THE

GEOLOGICAL MAGAZINE.

VOL. III.

JANUARY—DECEMBER, 1866.

NH

THE

GEOLOGICAL MAGAZINE;

OR,

Monthly Journal of Geology:

WITH WHICH IS INCORPORATED

"THE GEOLOGIST."

NOS. XIX. TO XXX.

EDITED BY

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

ASSISTED BY

PROFESSOR JOHN MORRIS, F.G.S., &c., &c.

AND

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

VOL. III.

JANUARY—DECEMBER, 1866.

LONDON:
TRÜBNER & Co., 60, PATERNOSTER ROW.
LEIPSIC: F. A. BROCKHAUS.
TURIN & FLORENCE: H. LOESCHER. NEW YORK: LEYPOLDT & HOLT.
1866.

HERTFORD:
PRINTED BY STEPHEN AUSTIN.

LIST OF PLATES.

MAP.

LIST OF WOODCUTS.

ERRATA.

At page	94,	line	1	from top,	*for*	Bynne *read* Wynne.
,,	225,	,,	29	,,	,,	Ontonogon *read* Ontonagon.
,,	225,	,,	32	,,	,,	ditto ditto.
,,	307,	,,	26	,,	,,	Felixtow *read* Felixstow.
,,	382,	,,	25	,,	,,	farm *read* form.
,,	184,	,,	17	,,	,,	Duxborough *read* Luxborough.
,,	185,	,,	15	,,	,,	shales *read* shells.
,,	185,	,,	18	,,	,,	Dumbledear *read* Dumbledeer.
,,	27,	,,	30	,,	,,	portion of the *read* portion, or the
,,	365,	,,	1	,,	,,	Scherzolite *read* Lherzolite.

THE

GEOLOGICAL MAGAZINE.

No. XIX.—JANUARY, 1866.

GEOLOGICAL PROGRESS.

No. 3.[1]

GEOLOGISTS assert that the operations of Nature, of which they are the expounders, are performed with a slowness that renders their progress almost imperceptible to actual observation. Geology itself, however, has, since its origin as a science—less than a century ago—grown with a rapidity and vigour the very opposite of the gradual movement of physical change.

But as sudden and rapid growth is seldom altogether healthy, so the exuberance of vitality in the young science has ever and anon originated errors which have, at times, checked its career.

Hasty generalizations, and loosely formed theories, advanced by would-be leaders of the science, have occasionally led their followers into wrong trains of thought, whereby they have failed to see the true bearing of facts brought before them, and have ceased, for a time, to advance their knowledge, on account of the incorrectness or insufficiency of their principles of explanation.

One great means of correcting existing errors and preventing for the future the general adoption of others, is to maintain for the scientific world an easily accessible medium of discussion.

In order, however, to render the discussion of any Geological topic useful, it must be based in the first instance upon accurately recorded observations; and as every year increases the number of observers, it also becomes important to enlarge the opportunities of preserving the results of their labours. The aim of the GEOLOGICAL MAGAZINE, since its commencement in 1864, has been to supply this need, and to supplement, as far as possible, the authoritative and old-established Journal of the Geological Society.

But the GEOLOGICAL MAGAZINE has in fact a wider scope, since it is not limited to the sphere of any one society, but opens its pages to all Geologists, in which to record their observations and discoveries, and so promote the general progress of the science both at home and abroad. Let us look at one or two points of Geological Progress during the past year.

[1] "Geological Progress," Nos. 1 and 2, appeared in the July and August Nos. of the GEOLOGICAL MAGAZINE, 1865, pp. 289 and 337.

Dr. Holl's work in the Malvern District,[1] is a labour of value in which the discussion of the origin of certain rocks will not merely alter their place and name in our classification, but will aid in the reconstruction of our ideas of the extent and distribution of strata which are the very basement of our entire Geological series.

In like manner Messrs. Salter and Hicks,[2] in a remote district of South Wales, have worked out the presence of rocks of at least an approximately similar antiquity, revealing to us a fauna hitherto almost unknown in Britain, and similar to, but not identical with, the Primordial Zone of Barrande; and for which the discoverers have proposed the new term "Menævian Group."

The interesting question of the earliest-known forms of life[3] remains much where it was left in 1864, the discussion at Birmingham having elicited no new facts to alter the conclusions arrived at by the generality of British and Canadian Geologists, neither has further investigation afforded any new forms.

Sir W. E. Logan,[4] Mr. T. Sterry Hunt,[5] Dr. Dawson,[6] Dr. Carpenter,[7] and Prof. Rupert Jones,[8] have each published the results of their separate investigations of *Eozoön Canadense.* Dr. Carpenter finds no difficulty in placing *Eozoön* in the Nummuline series of *Foraminifera,* with certain resemblances to *Calcarina.*

It is wonderful to find so very lowly an organism spreading out in these ancient seas, and forming masses as large as coral-reefs; but our astonishment becomes even greater, when we are assured by Messrs. Parker and Jones[9] that the *Foraminifera* of the present day, form no less than 95 per cent of the ooze covering the floor of the wide Atlantic ocean.

The Chalk is doubtless also largely indebted to these humble foraminated shells; whilst in some of the older Tertiaries they play a more conspicuous part than any other organism—the Nummulitic formation often attaining a thickness of many thousand feet, and extending from the Alps to the Himalayas, and from Algeria to Caboul.[10]

In addition to the great palæontological value of Dr. Duncan's descriptions of West Indian and other Tertiary Corals, etc.,[11] his papers possess a higher claim to notice, in the suggestions they offer us concerning the physical history of particular localities, and also as aids in explaining more general geological phenomena of the movements and distribution of life in past times, and the share of such past life in forming our present faunas.

The power of Glaciers to excavate Lake-basins met with an ener-

[1] Quart. Journ. Geol. Soc., vol. xxi. p. 72.
[2] Ibid., vol. xxi. p. 476, and present No. of Geol. Mag. p. 27.
[3] Geological Magazine, vol. i. p. 225.
[4] Quart. Journ. Geol. Soc., vol. xxi. p. 45.
[5] Ibid., p. 67. [6] Ibid., p. 51 (Plates VI. and VII.)
[7] Ibid., p. 59 (Plates VIII. and IX.), and Intellectual Observer, vol. vii. p. 278.
[8] Popular Science Review, April, 1865.
[9] Phil. Trans., 1865, pp. 325-341. 8 plates.
[10] Lyell's Elements, 1865, 6th edition, p. 305.
[11] Quart. Journ. Geol. Soc., vol. xxi. pp. 1, and 349.

getic opponent in the President of the Geological Society, Mr. W. J. Hamilton, who, in his Anniversary Address,[1] discussed adversely the views lately promulgated by his predecessor, Professor Ramsay, from the same chair.

Professor Phillips[2] has also expressed his views and observations upon Ice-action, and the height to which it is possible for Glaciers to ascend by the continuous pressure of the mass above. But his examination of Wastwater, in Cumberland, led him to the conclusion that Ice would not have been effective in excavating its basin.

The eminent Swiss Geologist, M. Desor, in his recently published work, "Der Gebirgsbau der Alpen," adds the weight of his name to the adverse party. He divides lake-basins into three classes, namely: 1, lakes situated in depressions between mountains, at right-angles to their general direction—to which class belong the Italian lakes; 2, lakes in the plain or on the borders of mountains, whose basins have been excavated by water; and 3, moraine-lakes, whose waters are dammed up at their outlet, as the Brienzer-See.

Every thoughtful geologist must admit that Seas and Rivers, Frost and Snow, Rain and Ice, have all shared in the labour of fashioning the present surface of our earth—nay, more, are doing so to-day—each performing its own portion of the task, and leaving (as Mr. J. F. Campbell[3] has admirably shown) its "tool-marks" to testify to the engine used.

Again, though many metamorphic rocks, formerly attributed to Igneous origin, are now known to be in reality sedimentary deposits, crushed and altered by pressure, beneath superincumbent strata of more recent date; we have still left, in all parts of the world, evidences of upheaval by volcanic action, accompanied by deposits of truly erupted or intruded material, the nature of which cannot be explained by shrinkage of the mass, or crumplings of the crust by lateral pressure, though each of these causes has produced its effect. Volcanic outlets like the Sumatran and Javan range, which comprise no less than 109 lofty fire-emitting mountains,[4] or like that of Central America (lately visited by Professor K. von Seebach, of Göttingen, who examined upwards of 30 craters, nearly all of which were active) are slight surface-indications of what must be the pressure, and consequently the heat, at great depth beneath the crust of our globe.

We trust that physical geologists will this year agree to divide the burden of work more equitably between Seas, Rivers, and Ice, Fire and Rain, Frost and Snow, taking into careful consideration the relative powers of each agent (as seen at work to-day) in having produced like results, but on a larger scale perhaps, in the past.

(*To be continued.*)

[1] Quart. Journ. Geol. Soc., vol. xxi. p. lxxxvii., Anniversary Address.

[2] Geol. Mag., vol. ii. p. 513.

[3] Frost and Fire, etc. By a Traveller. Edinburgh: Edmonston and Douglas. 1865. 2 vols. 8vo. pp. 1015, and 117 illustrations.

[4] Scrope on Volcanoes, 2nd edition, 1862, p. 12.

ORIGINAL ARTICLES.

I.—On the Discovery of several New Labyrinthodont Reptiles in the Coal-Measures of Ireland.

Communicated by Robert Etheridge, F.R.S.E., F.G.S., Palæontologist to the Geological Survey of Great Britain.

I REGRET that this short but important communication was too late for insertion in the December number of the Geological Magazine, as it was intended to announce the discovery of no less than four, if not five, *new Genera* of Amphibian Labyrinthodont Reptiles from the true Coal-beds of Jarrow Colliery, Kilkenny, Ireland.

In the latter part of November, 1865, Professor Huxley visited Ireland for the purpose of examining some collections, chiefly formed by the labours of Mr. Brownrig and Dr. E. P. Wright, which were brought together for his inspection. It has resulted in the discovery and determination of the existence of five new and remarkable forms of Reptilia, truly Amphibian and Labyrinthodont, all of which are from the workable Coal-seam of the above-mentioned Colliery (Jarrow). To this rich harvest of Reptilian Vertebrata of the Carboniferous epoch, must also be added a new genus of fish (probably Ganoid) possessing an unossified notochord, and strong, bony, much recurved ribs. This new form Prof. Huxley has termed "*Campylopleuron.*" It will shortly be described and figured with the Reptilia.

It is, however, to the new Amphibian Reptilia that he is anxious to draw the attention of Palæontologists as being perhaps one of the most important discoveries and additions made to Palæontological research during the past ten years. Three, out of the five forms, of these Amphibians are *undoubtedly new* to science, and, in all probability the remaining two also.

The first, and most remarkable genus, Prof. Huxley has named "*Ophiderpeton,*" having reference to its elongated, snake-like form, rudimentary limbs, peculiar head, and compressed tail. In outward form *Ophiderpeton* somewhat resembles *Siren lacertina,* and *Amphiuma,* but the ventral surface appears covered with an armature of minute spindle-shaped plates, obliquely adjusted together, as in *Archægosaurus* and *Pholidogaster.*

The second new form, which he names *Lepterpeton,* possesses an eel-like body, with slender and pointed head, and singularly constructed hour-glass shaped centra, as in *Thecodontosaurus.*

The third genus which Professor Huxley names *Ichthyerpeton,* has also ventral armour composed of delicate, rod-like ossicles; the hind-limbs have three short toes, and the tail was covered with small quadrate scutes, or, apparently horny scales.

The fourth new Amphibian Labyrinthodont, he appropriately names *Keraterpeton,* a singular salamandroid looking form, but minute as compared with the other associated genera. Its highly ossified vertebral column, prolonged epiotic bones, and armour of overlapping scutes, determines its character in a remarkable manner. These remains were collected by Mr. Galton of the Geological Survey of Ireland.

The remaining genus is represented by portions of the posterior half of an animal nearly seven feet in length, which Mr. Huxley is inclined to believe may belong to the genus *Anthracosaurus*, or one closely allied to it.

We cannot dwell upon these new and remarkable discoveries, and additions to the reptilian fauna of the Palæozoic epoch (Coal period) without reference to our often preconceived views upon the early distribution of vertebrate life upon the earth. We should be very cautious in assuming upon negative evidence, the non-existence of any group of the animal kingdom, which may have long since lived and passed away, but whose remains are nevertheless as yet undiscovered, nay almost unsuspected. But admitting the value of such deductions, the process must indeed be an exhaustive one before the non-existence of any group or form can be held as established, because we have not yet succeeded in ascertaining its existence in a fossil state in any region of the globe. Like many other discoveries of the same kind, the present one only tends to shew the necessity for caution in generalizing too positively upon negative evidence as to the non-occurrence of any forms of Vertebrates which may have lived, but whose remains have not yet been found.

Museum of Practical Geology,
Jermyn Street.

Note.—Professor Huxley, and Mr. E. P. Wright, are preparing a joint Memoir upon these remains, for the Royal Irish Academy.—R. E.

