rock throughout, might have been left by the sea during a gradual rise of the land, or it may have been unequally elevated after its formation. Subaërialists are not consistent in calling the latter supposition "groundless and unwarrantable," seeing that their theory (as explained by Messrs. Foster and Topley) involves a successive tilting up of the inner end of a valley to give "excavating power" to its stream.

*Relation between Escarpments and Plains.*—In the case of many Tertiary, Chalk, and Oolitic escarpments in Hampshire (especially in the vicinity of Southampton, where the parental relation between escarpments now formed by the sea, and inland escarpments on the same horizon, or at different parallel levels, is indisputable), Wiltshire, and Somersetshire, the top and base are continuous parallel planes. The level areas above and below will be admitted to be the work of the sea, and unless we can conceive of a *coastless* ocean, it is difficult to resist the belief that the face of the escarpment is likewise of marine origin. That the areas at the base of escarpments should be slightly inclined affords no presumption against the marine theory, as this is often the case with table-land "planes of marine denudation."

*Weathered Escarpments.*—Mr. Whitaker speaks of "a sea-cliff, weathered down into a slope with a *talus*," as distinct from an escarpment; but if the *talus* be a proof of the marine origin of a cliff, the escarpments of the Oolite, Lias, and all the older rocks must have been sea-cliffs. A striking instance is furnished by the Cotswold escarpment, especially near Cheltenham and Gloucester, where a rocky cliff is for great distances concealed under a sloping *talus*, and where the atmosphere is still destroying a smoothly-grooved (especially near Crickley) and pitted sea-wall, which, at intervals, has resisted its action. The rocky limestone and millstone-grit escarpments of Derbyshire, Yorkshire and other counties, have their bases buried in accumulations of blocks, fragments, and rubbish (where they have not at intervals been swept clean, leaving a grassy platform or slope), which rains do very little to remove. The size of the fragments we see at the base of these cliffs (many of which are in situations where they could never have fallen) must be regarded as representing the size of the fragments which have been carried away, and indicating the power (nothing short of stormy waves) by which the transportation was effected. The so-called rain-wash, in many cases, must have come from a distance, and has not been furnished by a pluvial disintegration of the fragments on the spot, as is evident from its composition.

*Assumed Distinctions between Escarpments and Sea-cliffs.*—Mr. Whitaker institutes a series of distinctions between escarpments and sea-cliffs, most of which do not apply to the escarpments with which I am acquainted. I have only space for a few counter-statements.

1. The bottom of an escarpment *does* often keep to one level, and the top is often uneven.
2. Sea-cliffs *do not* always run straight through homogeneous rocks, but very often wind about in a succession of small capes and coves, which are included in "curves of large radius."
3. Among Archipelagos, such as the South of England must once have been, coasts are as often *beachless* as are the foot of escarpments. Shores suddenly sloping into deep seas, at a stationary level, or any kind of shores continuously rising, could never become covered with rounded shingle.
4. Sea-cliffs are *not* "backed by higher ground" in many parts of Archipelagos. Escarpments *are* often backed by higher ground.

*Destruction of Sea-cliffs.*—What Mr. Whitaker says about the atmosphere assisting the sea reads like special pleading for a favourite agent. It is as obvious that the sea makes its cliffs as it is that without the sea there would be no cliffs. At least two-thirds of the downfalling is the result of sheer gravitation through undermining. Many sea-cliffs for ages stand at the angle of gravitational repose. But as Mr. Whitaker admits that an immensely greater quantity of rock is denuded by the sea than by the atmosphere, it is not necessary that the relative claims of "the organ and the blower" should in this case be applied. The fact that the atmosphere does wear down and destroy sea-cliffs does not, however, seem quite compatible with the theory which assigns to the atmosphere a power of forming cliffs or escarpments.

*Preservation of Ice-marks.*—Mr. Whitaker attributes a deficiency of reasoning power to his opponents, while he himself uses one kind of reasoning in speaking of the sea, and another in reference to the atmosphere. If the preservation of glacial striæ under the sea, in some parts of the fjords of Norway, be an evidence against sea-action, their perpetuation on rock surfaces under the air must afford an equal proof of the inefficiency of rain. As regards the latter, it should be remembered that they often extend over great areas under a covering of soil, which could not be the case if "soil is rotted subsoil" (as Col. Greenwood calls it) on its way to a lower level.