II.—The Raised Beach of Cantyre.

By Edward Hull, B.A., F.G.S., etc.

AMONGST the many objects of interest to the naturalist in that remarkable limb of the Western Highlands, variously written "Cantyre," "Cantire," or "Kintire," are the raised beach and sea-worn rocks which may be traced all along the coast under varying forms and aspects. This beach is the same as that which has been described by various writers as skirting the coast of Scotland from the Roman Wall northward, and winding through the innumerable fiords and sea-locks of the Firth of Clyde and the western coast; and to which attention was first called, I think, by Mr. Smith of Jordanhill, in 1836 and 1838, in papers read before the Geological and Wernerian Societies, and with other memoirs condensed into a small volume, in 1862.[1] It is the last and by far the most strongly pronounced of all the raised beaches of Scotland—of which there are several—and is very graphically described by Mr. Geikie in his recent work.[2] Now it is worthy of remark, that each of these authors draws opposite conclusions regarding the age of this raised beach from the same evidence; for Mr. Smith, of Jordanhill, con-

[1] Researches in Newer Pliocene and Post-Tertiary Geology. Glasgow.
[2] Scenery and Geology of Scotland, p. 320.

siders the beach to be more ancient than the Roman period, and Mr. Geikie, on the contrary, more recent, both appealing to the position of the Roman Wall at its termination on the western and eastern coasts as evidence of the correctness of their views. Who shall decide when such authorities differ? Perhaps, after all, it is an advantage to science that the point should not be decided *ex cathedra*—and I cannot but feel something of the satisfaction expressed on a former occasion by the Professor of Geology in one of our Universities, when referring to the controversy regarding the age of certain fresh-water strata in his neighbourhood—that there was a probability of a question being left which would afford matter for speculation to all future generations of students in geology.

Professor Nicol, in his description of the Geology of Cantyre,[1]—to the accuracy of which I can bear a willing testimony—gives a brief description of this old coast line; which from the level of its inner limit above high-water mark, may be called "the thirty-feet beach." All along the coast the ancient sea-margin may be traced by a line of cliffs of various degrees of steepness, according to the nature of the rock; sometimes as a bank umbrageous with trees and shrubs; sometimes as a rocky cliff projecting to the water's edge, and again receding inland for several hundred yards. In many places this old coast-cliff is hollowed into caverns of all sizes and forms; and these caverns have been hewn not only in the softer beds of the Old Red Sandstone and Conglomerate, or even in the Mica-schist, but in such hard rocks as the porphyries of Davar Island, at the entrance to Campbelton Bay.

From the base of this cliff a slightly shelving terrace extends to the present sea-margin, on which are built most of the villages, as well as some of the ruined churches and graveyards, which probably date as far back as the 12th or 13th century. The terrace has also been taken advantage of with considerable judgment for laying out the roads which skirt the shore; and I venture to think no traveller can come away from that wild country without complimenting the inhabitants on the excellency of their roads, over which, on the darkest nights, a carriage may be driven at a rapid pace with the greatest safety; and, as an additional recommendation, I may add, that there are no turnpikes.

The surface of the terrace is often diversified by rocks, sometimes rising in isolated and fantastic masses above the level surface of the terrace, and resembling in form and features those at a lower level which are now subject to the full play of the breakers. So little altered, indeed, are these inland rocks from the skerries and sea-stacks of the coast in the immediate vicinity that, as Mr. Geikie observes, were you to strip them of their garniture of lichens and mosses, and tear away the shrubs and brambles which cling to their sides or spring from their tops, and in their place clothe them with a slaggy covering of sea-weed, limpets, and *Balani*, you might suppose they had only yesterday been lifted out of the waters of the sea.

[1] Journ. Geol. Soc., vol. viii.

I venture to offer a few remarks on the several forms in which these monuments and vestiges of ancient sea-action present themselves.

Along the western coast, north of Machrihanish Bay, the rocks of Mica-schist (forming the fundamental rock of the country) assume the most fantastic forms, and their wrinkled and weather-beaten surfaces often bear the closest resemblance to the knotty stem of an old oak. The beds are often intensely crumpled, but are traversed by a system of joints, running generally in a north-westerly direction, and cleaving the rock in nearly vertical fissures of wonderful regularity (see Fig. 1). In the case of this rock the action of the sea has resulted, not in the formation of caves, but of chasms, hewn out along these joints, sometimes to a depth of 40 or 50 feet. One of the most striking of these fissures is represented in Fig. 1. It is bridged across for the road at the spot from which the sketch is

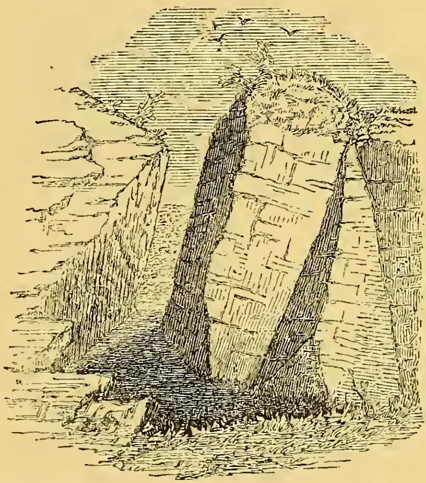


Fig. 1.—Sea-worn Fissures in Mica-schist, beyond the Present Reach of the Sea. Raised Coast of Cantyre.

taken, and in looking up the vista between the two vertical walls, the impression conveyed is that the walls have been rent asunder, so like are they to each other, and so true is their parallelism. Such an impression, it need scarcely be stated, would be erroneous; the true explanation being, that the intervening portions of the rock have been swept away, The jointage has been here evidently the guide to the sea-action, and the waves, taking advantage of those places where a number of fissures, running close together in parallel planes, has offered to their action a line of weakness, have loosened and carried away block after block, till such chasms are formed as those here presented to us. We have only to step down a few paces to the actual shore where the waves are at work among the same rocks to observe the present mode of hewing out similar fissures; but it is impossible to observe a fissure in these tough schistose rocks of the old sea beach of such dimensions as the above (about 150 feet in length, and 35 or 40 in depth) without being impressed with the conviction that the time required for this work must have been long indeed.

The caves which are found at intervals all round the coast, and which form a range of natural rock-hewn compartments at a level of 10 to 30 feet above the present tidal limits, are perhaps the most convincing of all the various evidences of ancient sea-action which can be adduced. These caves are hewn, not only in the softer strata of the Old Red Sandstone, but also in rocks of such firmness as the porphyries of Davar Island, at the entrance to Campbelton Bay. This island, which on the landward side slopes gradually down to the water's edge, on the opposite side is girt by a wall of rugged rock, rising vertically from a ledge which slopes gradually downward and terminates in a vertical cliff under low water. The wall above the ledge is honeycombed with fissures and caves in a position beyond the reach of the sea, and unquestionably referable to a past age. One of these caves has a double mouth, and is stated by Professor Nicol to be 130 feet in length, and was originally even longer, because the face of the cliff is itself being gradually worn backwards, as is attested by the blocks of rock which lie scattered over the surface of the sloping ledge, which are loosened by the past rains and spray, and carried off by the waves. Professor Nicol remarks upon the length of time which must have been necessary to excavate such a cave as this. He says: "Even though some fissure in rock, or softer vein of stone, may have determined the greater waste in this place, still the time required for its formation must have been enormous. It seems, indeed, almost impossible to estimate the number of ages spent by the waves in cutting out a cave of 130 feet in length in rocks of such hardness as the porphyries of Davar Island."[1]

Caves in the rock-bound coast between Campbelton and Keill are of frequent occurrence. The Old Red Conglomerate in which they are for the most part excavated is, in itself, well calculated to astonish any one who, like myself, sees it for the first time. It is a "pudding-stone," in which the plums are often of the size of the largest mortar shells, reaching three feet in diameter. Yet are they always so smooth and rounded, that they must have been rolled about for a long time by the waves before they became imbedded. The stones and boulders consist of felspar and claystone porphyries (some like those of Davar Island) indurated grits and sandstones, white and coloured quartz, and more rarely granite, but (as Professor Nicol has observed) there are no specimens of the prevailing rock of the country—mica-schist. I could not, however, help remarking frequent examples of that peculiar "liver-coloured" quartzite which occurs so abundantly in the New Red Conglomerate of Central England, and the source of which is still so mysterious.

Some of the caves at Keill, close by the spot where St. Columba

[1] Geology of Cantyre, p. 422.

is supposed to have landed on the shore of Scotland (A.D. 561), are fine specimens, and each has its legend devoutly treasured in the memories of the inhabitants, and happily preserved from the possibility of oblivion by the pen of Cuthbert Bede.[1] Further north, about three miles south of Campbelton Bay, is a cave held in

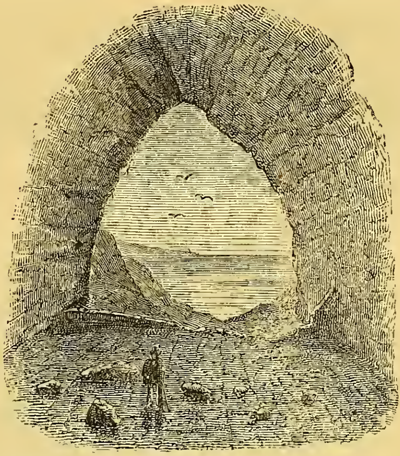


Fig. 2.—St. Kieran's Cave. Raised Coast of Cantyre.

peculiar veneration by the men of Cantyre. It is the cave of St. Kieran, "The Apostle of Cantyre," and the traditionary preceptor of St. Columba himself (Fig. 2). To this solitary dwelling he was wont to retire at the intervals between his missionary journeys amongst the savage clans and roving barbarians of this wild region. It is hewn in Conglomerate, reaching inward to a distance of about 120 feet from the entrance. From the interior, the southern extremity of Arran appears, and the entrance has a rude resemblance to a loftily-pointed arch. At the entrance the floor of the cave is about 12 feet above the present high water level, but it gradually ascends inwards to a height of at least 30 feet. The roof reaches an elevation of about 40 feet above the floor, and the cave itself is truly of ancient date.

From an examination of the caves which came under my notice, where the entrance was pointed or arched, it became evident to me, that they always had their origin in a fissure or joint, which offered a line of weakness for the action of the waves. In any case, however, the work of excavation must have been a long and laborious one. The huge boulders as they became dislodged from their beds, were doubtless wielded with powerful effect by the waves in battering the sides of the fissure when once an entrance was made, and when we recollect that the lower portions of the cave were subject to this action for a longer period than the upper it is not difficult to account for the arched form of the interior.

[1] See "Glencreggan."

In the cases above cited the conglomerate beds are highly tilted, but another kind, namely, flat-roofed caves, may be observed where the beds are horizontal. A good example of this class is afforded by a nearly isolated rock of Old Red Sandstone at the village of Ballochantye (Fig. 3); a rock, truly wave-worn, and now so far

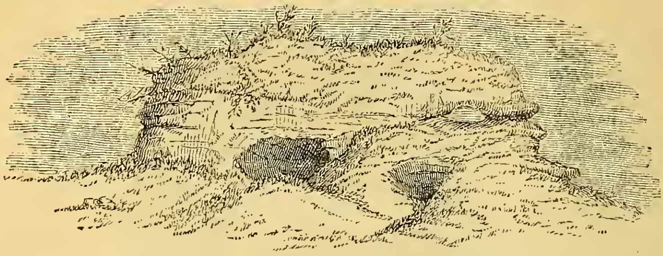


Fig. 3.—Cave in Old Coast-cliffs, Ballochantye, Cantyre.

out of reach of the sea, that the village is built between it and the shore, at a lower level. In this case the sea has acted horizontally by working in a stratum softer than the others within its reach, somewhat after the plan adopted by coal-miners. The upper layers then give way until one is reached sufficiently firm to form the roof. In another part of the rock a hole has actually been pierced right through along the line of another softer layer of sandstone.

Though the very recent elevation of the land, the evidences of which we have now been considering, has added some millions of acres to the area of Western Scotland, it cannot be doubted that the present action of the sea tends year by year to narrow the terrace, and to obliterate the vestiges of ancient sea action. As the present sea cliffs and skerries are being worn back towards the former coast-line, the two have in some places become as one, and it is sometimes impossible to trace the dividing line. Still, for all we can say to the contrary, it is quite possible another elevation of the coast may take place before all traces of "the thirty-feet" beach have disappeared.

III.—On a New Crustacean (Æger Marderi, H. W.), from the Lias of Lyme Regis, Dorsetshire.

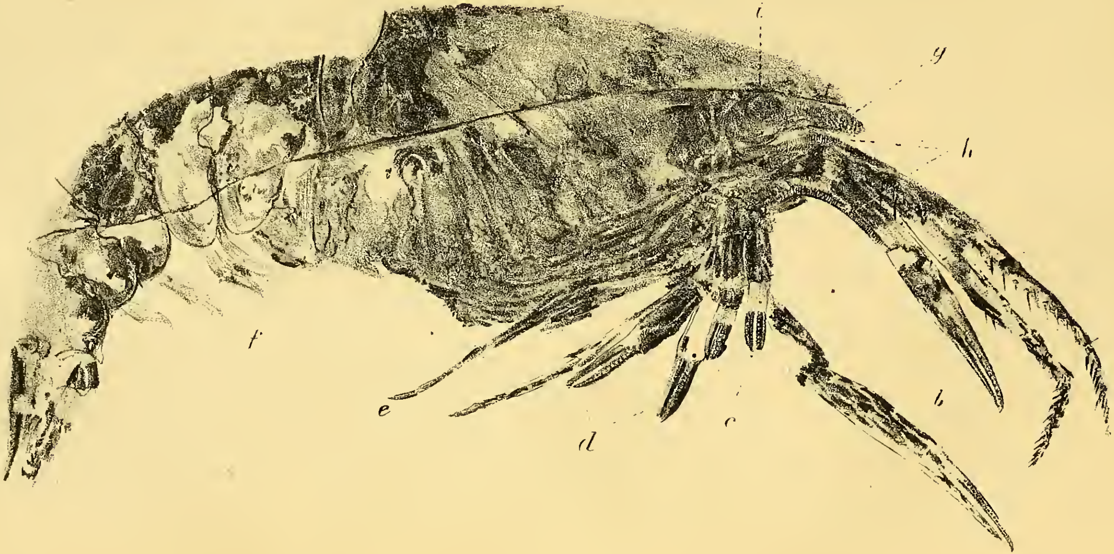
By Henry Woodward, F.G.S., F.Z.S.

(PLATE I.)

THE beautiful crustacean, forming the subject of this paper, which is represented of the natural size in the accompanying plate, was obtained by Mr. J. W. Marder, from the Lower Lias of Lyme Regis, in Dorsetshire.

It is the first British example of the genus *Æger* of Count Münster,[1] a well-known form in the Lithographic stone of Solenhofen, in Bavaria. The specimen, which is now in the Geological Collection of the British Museum, is exposed on a slab of soft Blue-

[1] Münster's Beiträge Zur Petrefacten-kuude. Bayreuth, 1839. Heft ii. p. 64.



E. Fielding, del[t]. Hanhart Imp[t].

AEGER MARDERI. *H. Woodw.*

Lias-clay: the shelly envelope, black, and glistening, still remains upon the darkest parts, whilst the lighter portions, though retaining the brown stains which indicate the general contour of the animal, have been decorticated, as it were, by the shrinkage of the clay in drying.

[All fossils from clay strata, but especially those from the Gault, the Oxford-clay, and the Lias, require almost daily care and attention for the first few weeks after they are removed from the bed in which they occur, or the entire surface will flake off in drying. A judicious application of very dilute gum, mixed with one-fourth part glycerine or sugar, is found to give the necessary tenacity to these delicate remains. But the practised fossil-collector prefers treating such objects with thin gelatine as a more durable hardening material.[1] The Readers of the Geological Magazine must pardon this digression, but I speak feelingly, having seen beautiful specimens perish, for lack of daily gum-water.]

Although the extremely long and slender rostrum (see woodcut, fig. 1) observable in most specimens from Solenhofen (and most

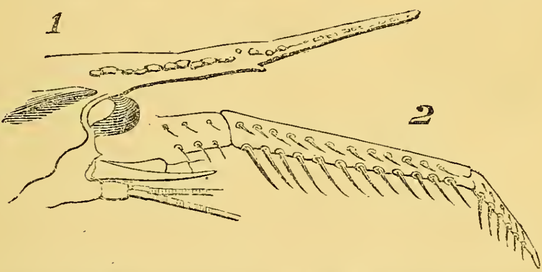


Fig. 1.—Rostrum of *Æger tipularis*, Schlot. sp. Lithographic stone, Solenhofen.
Fig. 2.—Distal extremity of 1st thoracic limb of *Æger tipularis*, showing the double row of *setæ* with which it is furnished.

probably existing in all the species of this genus[2]) is wanting in this Lias example, it may have been present when first removed from the cliff. The slab has, however, been unfortunately fractured longitudinally, just across the very part where the rostrum would have laid. The five pairs of thoracic limbs and the abdominal segments are very well preserved, and I have therefore no hesitation in assigning it to the genus *Æger*.

If we refer to the plate we shall see that the first pair of thoracic legs (marked *a*) are long and slender, with monodactylous extremities; each joint is fringed with a double row of fine spines or *setæ*. In this well-marked generic character it agrees exactly with the Solenhofen species (see woodcut, fig. 2); but the body and limbs are much more robust in our Lias example, than in any of

[1] See Geological Magazine, vol. ii. p. 239.

[2] Dr. Oppel in his valuable work, Palaeontologische Mittheilungen, etc., Stuttgart, 1862, has figured and described five species of *Æger* from Solenhofen, two of which, *Æ. Bronni* and *Æ. armatus*, are destitute of any prominent rostrum.

the species found in Bavaria. The second pair of limbs (*b*) are much thicker, and are furnished with long and tapering *chelæ*. The third and fourth pairs of appendages (*c* and *d*) are also chelate, but are much shorter and more robust than the preceding pair. The extremities of the fifth and last pair of legs (*e*) are extremely long and slender and are destitute of *chelæ* or *setæ*.

The antennæ are but imperfectly preserved, but portions of their many-jointed filaments may be seen at *h*; there is also a scale-like body seen at *g*, which was no doubt attached to the base of the outer antenna. This lamellar appendage is not shown in any Solenhofen example of the genus *Æger*. A dark oval spot (*i*), just beneath the projection formed by the rostrum, indicates the position of the eye (see also woodcut, fig. 1).

The carapace has been slightly displaced by pressure, in an upward direction, as is usually the case in the fossil *Macrura*, both from the Lias and the Lithographic stone. That portion of the shield which would have covered the *branchiæ*, or gills, being absent, the internal vertical walls (formed by the re-duplication and infoldings of the shelly portion of the thoracic segments) to which the muscles of the limbs are attached, are exposed to view.

The branchial and nuchal furrows can be traced upon the surface of the carapace, and also an oblong ridge, or tubercle (similar to that in *Æger tipularis*, see woodcut fig. 1), near the eye, in the hepatic region. The surface of both the carapace and abdominal segments is smooth, and destitute of ornamentation. The 1st abdominal segment is imperfect, but the epimeral borders of the 2nd and 3rd segments are rounded, whilst the 4th, 5th, and 6th are broadly falcate, with their points directed backwards. The exterior caudal plate is long and slender, with a groove down its centre, and appears to be divided near the extremity by a transverse line of articulation or suture, marked by a small spine on the border as in the *Astacidæ*. The inner caudal plate is smooth, and is not divided at its extremity. The central plate is narrow, and ornamented with two deep grooves; the extremity is pointed. Parts of four or five pairs of the false abdominal swimming-feet (Plate I., *f*) are also preserved upon the surface of the slab.

The specimen figured in our plate is the only example I am acquainted with from the English Liassic formation. In compliment, therefore, to the discoverer, Mr. J. W. Marder, of Lyme Regis (a well-known local geologist and earnest collector of Lias fossils), I have named it *Æger Marderi*.

The present well-marked genus offers another connecting link between the Crustacean fauna of our Lias, and that of the Upper White Jura of Germany.

In my Report to the Geological Section of the British Association this year, I have recorded six genera (namely, five Decapods—*Eryon, Palinurina, Æger, Glyphæa,* and *Pseudoglyphæa;* and one Stomapod of the genus *Squilla*, or *Sculda*), as occurring both in England and Bavaria, and represented in this country by no less than sixteen species, several of which are as yet undescribed. Dr. Oppel's work (already referred to) furnishes us with figures and descriptions of the Lithographic limestone species; and the specimens may be studied to great advantage in the British Museum, which is now the fortunate possessor of probably the finest collection of Solenhofen fossils ever yet brought together. We allude, of course, to the Häberlein collection, which contains, among other rarities, the wonderful long-tailed bird, the *Archæopteryx*. When the entire English series are figured and published by the Palæontographical Society, it will afford one of the most instructive groups for comparison between two distant formations of dissimilar age, that has yet been called up to give evidence against that most unphilosophical dogma of the contemporaneity of particular strata, because they happen to occur in a similar geological horizon.

EXPLANATION OF PLATE I.

Æger Marderi (H. Woodw.) natural size, Lower Lias, Lyme Regis. Drawn from a specimen in the Geological collection of the British Museum.

- *a.* First pair of monodactylous thoracic limbs, with the *setæ* (seen more clearly in the woodcut, fig. 2).
- *b.* Second pair of thoracic appendages, which are chelate.
- *c.* Third pair of thoracic appendages, also chelate.
- *d.* Fourth ditto ditto.
- *e.* The fifth pair of limbs, long, slender, and monodactylous.
- *f.* The false abdominal swimming feet.
- *g.* The broad scale attached to the base of the outer antennæ.
- *h.* Remains of the many-jointed filaments of the antennæ.
- *i.* The eye (its position and form are shown clearly in the woodcut of *Æger tipularis*, fig. 1).

IV.—Notes on the Correlation of the Cretaceous Rocks of the South-east and West of England.

By C. J. A. Meÿer, Esq.

(PLATE II.)

It is attempted in the accompanying diagram (Plate II.) to exhibit, as clearly as is possible in a single section, the local chronological arrangement and position of the more remarkable Cretaceous deposits between Folkestone and Guildford, and also their probable correlation with the same series in the Isle of Wight and the vicinity of Lyme Regis. The diagram therefore represents an ideal section of the Cretaceous series from Folkestone in Kent to Lyme Regis in Dorsetshire, exhibiting at a glance the relative positions of the strata in the order of their deposition, but without allowing for variation in thickness or *possible* want of conformity in stratification.

The section is divided into several distinct horizons, in accordance with the recognized sub-divisions of the Cretaceous series as named in the margin.

Without either questioning or asserting the correctness of these sub-divisions, I propose to trace each group separately in its course from East to West, briefly noticing such of the principal variations in its component rocks as have resulted from changes of mineral character or from the thinning out or intercalation of particular beds: omitting, however, any mention of the Wealdon strata on account of their being so little exposed along the line of section.

1. The lowest sub-division of the Greensand—the Atherfield clay of Fitton, and Lower Neocomian (in part) of foreign authors, is known to occur beneath the Kentish-rag series at Folkestone[1] although unexposed in the coast-section, and its continuity has been traced inland past Maidstone,[2] Sevenoaks,[3] Redhill, and Guildford.[4] It is visible on the shore beneath Redcliffe and still more conspicuously at Atherfield, in the Isle of Wight; westward of which it scarcely appears to have extended. The thickness and mineral composition of this group is very uniform throughout its course, consisting in its lowest layers of sandy-clay which, where the fossils are most abundant, has become consolidated into hard, nodular concretions of shell-rock. A stiff brown or bluish clay (the "Lobster-clay" of Atherfield) prevails throughout its middle portion, becoming gradually more arenaceous in its passage upwards.

2. The Hythe-beds—the Kentish-rag series of Fitton, are well exposed in the vicinity of Hythe and in the famous quarries at Maidstone; and may also be observed at Sevenoaks, and at Bletchingley, near Nutfield. To the westward of Nutfield these beds alter their character so considerably as to be no longer clearly recognizable; the regular beds of limestone and hassock so conspicuous at Hythe and Maidstone being replaced by sandrock and chert, as at Leith Hill, or almost entirely by sand, as at Guildford and Godalming. The argillo-arenaceous deposits, which in the Isle of Wight represent the Hythe-beds, are also devoid of stone; unless we include in this division the "Crackers-rock" of the Atherfield section,[5] which appears, however, to belong more properly to the lower division, and is so placed in my section. It is worthy of remark that the numerous fossil Mollusca of the Crackers-rock occur at East Shalford (in Surrey), on nearly the same level as the Perna-bed and *below* the principal clay-bed instead of above it as at Atherfield.

3. The Hythe-beds are succeeded in the vicinity of Folkestone by a deposit of dark-coloured argillaceous sand, from 140 to 150 feet in thickness,[6] geologically known as the "Sandgate-beds," and representing the "Middle or Argillaceous division" of Fitton. The out-crop of this bed is very conspicuous on the shore between Folkestone and Sandgate, where it forms a low and ugly cliff of a blackish-green color, and its presence may be traced westward for a considerable distance. I cannot, however, agree with Dr. Fitton in tracing his "Argillaceous division," *as a clay-bed*, so far inland as Nutfield, and (as will pre-

[1] Simms, Quart. Journ. Geol. Soc. vol. iv., p. 206.
[2] Fitton, Quart. Journ. Geol. Soc. vol. iv., p. 209.
[3] Evans, Proc. Geol. Association, vol. i., p. 395.
[4] Austen, Quart. Journ. Geol. Soc. vol. iv., p. 172.
[5] Fitton, Quart. Journ. Geol. Soc. vol. iv., p. 398.
[6] Simms, Quart. Journ. Geol. Soc. vol. iv., p. 206.

sently be shown in treating of the Fuller's-earth of Nutfield) we differ totally as to its position in that neighbourhood. Neither does it occur as an argillaceous deposit either at Guildford or Godalming; its position being there occupied by layers of regularly stratified sand, mostly of a light ash-colour. The Sandgate-, like the Hythe-, beds, appear in fact to lose their distinctive features in passing westward, the two series gradually coalescing and becoming thereby almost undistinguishable.