*Professor Jukes on the Avon Gorge.*—In your MAGAZINE (Oct., 1867,) this able geologist applies the "hard gorge and soft valley," theory of Col. Greenwood, to the neighbourhood of Bristol. But from his explanation, it is obvious that the theory requires the assistance of a sliding scale to make it fit different localities. Besides the Clifton gorge and the Bristol basin, there are at least ten hard gorges leading out of soft valleys (some of them perfectly flat-bottomed plains, with level-based escarpments, for instance, near Keynsham), which, from the relative nature of the rocks in which they occur, would appear to be inexplicable on the above theory. It may likewise be asked, if the limestone on both sides of the Clifton gorge escaped pluvial disintegration through being covered with newer rocks, how were the limestone ridges of the Western Mendips preserved, in Palæozoic times, when the Old Red Sandstone was in course of being eaten away so as to form the Vale of Winscombe? Professor Jukes implies that the sea, during the Glacial submergence, did no more to make valleys than a canal is made by the water it contains. I think the contrary can be shown by three facts: 1. The rate at which the sea wears back its cliffs in many parts of the Bristol Channel may be fairly stated as, at least, a foot in a year. 2. The accumulations of drift in the midland and other counties (which exhibit no trace of being re-arranged Tertiary gravels, and which are only a part of what must have been excavated and removed to a distance,) would be sufficient to fill up many valleys, and obliterate many escarpments. 3. The duration of the glacial submergence may have been at least 50,000 years, probably much longer. During this period the sea *must* have converted many ◡ shaped vales into ⊔ shaped plains, and may have eaten back many miles of the eastern side of the Severn valley so as to leave the great Cotswold escarpment.

D. Mackintosh.

P.S.—I see that the number of the Quart. Journ. Geol. Soc. for the present month (Nov.) contains several important articles in favour of marine denudation.

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## RESEARCHES IN BRITISH MINERALOGY.

*To the Editor of the* Geological Magazine.

Sir,—Mr. David Forbes in a paper in the November number of the *London and Edinburgh Philosophical Magazine*, under the title of "Researches in British Mineralogy," gives the results of an analysis made by himself of a silver-fahlerz from the Fox-dale silver-lead mine, in the Isle of Man, and in the introductory paragraph he says, "Although the cupriferous tetrahedrite (occasionally containing traces of silver) has been found in small quantities at various localities in both England, Scotland, Ireland, and Wales, there is no analysis of true silver-fahlerz or polytelite, or even occurrence of the mineral itself recorded, as far as the author has been enabled to ascertain." From this I infer that Mr. Forbes will be surprised to learn that silver-fahlerz has already been found in quantity in this country and mined for the silver it contains. For several years past it has been raised and sold as a silver and copper ore at the Silver-vein Mine, near Lostwithiel, Cornwall. Indeed this mine is, and has been worked solely for the silver-fahlerz, no other ore being found in any useful quantity. The lode (for it is not found in "pockets" only) runs about 43 degrees east of north and west of south. Its width appears to have varied considerably, but at the present time it is about four feet wide. It traverses the "Killas" or clay-slate of the district and, so far, the ore has become richer in silver as the depth increases. I know of no accurate analysis having been made of this ore, so that Mr. Forbes would be doing further good service to British Mineralogy if he would take such a work in hand. From eight assays made by Messrs. Johnson and Johnson and others, some years since, the average yield of silver was 68½ ounces to the ton of ore, but the ferruginous gossan at that time contained much silver also, in what form I know not; and I cannot ascertain whether the gossans were assayed only, or the compact silver-fahlerz likewise. In one instance the proportion of silver to the ton of ore was 214 ounces! The last sample sold contained 36½ ounces to the ton. Unlike the position of this mineral in the Fox-dale mine, there is no granite within a distance of two or three miles. This mine affords the only known instance in this country of a continuous lode of silver-fahlerz, and, as I have before stated, no other ore is found in sufficient quantity to be of any commercial value. The associated minerals are quartz (which in some parts of the lode is much mixed up with the tetrahedrite) chalybite, and iron-pyrites. Under the name of Wheal Fortescue, Silver-vein was formerly worked for the rich deposits of silver it contained; I suppose in the state of sulphide, but was abandoned for want of capital. If Mr. Forbes should be sufficiently interested in the fact as well as in the mode of occurrence of silver-fahlerz in this locality as to visit it, I can assure him that he will meet with very willing assistance from my friend, Mr. Talling, of Lostwithiel, who knows every part of the mine well, and who I have to thank for many of the above particulars which I had nearly forgotten, as it is now three years since I descended it in his company.

I am, Sir, yours very truly,

British Museum. Thos. Davies.

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## THE BELGIAN TERTIARIES.

*To the Editor of the* Geological Magazine.

Sir,—I am desirous to correct a mistake which I unintentionally made in my paper on the Belgian Tertiaries, contained in the Geological Magazine of November 1st. I have there stated (p. 504) that Mr. Searles Wood had remonstrated against certain views explained by Mr. Godwin-Austen in his paper, "On the Kainozoic Formations of Belgium." I now learn from Mr. Searles Wood that he has not published any paper relating to this subject, but that the opinions which he had expressed with regard to certain of Mr. Godwin-Austen's views were communicated to me in letters which we exchanged on that subject. I trust to be excused for this error on the ground that my paper was written at a time when I had none of my books at hand to refer to, as already stated (p. 506).—Yours truly, A. von Koenen.

University of Marburg,
*November 18th*, 1867.

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## MISCELLANEOUS.

We are informed that the collection of M. Deshayes' Eocene Shells, from the Paris Basin, forming the types of his great work, "Description des Coquilles Fossiles des Environs de Paris," which has occupied so many years in publication, has just been purchased by the French Government, for the Museum of the Jardin des Plantes, Paris, for the sum of 100,000 florins.

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