In the Isle of Wight the Sandgate and Hythe-beds may be best observed in the coast-section between Dunnose-point and the middle of Sandown Bay. The former appearing to be represented by blackish-green strata which rise on the shore beneath Knock cliff, and which traversing the lower part of Shanklin and upper part of Small Hope chines continue visible in the cliffs as far as Little Stairs point. The cliffs thence to Sandown being almost entirely occupied by the representative of the Kentish-rag series.

4. The Folkestone-beds, the series next in order of succession, and which constitute the "ferruginous, or upper division" of Fitton, although including in their inland course a somewhat complicated series of deposits, exhibit in the Folkestone section but little variation in mineral character, the strata consisting almost entirely of light-coloured sands with irregular concretions of siliceous sandstone. The absence of ferruginous sands below the Gault, which form so conspicuous a feature at Redhill and Guildford, being specially remarkable.

In the first twenty feet of strata above the dark "Sandgate-beds" one may however observe, in the occurrence of thin layers of pebbles, a first appearance of those pebbly strata which become so much more conspicuous to the westward,[1] and in the layers of semi-indurated argillaceous sand and sandstone, a corresponding equivalent to the Fuller's-earth and sandstone of Nutfield. The siliceous concretions[2] of a slightly higher level agreeing, also, both in position and in the abundance of their almost solitary fossil (*Avicula pectinata*, Sow.), with the upper stone-beds of Nutfield and with the Bargate-stone of Godalming.[3]

To those who are acquainted with Dr. Fitton's description of the vicinity of Nutfield, it will be evident that we differ materially as to the geological position of the Fuller's-earth, Dr. Fitton placing it near the top of the Kentish-rag series and beneath the Sandgate beds,[4] whereas it is placed in my section near the base of the Folkestone-beds and almost on a level with the Bargate-stone of Godalming, which is without doubt its true position.

On a recent visit to Nutfield I carefully examined the outcrop of the strata exposed in the lane-sections to the south of the high road between Redhill-junction and Bletchingley, and not only observed the out-crop of the pebble-beds from beneath the Fuller's-earth (of

[1] Geol. Mag., vol. i., p. 249,
[2] Fitton, Trans. Geol. Soc., 2nd ser., vol. iv., p. 108.
[3] Murchison, Trans. Geol. Soc., vol. ii., 2nd series, p. 101.
[4] Fitton, Trans. Geol. Soc., 2nd series, vol. iv., pl. x*a*, section No. 3.

which I was already aware), but also ascertained the existence of a group of sand-beds, from 100 to 130 feet in thickness, between the pebble-beds and the highest layers of Kentish-rag; and I have no doubt that these sand-beds, although containing but little argillaceous matter, are the real representative of the Sandgate-beds. The outcrop of these pebbly-sands may be best observed in a lane immediately opposite the entrance to the principal Fuller's-earth pit. The succession of the strata being as follows:—

a. Layers of Sandstone, passing under high-road and forming floor of Fullers-earth pit	6ft.?	
b. Coarse gritty-beds; light fawn colour	5ft.	16ft.
c. Ditto, with minute pebbles, and hardening into conglomerate	6ft.	
d. Gritty-sands,—as above . , ...	5ft.	
e. Light ash-coloured and ferruginous sands (part of middle division), becoming slightly argillaceous as they descend	50 to 100ft.	

These beds dip gently to the north, and following the slope of the ground it is evident that the Fuller's-earth must still be near the surface in Nutfield Marsh, where Dr. Fitton had placed the outcrop of his "Middle-division."

In the Isle of Wight the strata composing the middle and upper portion of the cliffs southward from Shanklin chine to their junction with the Gault probably represent the Folkestone beds, and may be said to approach, somewhat roughly, in character to those of Nutfield and Godalming. Several thin layers of pebbles, bands of argillaceous matter, and concretions of sparry limestone, abounding in fossils, occurring in the lower portion; the higher strata consisting of sands of various colours, frequently yellowish or ferruginous, like the upper beds of the Lower Greensand, of Surrey.

Turning now to the section it will be seen that the range of the Folkestone-beds has been continued as far westward as Lyme Regis; for, although aware that this arrangement is contrary to generally-received opinion, such I believe to be the position of the oldest Cretaceous deposits of that neighbourhood. The composition and succession of the strata at Black Ven, the typical section for the lower beds of the Cretaceous series of Dorset and Devon, having much more in unison with the Folkestone-beds than with the Gault or Upper Greensand to which they are more usually attributed. And that it is by no means unreasonable to continue the range of the Lower Greensand to the westward at the period of the deposition of the Folkestone-beds is evident by its vastly-increased area (at the same period) to the north-west and north; the Lower Greensand beds of Devizes and Calne in Wiltshire, of Farringdon in Berkshire, and the Carstone-beds of Norfolk, all clearly belonging to the Folkestone-series, the ferruginous or upper division of Fitton.

The remaining subdivisions of the Cretaceous series are so well known that I shall mention them merely in connection with the western extremity of my section.

5. The Gault or Folkestone-marl, which at Folkestone attains a thickness of nearly 130 feet, thins out so considerably to the west of Reigate as to favour the idea that this bed, like the Sandgate-beds in the Lower Greensand, is, in spite of its great extent, but a subordinate member in the Cretaceous series; or that, in other words, it may be synchronous in part with the Upper Greensand, and in part also with the ferruginous beds at the top of the Lower Greensand: as has been suggested by Mr. Seeley with respect to the Carstone-beds of Norfolk.—(Sequence of Rocks and Fossils. Geol. Mag., vol. ii., p. 262.) That such to some extent is the case in the vicinity of Guildford I have little doubt, and probably also in the Isle of Wight, where both the Upper and Lower Greensand strata are so largely developed in comparison with the Gault.

Passing further to the westward I should suppose the Gault to be partly represented in the vicinity of Lyme Regis by the "yellowish-brown sand or Fox Mould" which, forming a bed of from 70 to 80 feet in thickness,[1] interposes itself between the undoubted Upper Greensand-strata and the Cowstone-beds of the Black Ven section.

6. The Upper Greensand-strata include, in their passage westward from Folkestone, the Firestone-beds of Godstone and Reigate, the Malm-rock of Western Sussex, and the Chert-beds of the Isle of Wight; these latter beds being probably continuous with the "yellowish-brown sandstone with Chert-seams" of Lyme Regis. (De la Beche, Trans. Geol. Soc. 2nd ser., vol. ii., p. 113.)

7. The Chloritic Marl from Folkestone westward to Guildford, is barely recognizable, but becomes a distinct bed in the Isle of Wight. At Pinhay near Lyme Regis it forms a stratum about four feet in thickness—abounding in fossils, mostly similar to those of Chardstock and Warminster.

8. The three succeeding groups—the Chalk-marl, and the Lower and Upper Chalk, are too uniform in their passage from east to west to need special notice, and are therefore merely indicated in the section.

I have also endeavoured to represent on the section by difference of strength of shading or other markings the lateral passage of argillaceous into arenaceous deposits or of limestone-beds into sandstone and sand, as in the cases of the Sandgate and Hythe-beds respectively; the ranges of the particular beds or series of strata named in the margin being shown by the short vertical lines numbered one to fifteen. The grouping of the faunas, which for want of space I have not mentioned in the text, is also roughly indicated on the section by a series of graduated vertical lines.

Regarded as a whole the various groups of strata included in the section are clearly continuous; that is to say—all were in turn deposited beneath the same ocean without serious break or intermission between them. The variations in the mineral character of the beds, and the more or less sudden changes from arenaceous to argillaceous or calcareous deposits being attributable solely to gradual increase or diminution in depth of water, or to change of level, or

[1] De la Beche, Trans. Geol. Soc., 2nd ser., vol. ii. p. 113.

partial submergence of the surrounding land-surfaces; the character of the fauna necessarily changing with the varying depth or altered nature of the ocean-bed.

I can scarcely therefore agree with those geologists who, judging by the change of fauna, insist on the lapse of a long interval of time in the passage from Lower Greensand to Gault. As well might we require this lapse of time at the still greater change from Wealden to Lower Greensand, the deposition of which is in places absolutely continuous with the Wealden, and whose fauna we know to have already existed to the southward long previously to its introduction into the Wealden area by the intrusion of the Cretaceous ocean.

And is it not, in like manner, equally possible that, previous to the deposition of the Gault, much of its fauna may have been elsewhere already in existence, as, for instance, in the Blackdown Greensand? The seemingly abrupt change of fauna from Lower Greensand to Gault in our southern counties, being but the natural result of as sudden a change from a sandy to an argillaceous deposit.

The strictly horizontal arrangement of the groups of strata shown in the section, though true for short distances, is therefore, probably, incorrect for each and all the groups, if traced throughout their utmost range, and must be regarded as merely an approximate arrangement; it being, probably, as true for sedimentary strata as for forms of life, that all originated at some given point, and that, consequently, their lateral extension can seldom be represented by a horizontal line.

EXPLANATION OF PLATE II.

The right-hand portion of this section, extending from Folkestone, in Kent, to Farnham, in Surrey, is taken along the range of the North Downs; its course is consequently nearly parallel to the line of the South-Eastern Railway, along which, between Reigate and Guildford, several of the lower sand-groups are well exposed.

Vertical sections taken along this course, as at Nutfield or Guildford, would exhibit such a succession of strata as is represented in the plate.

The left-hand portion of the section follows a line nearly parallel to the above, but is taken from the eastern coast of the Isle of Wight to Lyme Regis, in Dorsetshire.

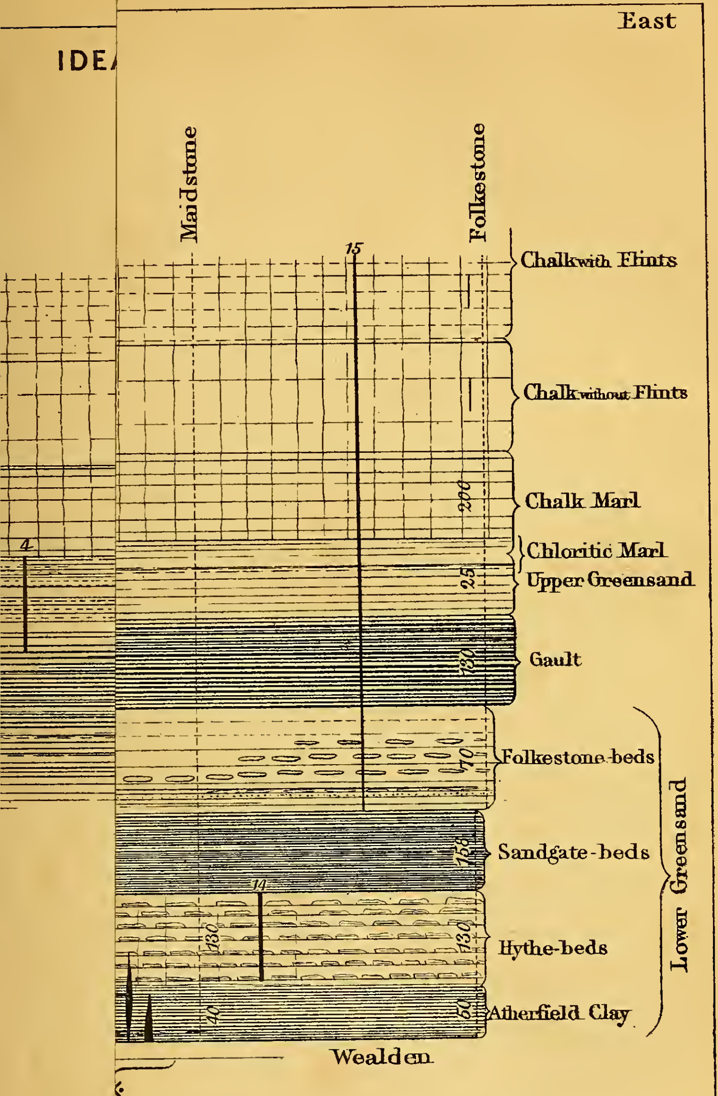
The names of the various groups are given to the right and left of the section; the changes in the mineralogical character of the beds, as from limestone to sandstone, or from argillaceous to arenaceous deposits, being in part indicated by difference in strength of shading or other markings.

The short vertical lines numbered 1 to 15, indicate the corresponding vertical ranges of the several groups named below; such of them as do not strictly fall within the line of section having been introduced for the sake of comparison with the others.

I have also endeavoured to indicate on the section, by means of graduated vertical lines, a rough outline of the distribution of the Cretaceous fauna which want of space has prevented me from mentioning in the text.

The graduated lines on the section must, therefore, be understood to represent the vertical ranges of the fossils now contained in the several subdivisions of the Cretaceous rocks. For as each of these subdivisions contains a group of fossils peculiar to itself, and, also, some few species whose range is continued upwards through two or three more subdivisions, this difference in their vertical distribution is fairly represented by the longer and shorter lines on the section.

IDEA



...tfield.

...e of).

...e & Reigate.

...ertical ran...

...ng.

Vertical ran...

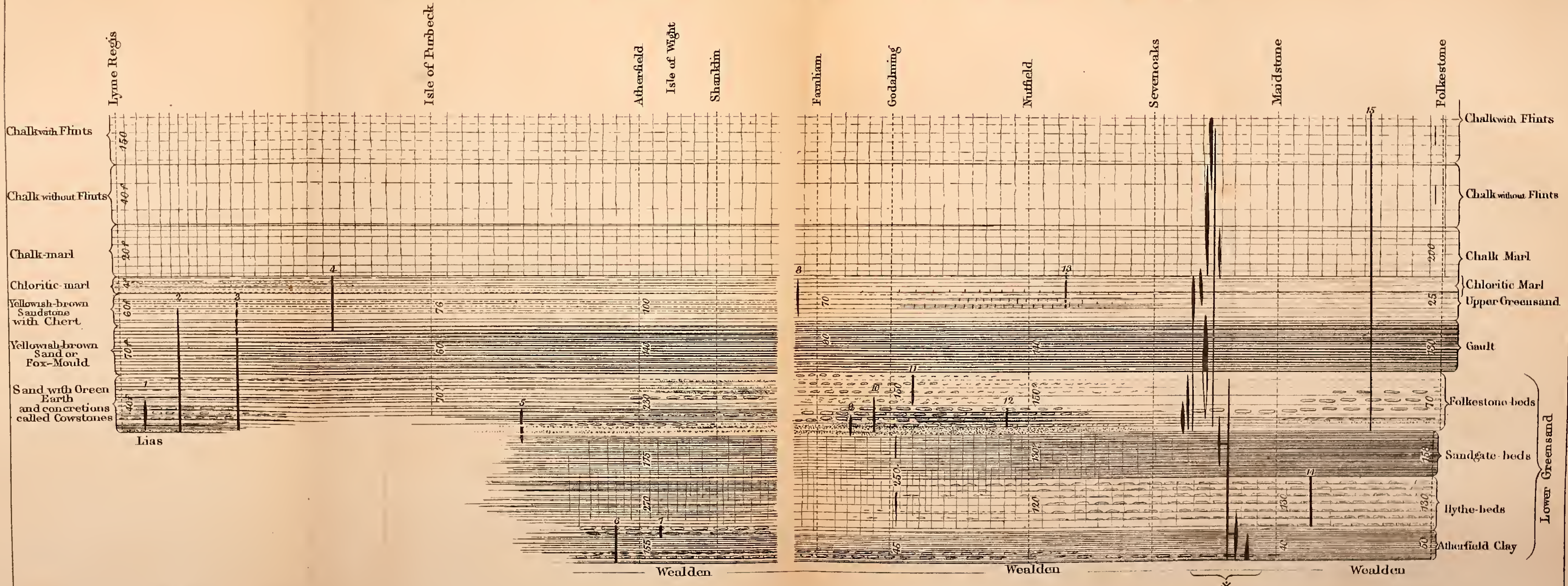
(*

14. Kentish-rag of Maidstone.

15. Cretaceous series of Norfolk.
(Vertical Range of)

F. Dangerfield lith. 22 Bedford St. Covent Garden

IDEAL SECTION OF CRETACEOUS ROCKS IN THEIR RANGE FROM FOLKESTONE TO LYME REGIS.



1. *Cow-stones of Lyme Regis.*
2. *Black Ven beds (Vertical range of).*
3. *Greensand of Blackdown (Vertical range of).*
4. *Greensand of Warminster (Vertical range of).*
5. *Sponge-Gravels of Faringdon (Vertical range of). (Geologist Vol. VII p. 5).*
6. *Atherfield-clay.*
7. *Crackers-rock (position of).*
8. *Malm-rock of Western Sussex.*
9. *Pebble-beds of Godalming.*
10. *Bargate-stone of D°.*
11. *Carstone beds of Godalming.*
12. *Fullers-earth of Nutfield.*
13. *Firestone of Godstone & Reigate.*
14. *Kentish-rag of Maidstone.*
15. *Cretaceous series of Norfolk. (Vertical Range of)*

(※ The graduated Vertical black lines are intended to indicate the grouping of the faunas of the several deposits.)

C. J. A. Meyer delt. F. Dangerfield lith. 22 Bedford S.t Covent Garden

ABSTRACTS OF BRITISH AND FOREIGN MEMOIRS.

I.—Ammonites from the Himalayas, etc.

(Palæontologische Mittheilungen. Nos. IV. and V. von Prof. Dr. A. Oppel.)

In this, his third contribution to Palæontology, Dr. Oppel first concludes his descriptions and figures of the Ammonites which are contained in the Schlagintweit collection of fossils from the Secondary formations of the Himalayas, and the discussion of which was commenced in the second part of the "Mittheilungen." The formations represented by these fossils *appear* to be equivalents of the Kelloway rock, Oxford Clay, and Hallstädt beds of Europe; but the author makes some cautious reservations on account of considerations founded on the inferred existence of "Homoiozoic belts" during the Jurassic period.

The succeeding memoir is devoted to a Geological Study of the Department Ardèche, in which the author recognises the Oxford Clay, Kelloway rock, and part of the Bath Oolite. Dr. Oppel describes the strata in the neighbourhood of Valence, and gives a section and copious lists of fossils, showing the stratigraphical and palæontological relations of the different beds, which he considers to represent the following zones of life:—

Zone of	*Terebratula impressa,*	Oxford Clay.
,,	*Ammonites transversarius*	
,,	*Ammonites cordatus*	
,,	*Ammonites Lamberti*	
,,	*Ammonites athleta*	Kelloway rock.
,,	*Ammonites anceps*	
,,	*Ammonites macrocephalus*	
	Bath group.	

H. M. J.

II.—On Certain Joints and Dikes in the Devonian Limestones on the Southern Shore of Torbay.

By Wm. Pengelly, F.R.S., F.G.S., etc.

[Read before the Members of the Torquay Natural History Society, Nov. 8, 1865.]

Most rocks are traversed by various kinds of divisional planes, some being coeval with the rocks themselves, whilst others have certainly been superinduced.

In stratified rocks the principal planes of division are those of stratification, lamination, foliation, cleavage, and jointage.

Stratification and lamination differ in degree only. Each marks a pause—greater or less—in the process of deposition or sedimentation. Foliation is chiefly confined to crystalline strata, and is applied to rocks composed of laminæ alternately of different kinds of mineral matter. The planes of lamination may or may not be inclined to those of stratification.

Cleavage is that tendency which occurs in many rocks—but most distinctly in slates—to split into illimitably thin laminæ, whose planes are more or less inclined to those of stratification.

Jointage is the name given to divisional planes which occur in both stratified and unstratified rocks, follow definite and constant directions through great tracks of country, and by their intersections resolve the rocks into blocks having constant forms.

The spaces between the joints are very variable, but, in virtue of the jointage planes, the rock is never capable of being split into illimitably thin plates.

The following are amongst the questions on which the geologist desires information respecting the rock-joints of any district. Their origin, their directions, and their ages, both in relation to one another, and to the chronological periods of geological science.

That they have been superinduced, or formed since the rock itself was formed, there can be no doubt; but it may be questioned whether any satisfactory explanation of their origin has been given to the world. There seems a general tendency to ascribe them chiefly to contractions in the mass of the rock during its consolidation. It has also been suggested that in some cases they may have been formed in a mass of rock that is in a state of tension from a mechanically expanding force. Professor Harkness supposes that in many instances they may be due to pressure; whilst others, in their despair, have invoked the aid of electricity, or some other polar force.

As long ago as 1839, it was remarked by Sir H. De la Beche that "As a whole the great divisional planes of Devon and Cornwall may be said to prevail more in directions from N. to N.W. and from S. to S.E. than in others, the greatest number holding their courses within a few degrees of N.N.W. and S.S.E.; these lines being cut by others, which chiefly form angles from 70° to 90° with them." (Report, page 274.)

It has long been known also that the joints which affect a more or less northerly and southerly direction always cut through, and are therefore more modern than, those which have a course approximately east and west; but so far as I am aware no definite information has been given beyond this on the chronology of joints. I am not without a hope that trustworthy facts will be produced in this brief communication by which the exact geological age of the north and south joints of Devonshire and Cornwall may be established.

The Devonian slates and limestones in the Torbay district are traversed by two well-defined systems of joints; one having a direction from N. 82° E. to S. 82° W., the other very nearly in the present magnetic meridian or about N. 23° W. to S. 23° E., so that the two systems intersect at nearly right angles. As a matter of convenience I shall in this communication speak of them as the east and west and north and south systems respectively. The first has commonly a considerable underlie towards the south, whilst the second system is in most cases sensibly vertical.

It is not my intention to enter on a consideration of all the phenomena and relations of these joints, but simply to call attention to a few probably unique facts connected with them, which are well displayed in the limestones along the southern shore of Torbay, and especially at a small beach almost immediately beneath Berry Head House, about midway between the Head and Brixham.

At the spot indicated, the limestones dip at a low angle towards the south or landward, and the joints of both systems are occupied with vertical dikes or wall-like masses of compact tolerably fine-grained red sandstone, which are traceable at by no means wide intervals from Berry Head to the Torbay and Dartmouth Railroad. There is no manner of doubt that the dikes belong to the Triassic or New Red Sandstone formation, which is so fully developed in the central shores of the bay. It may be presumed, therefore, that this formation formerly covered the Berry Head limestone: and, indeed, there is further evidence of this in the fact that diminutive outlying patches of red sandstone and conglomerate are met with here and there throughout the district. It is obvious too that both systems of *joints* were in existence during, but not necessarily before, the Triassic era.

A careful inspection of the dikes discloses the fact, that in every instance of intersection, the north and south series cut through those running east and west. It is also observable that there is a perceptible, though comparatively slight, difference in the colours of the two systems. We, therefore, advance another step, and conclude that the dikes running north and south are more modern than those through which they pass; but we may proceed still further; for it is obvious that had the north and south *joints* been in existence when those having an east and west direction were filled in with red sand, they would have been filled in also, and the two systems of dikes would have been of the same age; hence we may safely conclude that the north and south *joints* were formed after the east and west dikes, and therefore that the joints having a north and south direction are not only more modern than those running east and west, but that they were absolutely formed after the commencement of the New Red Sandstone era.

It requires but little reflection, however, to advance another step; for since the north and south joints are filled with red sandstone dikes, they must have been formed before the close of the Triassic era. Here, therefore, we have, what so far as I am aware, was never produced before, conclusive evidence that the north and south joints of the Devonian rocks of the Torbay district are of Triassic age; and assuming that the joints having the same direction in Devon and Cornwall generally, are all of the same age, it follows that the entire district is brought under this generalization.

These dikes, moreover, bring before us very prominently the enormous amount of time which the red rocks of this district represent; and this is seen most clearly when a ground plan or bird's-eye view of the phenomena is studied. It then appears (1) that the east and west dikes are not only intersected but faulted; and (2) that they are traversed by longitudinal veins of carbonate of lime, which do not enter the intersecting dikes. Hence we are enabled to trace the progress of events somewhat in detail. We have :—

1.—The filling in of the east and west joints with red sand, at a period not earlier than, if so early as, the commencement of the Torbay Trias.

2.—The induration of this sand into coherent and durable dikes capable of being fissured and faulted without their sides falling in.

3.—The formation of longitudinal fissures in these dikes.

4.—The gradual filling up of these fissures, not with sand, but by the precipitation of carbonate of lime.

5.—The formation of transverse joints, passing in a north and south direction, through the dikes and veins, and the pre-Triassic rocks.

6.—The faulting of the entire mass, rocks, dikes, and veins, by inequalities of movement in an approximately horizontal direction.

7.—The filling in of the north and south joints with red sand, as in the first instance, so as to form dikes passing through those previously existing. The two systems being distinguishable by well-defined walls and a marked difference of colour.

All the events here detailed occurred within the era of the Torbay Trias, and, indeed, apparently during that portion of it in which sandstone alone was deposited, inasmuch as there are no traces of conglomerate in the dikes.

Before closing this brief communication, I would remark that though I am altogether unprepared to offer any opinion respecting the origin of the joints in question, it appears certain that at least those running north and south cannot be due to contraction in the mass of the rock during its consolidation; for the rocks themselves are of Middle Devonian Age, between which and the Trias we have the Upper Devonian, the Mountain Limestone, the Millstone Grit, the Coal Measures, and the Permian ages; so that it is simply impossible to suppose that the rocks had remained unconsolidated. Moreover, the fact that they were already traversed by east and west joints, is a decisive proof that they had assumed the solid condition.

BRITISH ASSOCIATION REPORTS.

SECTION C.—GEOLOGY.

I.—On the Existence of Gold-bearing Eruptive Rocks in South America which have made their appearance at two very distinct geological periods. By David Forbes, F.R.S., F.G.S., &c.

THE author believed that the gold deposits of South America had not as yet been studied with a view to determine the geological period at which the gold itself had made its appearance. The present communication was the result of observations made during seven years' travels over a large part of South America, and which had enabled him to class all the deposits of gold which he had visited, under two heads, both of which could be traced directly or indirectly to the intrusion or eruption of igneous rock.

Under the first head belonged all gold derived from the disintegration of granitic rocks of an age later than much, if not of all, of the Silurian strata, but probably not later than the Devonian period. The largest gold washings of South America, and probably of the whole world, he looked upon as derived from this source as well as the auriferous quartz veins, as they could be traced to the proximity of the granite, and which he believed to have originated in or been injected from the granite into the neighbouring strata, carrying the gold, which was a normal constituent of the granite itself, along with it. This granite, wherever met with, is invariably auriferous in itself, and although it would not pay to grind down granite mountains, and work out the gold in them, yet in many parts of South America, in Brazil, near Valparaiso, etc., the granite apparently solid, was frequently decomposed *in sitû* to depths ôf even over 200 feet, as shown frequently in railway cuttings, and then it sometimes repaid the labour of washing the whole mass for the sake of the gold in it. To this class also belong many metallic veins injected also from the granite into the neighbouring Silurian strata, which contain gold, and are remarkable for the presence of other minerals, very characteristic, as oxide and sulphides of Tin, Tin pyrites, Copper pyrites, compounds of Bismuth Tellurium, Selenium, etc., many of which are seldom or never met with in later rocks.

The second appearance of gold is however totally distinct from the above in mineral character, as well as in geological age, and results from the eruption of Dioritic (Greenstone) rocks, composed of hornblende and feldspar (without quartz), which break through strata, even as late as those containing Oolitic fossils, and consequently must be regarded as younger than the Oolitic period, but as far as researches have yet shown are probably not posterior to the deposition of the Cretaceous strata. In this case, instead of quartz veins carrying the gold from the granite into the neighbouring strata, veins of metallic sulphides and arsenides act in the same manner, and the gold is found imbedded in its metallic state in the compounds of sulphur and arsenic with iron, copper, etc., and from some unknown cause the more superficial parts of these veins appear as a rule to be much richer in gold, which by the miners is generally supposed to decrease in depth. The minerals commonly found in these veins are not the same as in the metallic veins mentioned as occurring with the granitic rocks under the first head, and as far as observations have gone, the metals, Tin, Tellurium, Tungsten, Titanium, Selenium, etc., are never found in the auriferous veins of later dates. Nothing could be more conclusive than the totally distinct age of these two sets of auriferous eruptive rocks which the author believes to represent the only ages at which gold has been introduced into the upper crust of the globe, and thinks it probable that this generalization may be carried into other parts of the world if it be not altogether universal.

II.—On the Igneous Rocks of Staffordshire. By D. Forbes, F.R.S., F.G.S.

Mr. David Forbes read a paper, in which he stated that, at the request of the committee of Section C., he undertook to investigate and report upon the igneous rocks of Staffordshire, and he now came forward merely to report progress—not having yet been able to make a complete examination. After having collected all the published information on the subject that was attainable, he found that our chemical knowledge was confined to some two or three analyses made at random. The two analyses of Rowley Rag, made by Mr. Henry, and inserted in Mr. Beete Juke's memoir, represented no doubt the exact composition of the hand specimens sent to Mr. Henry, whose skill was unquestionable; but he was satisfied that they did not represent the composition of the rock masses in general, and would not be such as a geologist would select to represent what he considered as a fair specimen of what the rock mass really was. In these investigations it was absolutely essential that the chemist, geologist, and mineralogist should go hand-in-hand. It was, therefore, necessary to make a personal visit to each of the principal localities where these rocks occurred, and to select specimens which would fairly represent the unaltered rock mass distant as far as possible from the external surface, which naturally was invariably more or less altered by the action of air, water, carbonic acid, etc., as also from the intermixture and absorption of the surrounding strata with which it came into contact. A series of specimens were submitted to chemical examination, and at the same time thin sections had been carefully prepared for the microscope, thus showing that the rocks (which to the naked eye present nothing but a dark indistinct surface, as if composed wholly of one mineral) are resolvable into the various minerals which actually entered into their composition.

Their specific gravity was also determined. Rocks had been analyzed from seven different localities, and microscopical examinations made of about fifteen localities. As might be seen from the map of the Ordnance Geological Survey, the bosses of igneous rock which presented themselves at the surface were some thirteen in number, the most extensive of them all being the Rowley Hills, covering an area of probably about two and a-half square miles; after which the Wednesfield and Barrow Hills eruptions came respectively next in extent, whilst the remainder were on a much smaller scale. Besides, however, such rocks as were visible on the surface, the extensive mining operations for coal had disclosed numerous dykes cutting through the Coal-measures, and frequently forming large masses, or more or less regular sheets of rock imbedded in the strata. These were generally less compact in appearance and of lighter colour than the larger masses, and were known to the miners of the district as "green rock," presenting some resemblance in external appearance to a greenstone, but in reality quite distinct from that rock. A third variety of igneous rock formed small dykes and veins, often very irregular and altering both the coal and the rocks in contact with it. It was known to the miners as "white horse," and was occasionally called "white trap," or feldspathic trap." All these rocks, however dissimilar in their present appearance, were in reality one and the same rock, or, rather, were originally identical, and in all probability erupted from one focus, and were more or less contemporaneous.

He could not, however, endorse the opinion, that they were contemporaneous with the Coal-measures, but was rather inclined to look upon them as of later date, intruded after the consolidation of the coal. For this reason also he was disposed to look upon the belt of what was termed basaltic ash, as laid down in the latest edition of the maps of the Ordnance Geological Survey, as rocks decomposed *in sitû*—in part consisting of decomposed igneous rock, and in part of the decomposed previously altered sedimentary rocks in contact with the same; believing that the present Rowley Hills had been exposed and laid bare, by denudation of the strata which he supposed to have originally covered them when they were an irregular mass of igneous rocks imbedded in the strata, similar to what could be seen at Pouk Hill. The apparent height of the Rowley Hills, if looking upon them as a mass of igneous rock, as they until lately had generally been regarded, was quite deceptive; the recent sinkings and cuttings having demonstrated that the igneous rock is but a superficial cap, at most of inconsiderable depth. The Netherton canal tunnel, which was driven through the very base of the Rowley Hills from one side to the other, showed that this cap of igneous rock had been erupted through a dyke not more than eight feet wide, and which was the only one cut through in driving the entire length of the tunnel, and which was apparently the only channel or conduit. The terms of basalt, greenstone, trap, white rock trap, feldspathic rock, and locally, Rowley Rag, white horse, green rock, etc., had all been applied to these igneous rocks, without much discrimination, and it was to be regretted that in England much looseness prevailed in the nomenclature of the Plutonic rocks. A microscopic examination of the close grained and more compact varieties effected completely that which the naked eye could do in the case of the more crystalline and coarser grained rocks, and showed them in every case to be composed chiefly of soda, lime, and feldspar (possibly labradorite), along with a small amount of augite and a small amount of titano-ferrite or titanite of iron, which was never wanting. Other minerals were but seldom present, but traces of zeolites and carbonate of lime might occasionally be found, and possibly a little olivine, though its existence was not yet satisfactorily proved. The rock was therefore what might be termed a true Dolerite, which must consequently be regarded as the sole igneous rock of the district. The presence of titanium was peculiarly constant where these rocks were found.

However altered and decomposed they might appear, as in the white rock or in the red clay, on the slopes of the Rowley Hills, proceeding from the disintegration of the igneous rock itself—there was found the titanium, which thus furnished an excellent guide for tracing out the connection with the parent mass. He had made very careful examinations to determine whether metallic iron existed in these rocks (as was the case in the rocks of the Giant's Causeway, in Ireland, according to some analyses), but with a negative result.

The alteration in external appearance, which had so long led to the supposition that they were so many distinct species confounded under the names of basalt, greenstone, and white feldspathic trap, was due in part to crystallization, in part to the action of water; and, lastly, in some part also to the fact that in the smaller veins and sheets, the rock was generally found to contain somewhat less feldspar and more augite, apparently for the reason that feldspar being the less fusible mineral, had a tendency to cool and become less fluid at a temperature at which the augite was perfectly liquid.

There appeared therefore to be a greater tendency for the feldspar to retain itself like a spongy agglomeration of crystals in the main mass of the rock, whilst the more fluid portion travelled furthest into the smaller chinks and cracks of the rocks. The so-called green rock therefore was in general more rich in augite of a green or brown green colour, and was in general more crystalline and coarse-grained, and might easily be mistaken for a greenstone without more minute examination. Commonly also it was to be found more decomposed than the main mass of rock from which it had proceeded, for the reason that having been injected between sedimentary strata, it absorbed water from these beds, or from the springs connected with them. This percentage of water was frequently found to amount to 9 per cent., without much alteration of colour, due to the oxidation of the iron present in the augite. The small white rock or white horse had gone a step further in decomposition—most probably due to the fact that it occurred in general in small veins or strings, and often had absorbed so much water as to be totally altered in appearance, as in the specimen exhibited, which contained as much as 20 per cent. of water; and in fact, at first sight, it looked more like a clay rock, and would not be taken for an igneous rock at all. It must be however remembered that all clay was but decomposed feldspar, and that this feldspar constituted four-fifths of the igneous rocks or dolerites here alluded to; it was easy, however, to trace the change *in sitû* from the unaltered dolerite to the white rock, or even to the clay which, in its turn, was produced from the disintegration of the white rock. This he had observed in several open sections were the contact of the Rowley Rag and Coal-measures occurred near Dudley, and in the section of the thick coal at the Pensnett Colliery, it might be seen that the decomposition had not yet gone quite so far as to obliterate the peculiar concentric structure characteristic of decomposing igneous rocks of this class.

When in an unaltered condition the specific gravity of these rocks taken from the centre, or so far from the exterior as to be quite fresh, was wonderfully constant, from whatever part of the Coal-field the specimen might be procured. It might be regarded as 2·84, and this agreed well with the usual Titaniferous Dolerites of this class met with in other countries. When altered, as might be naturally expected from the absorption of water, the specific gravity diminished, and might descend to 2·63 or 2·55. The internal columnar structure and the peculiar concentric weathering of these rocks had also been the subject of special study, and the results of the observations made, quite disprove the evidence of any so-called globular structure in these rock masses, but that the columnar, or so-called Basaltic structure, was due merely to mechanical causes. The sedimentary strata in contact were themselves frequently so altered by the contact with the igneous rocks as to present in themselves a columnar structure or jointing, in some cases quite or even more perfect than in the igneous rock itself, and a bed of clay ironstone at Pouk Hill was found, jointed into regular hexagonal columns by the heating and subsequent cooling and contraction, due to the proximity of the igneous rock, which formed the boss of Pouk Hill. Numerous other examples could be cited.

III.—Researches in the Lingula Flags in South Wales. Joint Report by Messrs. H. Hicks and J. W. Salter, F.G.S.

THE results of these researches have led to the discovery of an entirely new British formation, and the authors propose a new term for the group. The district of St. David's was anciently called "Menævia," and hence, following the example of our leading geologists, the authors propose the term "Menævian" for the lower division of the "Lingula Flags." Mr. Hicks described five sections north and south of St. David's—the coast affording admirable views of all the beds, from the central syenite through the olive, grey, greenish, and purple beds of the Lower Cambrians, into the light grey, black, and dark grey shales of the Menævian group. Some of the sections show a passage from this group into the "Ffestiniog group" of Professor Sedgwick, which forms the upper portion of the "Lingula Flags proper," and in Whitesand Bay (a fine bathing strand, N.W. of St. David's) these are again overlaid by the "Arenig, or Skiddaw group" and the Llandeilo flags. Each of the sections has shown fossil traces after a long and persevering search. But the section at Porth Rhaw is not only the typical one, but contains all the principal fossil types—trilobites of six or seven genera, and about fifteen species; Brachiopod and Pteropod shells, Cystideæ, and sponges of two or three different kinds. All of them are distinct as to species, and many as to genera also, from the overlying rocks of the true "Lingula Flags."

The history of discovery in the Palæozoic rocks has hitherto been that every group beneath the Old Red Sandstone, containing a distinct fauna, has, when its relative position and mineral structure is ascertained, received a separate name. The authors hold it therefore of prime importance not to confound this fauna with that of any of the overlying rocks of the Lower Silurian, or even of the Upper Cambrian groups. If Llandeilo, Caradoc, Llandovery, and Wenlock imply distinct periods of creation, much more does the term "Lingula Flags" or "Ffestiniog group" indicate a distinct and remote period, in which very few, even of the genera of fossil animals common in the great Silurian deposits are to be found! All is distinct and anterior, the genera lower in point of organization, the species more limited in number, and, even, with some remarkable exceptions, diminish in size. We seem to be coming towards the zero of animal if not of vegetable life.

With regard to the distribution of the fossils themselves. The lowest beds, which actually lie among the uppermost coarse beds of the Cambrian grits! (only distinguished from them by the want of purple colour,) contain a species of *Paradoxides* (*P. aurora*), with which are associated some minute Trilobites, *Agnostus, Microdiscus*, etc. Further up we have *Paradoxides* again, but of a distinct species, and larger size—*P. Hicksii.* The mass of the fossils then come in (in all thirty-five species are known), crustacea, shells, and sponges; and higher up in the series a third *Paradoxides*, so large as to have attracted general notice—the well-known *P. Davidis.* The genus is unknown in this country above the horizon of this old formation, *Olenus* taking its place in the Ffestiniog group.

As indicative of the value of a close observation of these old faunæ, it may be sufficient to say, that by means of this Menævian group we can ascertain the true horizon of the gold-bearing rocks of Wales; we can also identify more accurately the oldest fossil-bearing strata of Bohemia and Sweden with those of our own country; and assign them an exact position, with respect to British strata, in the older Palæozoic series.

The genus *Paradoxides* becomes in this way one of the medals of creation, and the index of a most remote age—so remote, that only a few, and those the humbler members of the invertebrate classes, inhabited the sea—before the cuttlefish or even the nautilus was created; as these last were long anterior to the very earliest of the fishes.

Mr. Hicks described beds of contemporaneous trap, such as had been previously noticed by his colleague, as abundant in the lower strata of the group. He also showed their origin and direction. The faults of the region, chiefly N.W. ones, were touched upon, but could not be fully described. The district is evidently a prolific one, containing a new and most interesting formation; and as St. David's Cathedral is now being restored, and as there are excellent bathing places close by, it is likely that this remote corner of the island will attract both geologists and non-scientific visitors.

The paper having been read, the natural history of the new formation was treated in a condensed form by Mr. Salter, who called attention to the fact that no less than three distinct fossil-bearing formations—the Tremadoc, Ffestiniog, and Menævian groups—were now traceable below the Llandeilo Flags proper and the "Arenig and Skiddaw group," which last, the "Lower Llandeilo" of Murchison, and the equivalent of the "Quebec group" of Canada, forms the natural base of the Lower Silurian series.

The time allotted to the authors was but short, and only the general facts of the communication could be touched upon.

REVIEWS.

I.—The Quarterly Journal of the Geological Society. No. 84, November 1, 1865.

THIS No. of the "London Geological Society's Journal" contains the communications read before that Society from March to June, 1865, in full, with a few abridgements of Foreign Memoirs of late date. Amateur and professional Geologists have herein supplied facts and notions in relation to the Quaternary, Tertiary, Cretaceous, Jurassic, Triassic, Carboniferous, Devonian, Silurian, Huronian, and Laurentian Strata of different countries, and on fossils from several of these groups; they have given notes on some mineral matters; there is a paragraph or two on volcanic rocks; and we can readily find many and good observations on primæval man, the formation of valleys, on Homotaxis, and other interesting geological subjects. The Secretaries may have arranged their material so judiciously that the Fellows should have in eight evening-meetings and in one No. of their Journal a taste of every delicacy of the scientific season; or the Fellows and their friends, with a fair division of labour, may have aimed at supplying a little of everything they required. But it is more likely that the geological questions of the day have brought essays and remarks from working and thoughtful geologists interested in this or that division of the science, whether practical or theoretical, descriptive or argumentative, mineralogical or geological, and whether, in the latter case, interested in Tertiary, Secondary, or Primary rocks and fossils.

An ancient refuse-heap (or kjökkenmödding) of bones (many cut and sawn), horns, crab-claws, etc., near Richmond, in Yorkshire, described by Messrs. Dawkins, Wood, and Roberts, claims no real geological antiquity, but witnessed the association of the *bear* with man and the deer, fallow-deer, horse, short-horned ox, sheep, goat, hog, and dog. M. Lartet, in a short paper, points out that the musk-ox lived, together with man, in Southern France, 15 degrees further south than its present limit in North America; and that other associates were the great cave-bear, lion, wolf, reindeer, and aurochs. Busk, Falconer, and Warren supply notes on the Gibraltar Caves and their osseous contents, indicating that Gibraltar was a part of Africa when the more ancient infillings of the fissures took place; for the carnivores are African hyænas and felidæ. Man seems to have left his remains there at a much later period. A posthumous paper by Dr. Falconer points out that the evidences of a very high antiquity for the human race will probably be found some day in India, where, although the wide and deep alluvial accumulations of the Ganges and Jumna have not yet yielded *fossil* remains of man, yet even in the *Miocene* strata of the Sivalik Hills are found fossil the camel, the horse, and the buffalo, all which he has trained to domestic service,—the giraffe, his present contemporary,—the gigantic tortoise, which really figures in Indian mythology, with the elephant, python, and gigantic crane,—and lastly, the great apes, so near to him in physical structure, and living in such a climate and with such surroundings as alone would suit primeval man. At all events there is clear evidence that the present order of things had set in from a very remote period in India; and certainly less disturbance of surface-conditions has occurred there during Pliocene times than in Europe, Northern Asia, and North America, to interfere with the growth of the human species, or to remove the evidences of man's early presence. This paper on the ancient fluviatile deposits of the Nile and Ganges has a melancholy interest in being the last of its lamented author's works; and it has a high value as presenting the matured results of close observation and serious thought on the question of man's antiquity, first entertained by Falconer and Cautley in 1835, and in nowise invalidated by subsequent reflection and research. It is a legacy of clear notions and sound doctrine; and it prophesies a sure finding of fossil man in tropical and subtropical regions, when sought for with close scrutiny and keen intelligence.

From a renewed examination of the raised beach and overlying chalk-rubble in the cliff at Sangatte, near Calais, Mr. Prestwich gets further evidence of the Channel Straits having existed when the older alluvia of the Somme and Thames were formed, and of other old geographical conditions.

Messrs. Foster (D.Sc.) and Topley, both of the Geological Survey, have contributed a valuable paper on the river-gravel and brick-earth of the Medway Valley, and on the Denudation of the Weald by the action of rain and rivers. They clearly describe the Medway Valley and its alluvia; and they prove that some of its old river-gravel lies at a level of 300 feet above the present river-bed. If so, and if (as is fairly argued) there are many great difficulties in the way of accepting marine denudation as the cause of the Wealden hollows, then, with long time, rain and rivers could and must have washed away the missing material from the whole of the Wealden area. The geological surveyors show a real desire to search out and give credit for what has been already done and thought of; still we may remind them that the subaerial dissolution of chalk-land is not to be found for the first time in the Geological Survey Memoirs, and that Mackie's hypothesis of a tidal occupation of the Wealden, previous to the formation of the Channel-Straits, is quite worth a passing notice. We must admire their clear and comprehensive treatment of the features of the North Downs and the Weald; but we cannot understand how they can shut their eyes to the coincidences of river-courses and faults on their own fine map; nor why they decry the mathematical hypothesis of the Wealden Valleys. Even the Preston section, with its bold flexures of Rag-stone, fades away with them into a note of interrogation (p. 459). We really must accept rain and rivers as steady, hard-working, and therefore important agents (and some of the very elements of their physics are given in the paper under notice); but we are disinclined to say where on a rising land the action of the sea ends and that of the rain begins; and we are still less inclined to believe that England was ever so free from faults, that the trickling rain, or sweeping tide, could not find guiding channels for their course through what is now chalk down and granite hill. Even geologists have had the fair blank mind of infancy; and now the furrows and ruts of one style of thought or another, of one prejudice or another, traverses its scarred surface, guided by the weaknesses of unequal observations, faulty judgments, and individual fancy; so that, even with advancing years and growing experience, each new truth is seen only by glimpses, caught on devious ways, among projecting rocks and thick boughs, and lost awhile in fogs. The "rain-theory" is now in the ascendant; the "marine-theory" is losing ground; the "fracture-theory" is not yet broken down; we still have more to learn.

The same lesson is taught us by Messrs. Woods and Duncan, who have some Tertiary fossils of South Australia as their text. Are *similar* fossils, here and there, *contemporaneous?* Wait and learn in this, as in other things. The chances are that they are not. We must call them *Homotaxeous.* So also Cretaceous fossils,—whether Eastern Echinoderms, in the hands of Duncan, or Indian Cephalopods with Stolickza—they now hold up the finger of caution; bye and bye they will point to the key of the labyrinth. For the Cretaceous beds of England Mr. Whitaker does good service, with the close, open-eyed, and intelligent observation of a Geological Surveyor. Mr. Whitaker's "Chalk-rock" is a British institution now, but has a very sorry name. The "chloritic marl" (which by the bye is not chloritic at all, but glauconitic), and the Tattenhoe chalk, the "reconstructed chalk," and the "clay-with-flints," are all the better known for his researches; and his flint-band, holding up the headland at Scratchell's Bay is very interesting; but fig. 1 (p. 401) shows either the rising or the setting sun as we look southwards from that fair bay! Is it so in the Isle of Wight?

Waagen and Sandberger supply something on Jurassic Geology; the latter settles the Jura of Baden; the former classifies the Upper and Middle Oolites. The Trias and its plants have notices by Kurr and Sandberger; and we are not to forget that its flora has palæozoic genera.

The palæozoic rocks of the Black Forest, South Africa, New Brunswick, and Cashmere, are released from obscurity or from misapprehension; mistaken relationships are corrected, and more and more strata are snatched from "transition," "Grauwacke," and "azoic," thanks to Godwin-Austen, Matthew, Rubidge, and Sandberger. Hicks and Salter add new palæontological lustre to the Lingula flags. H. Woodward, unmasking a false Chiton, gives Cirrepeds a *Palæozoic* standing; and among the Crustacea he describes some new Eurypterida from the Old Red Sandstone and the Lower Ludlow, finding the long-looked-for link between Xiphosures and Eurypterids. Felspars are compactly tabulated by Tschermak. Wallace offers some interesting notions about Aragonite; and the possible age of the metalliferous trachytes of Hungary is touched upon by Andrian. We heartily recommend to our readers the pleasant task of studying this new number of the Geological Society's Journal.

II.—Barrande's Bohemian Cephalopoda. Système Silurien du Centre de la Bohême, par Joachim Barrande. Premier Partie; Recherches Paléontologiques. Vol. II. Cephalopodes, 1ère Series. Planches 1 à 107. Prague et Paris, 1865.

The author of the above work is well known to geologists and palæontologists (especially those who have occupied themselves with the fossils of the older rocks) for his indefatigable researches in the Silurian region of Bohemia during many years past, and for which the Geological Society of London properly awarded him the Wollaston Medal in 1857.

M. Barrande commenced his researches in 1833, and was further stimulated to prosecute them in 1840, by the publication of the Silurian System, by Sir R. I. Murchison; and a short sketch of his labours and classification of the strata appeared in 1846.[1]

M. Barrande had to contend at first with great difficulties, which would have daunted a less earnest geologist, for he had to make himself acquainted with the language of his partly-adopted country, in order to facilitate his intercourse with the Bohemian workmen engaged in the quarries round Prague. Many of these he interested in collecting fossils, retaining some of them as a kind of working-staff, not only assisting them with money, but supplying them with instruments to facilitate their labour; and so expert did they become, as readily to detect portions of well-known forms, and even to recognize new ones. By these means, and a constant devotion to the subject, an enormous amount of specimens were obtained from the Silurian rocks of the district, which have not only thrown a new light upon, but considerably increased our knowledge of, the Palæozoic fauna of Bohemia, so as to enable us to compare it with the fossil forms of presumed identical strata in Sweden, Russia, Great Britain, America, and elsewhere.

Anterior to 1840, from the first observations of Zéno, in 1770, to the death of Count Sternberg in 1838, and even two years subsequently (Emmrich, 1839; Münster, 1840), the number of species scientifically indicated from the Silurian rocks of Bohemia, was only twenty-two; although some forms, more or less defined, but not named by Count Sternberg, were deposited in the Prague Museum.

A large proportion of the forty works or memoirs published during this period were devoted to a description of the geological features, mines and rocks, as those by Irasek, 1786; Lindacker, 1791, and Reuss; the more instructive and useful are those of Dr. E. A. Reuss on the environs of Prague and Beraun, 1794-98; those of T. E. Gumprecht, who traced the limits of the Silurian basin on the south-east, 1835-37; those of Prof. Zippe, who indicated approximately the contour of the "Transition" strata, and the nature of the

[1] Notice préliminaire sur le Système Silurien, et les Trilobites de Bohême, par J. Barrande. Leipzig: 1846.

principal masses of rock, which form the surface of different districts; and also the geological map of Aloys Mayer, 1837.

In the second edition of "Siluria" will be found a clear account of the Palæozoic rocks of Bohemia and their British representatives, from a personal traverse of the different districts by Sir R. I. Murchison.

By the labours of M. Barrande, the numbers were soon increased to more than 1200 species, most of which were new to science, and which, in 1856, amounted to nearly 1500 species.[1] The first-fruits of these acquired treasures were given about thirteen years since, in a costly work, the first of a series,[2] containing a description of the Trilobites, forming a standard memoir on the subject, and consisting of two quarto volumes of nearly a thousand pages of text, and atlas of fifty plates, the latter carefully engraved by M. Fetters, under the immediate superintendence of M. Barrande. Prior to this work, the same author had published a volume (1847) on the Silurian Brachiopods,[3] comprising eight genera and 175 species, which group will be hereafter completed; as also a special memoir on the Graptolites (1850), a group which appear to have had a limited existence in Bohemia, commencing in the upper part of the Lower Silurian (Stage D), and disappearing before the end of the Upper Silurian (Stage E).

Although, since this period, M. Barrande has published many papers, either separate or in the scientific journals, among which may be noted the Defence of the "Colonies," his chief attention has been directed to the continuation of his great work, of which the title of the volume given above is a proof. It is a commencement of the Fossil Mollusca, comprising the first series of the *Cephalopoda*, and consisting of 107 plates of figures of about 200 species, representing the following genera—*Goniatites*, de Haan; *Nothoceras*, Barr.; *Trochoceras*, Barr.; *Nautilus*, Linn.; *Gyroceras*, Kon.; *Hercoceras*, Barr.; *Lituites*, Breyn; *Phragmoceras*, Brod.; *Gomphoceras*, Sow.; *Ascoceras*, Barr. The two other genera, *Orthoceras* and *Cyrtoceras*, which complete the family of Silurian *Nautilidæ* of Bohemia, being relatively much more rich in species than the preceding, will occupy the second and third series, the total amounting to no less than 350 plates for the Cephalopods alone. The *text* descriptive of the above ten genera will be shortly published; but the principal characters of the species are indicated in the description of the plates.

The genus *Ascoceras* is fully illustrated; this interesting form has also been identified by Mr. Salter, as occurring in the Upper Silurian of Britain, at Usk, Ludlow, and Malvern, and named by him *A. Barrandii*, in complement to the author of the above work.[4]

[1] Parallèle entre les Depôts Siluriens de Bohême et de Scandinavie.

[2] Systême Silurien, Première partie, Recherches Paleontologiques, Trilobites, 1852.

[3] Uber die Brachiopoden der Silurischen Schichten von Böhmen, Naturwissenschaftliche Abhandlungen, etc. Herausgegeben von Haidinger, Wien. Band I. and II. 1847-48.

[4] Salter, Quart. Geol. Journ. 1856, vol. xii. p. 381. Siluria, 2nd Ed. p. 259. *Ascoceras* and its affinities had been previously described by M. Barrande, in the Bull. de la Soc. Geol. de France, 1855. 2 Ser. t. xii. p. 157.

A fact to be remarked is the occurrence of *Goniatites* and *Gyroceras* in three of the stages, *F, G, H,* belonging to the Upper Silurian of Bohemia, according to M. Barrande, these genera being at present restricted to the Devonian rocks in the British area, a very interesting point, and somewhat suggestive, as—

Firstly, that Upper Bohemian rocks may represent the Devonian; or, secondly, that the Silurian forms may have continued longer in the Eastern than the Western area, and were cotemporary with the incoming of new forms; or, thirdly, that in the portion of the Palæozoic ocean, now forming Bohemia, certain new generic forms were introduced in the Upper Silurian period, species of which were only developed at a later period in the Western area, or so-called Devonian time. On this point M. Barrande observes in his former work that very few of the characteristic species of his three stages, *F, G, H,* are found in the Middle or Upper Silurian formations of England, and we must not consider, from their absence, that these parts of the Upper division are not of the same age, but should rather be inclined to believe that the earlier communication between these different regions had been more or less altered. Thus, the deposits may have been isolated in each district, either at the same epoch, or at different times, without our being able to recognize them; but the times are evidently comprised within the limits of the same period. In a previous paragraph, when treating of his Colonies (or the intercalation of certain species of the stage *E* amidst a lower fauna, or stage *D*), the same author remarks:—First, to what extent can the resemblance or palæontological identity demonstrate that formations geographically isolated from each other, may be contemporaneous? Second, to what extent does the dissimilarity between the faunas of isolated and distant basins, correspond to a difference in the epoch when the deposits were accumulated? These are questions intimately related to the laws of the diffusion and distribution of species, little studied at present, but the bearings of which are ably treated by Prof. Huxley in the Anniversary Address to the Geological Society, for 1862.

In comparing the Silurian rocks of Bohemia with those of Sweden, M. Barrande points out that notwithstanding the great difference in thickness between the two countries (30,000 feet in Bohemia to 12,000 in Sweden) they each possess three general faunas. In both countries the Primordial fauna is composed almost exclusively of Trilobites, distinguished generally by the great development of the thorax and the small pygidium.

The second fauna of both countries has the maximum development of Trilobites belonging to new types, in which the pygidium is large and the thorax reduced, of which about three-fourths existed in both countries, whilst the third fauna presented a greater harmony in this group, more than three-fourths having co-existed in each country, a contrast to Brachiopods which presented few common species, and the corals were very different.

The conclusion being, that the parallel between Bohemia and Scandinavia shows, that the general renewal of life in these ancient seas was equally independent of the revolutions of the globe and the variation in the nature of the sediments.

With a view of showing the vertical distribution of the above ten genera of Silurian Cephalopods of Bohemia, it will be necessary to give the divisions of the strata adopted by M. Barrande:

Stages *A*, *B*, *C*, *D*, Inferior division } of the
Stages *E*, *F*, *G*, *H*, Superior division } Silurian System.

The stages *A* and *B* are considered as the Azoic base of the Silurian system, and consists of crystalline, argillaceous and silicious schists, and conglomerates. The stage *C*, or Primordial zone, marked by peculiar Trilobites, is the equivalent of the Lingula-flags of England. The stage *D*, or Quartzites with schists, the equivalent of the Caradoc and Bala, constitutes the second fauna, as nearly all the genera of Trilobites of the first fauna are wanting, and new forms appear both of Trilobites and Mollusca. The stage *E*, or third fauna, is the most rich of all the divisions, as it contains the maximum of development of genera and species both of Trilobites—of which six new genera appear, with eleven of the previous zone, and between 200 and 300 species of Cephalopods, and nearly 100 Gasteropods, besides many Brachiopods, Corals, and Graptolites, the latter disappear in this zone. The stage *F*, or fourth fauna, shows an evident decrease, the Trilobites being reduced to ten genera, and the Cephalopods, Gasteropods, and Acephala affording but few species; but the Brachiopods attain their maximum of specific forms. In this stage the *Goniatites* and *Gyroceras* first appear. The faunas of *G* and *H* are considerably reduced, being represented by a very few species, the Trilobites being most abundant, and belonging to the same genera as in the previous period. The last four stages, *E*—*H*, are considered to be the representatives of the Upper Silurian series.

Vertical Distribution of the Silurian Cephalopods of the first series, in Bohemia.

GENERA.	LOWER SILURIAN.								UPPER SILURIAN.									SPECIES AND VARIETIES.
	A	*B*	*C*	*D*					*E*		*F*		*G*			*H*		
				1	2	3	4	5	1	2	1	2	1	2	3	1		
Goniatites	...	...	...	..	...	...	...	...	...	...	...	4	2	1	14	1	...	17
Nothoceras	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	1
Trochoceras	...	...	...	...	...	...	...	...	6	35	...	2	3	...	1	...	...	44
Nautilus	...	...	...	...	...	...	...	...	...	5	...	...	...	...	3	...	...	7
Gyroceras	...	...	..	...	...	...	...	...	...	...	...	1	2	1	3	1	...	7
Hercoceras	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	2
Lituites	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	1
s.g. Ophioceras	...	...	...	...	...	...	...	...	6	1	...	...	...	...	...	...	...	6
Phragmoceras	...	...	...	...	...	...	...	...	2	23	...	...	...	...	9	...	...	32
Gomphoceras	...	...	...	...	...	...	...	1	1	61	...	1	...	...	6	...	...	70
Ascoceras	...	...	...	...	...	...	...	...	1	10	...	...	...	...	...	...	...	11
s.g. Aphragmites	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	2
s.g. Glossoceras	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	2
	...	...	...	1	...	...	...	1	16	139	...	8	7	2	38	2	...	202

To the student of Palæozoic fossils this volume, like its predecessor, must be a valuable and necessary work, as well as to the naturalist who wishes to become acquainted with the singular forms of these ancient Cephalopodous Molluscs.

Those who best know M. Barrande, and are aware with what self-denial he has, alone and unaided, carried out these protracted scientific labours, and the great expense he has incurred, will readily join us in awarding him all honour due for this magnificent and costly work, for the completion of which we trust his life and health may be spared.—J.M.

III.—Seaside Studies in Natural History.

By Elizabeth C. Agassiz and Alexander Agassiz. London: Trübner and Co. Boston: Ticknor and Fields, 1865. Royal 8vo., pp. 155. 186 woodcuts.

WHAT Harvey's "Seaside Book" is to Britain, and Gosse's various works are to different localities around its shores, this volume is to a limited district on the east coast of the United States. It is almost too dainty to be used by wet hands on the seashore, and more like the drawing-room table, for it is a handsome volume, beautifully printed on thick toned paper, and profusely illustrated, chiefly with *negative* woodcuts, which are, perhaps, better suited to exhibit the transparent jelly fish and the hydroid polyps than the cuts generally used.

This volume is limited, not only to locality, but to subject as well. While the works to which we have referred introduce their readers to the remarkable organisms on the shores—animal or vegetable—this is confined to the Radiate family. But this is a recommendation, as it permits the authors to do more than simply satisfy the cravings of open-mouthed enquirers introduced to a novel world on the sea-shore. They have made their work a really good introduction to this interesting family. It is scarcely any drawback to the English student that the illustrations are all taken from the tenants of Massachusetts Bay, only one or two of which are referred to species found on the shores of Britain; for all these are so nearly allied to the forms which he will meet that facts as to structure, development, and classification are as clearly exhibited to him as if the British species were employed. The volume will be found to be as practically useful at Ilfracombe or Brodick as at Boston, Mass. The simple and clear style employed by Mrs. Agassiz will make it a favourite on both sides of the Atlantic. Every chapter abounds with examples of the facility which she has in expressing in happy terms the most recondite matter. The exposition of the structure and relations of the various parts of *Physalia* and *Nanomea*, two genera of the order *Siphonopheræ*, must convince the reader that they are rightly united to Hydroid Polyps, differing from the ordinary members only in being free and floating.

This work is not intended as a systematic introduction to the various species, but the facts are presented in such a connection with reference to the principles of science and to classification, as to give it to some extent the character of a manual of the Radiata. After treating of the family in general, the author prefixes a general sketch to each of the classes into which the Radiates are divided. This is followed by an examination in detail of the different specific forms.

Whatever adds to our knowledge of recent animals is of importance to the palæontologist. To work well a palæontologist must begin with the recent and known. The value of such information will be frequently apparent to the intelligent geological reader of this volume. We will close by quoting one illustration regarding a recent discovery of Professor Agassiz, not yet much known in this country.

"We must not leave unnoticed one very remarkable Hydroid Acaleph, resembling the Polyps so much that it has been associated with them. The Millepore is a coral, and therefore the more easily confounded with the Polyps, so large a proportion of which build coral stocks; but a more minute investigation of its structure has recently shown that it belongs to the Acalephs. This discovery is the more important, not only as explaining the true position of this animal in the animal kingdom, but as proving also the presence of Acalephs in the earliest periods of creation, since it refers a large number of fossil corals, whose affinities with the Millepores are well understood, to that class, instead of to the class of Polyps with which they had hitherto been associated. But for that we should have no positive evidence of the existence of the Acalephs in early geological periods; the gelatinous texture of the ordinary jelly-fishes make their preservation almost impossible. It is not strange that the true nature of this animal should have remained so long unexplained; for it is only by the soft parts of the body, not, of course, preserved in the fossil condition, that their relations to the Acalephs may be detected; and they are so shy of approach, drawing their tentacles and the upper part of their body into their limestone frame if disturbed, that it is not easy to examine the living animal. The Millepore is very abundant on the Florida reefs. From the solid base of the coral stock arise broad ridges, the whole surface being covered by innumerable pores, from which the diminutive animals project when expanded. The whole mass of the coral is porous, and the cavities occupied by the Hydræ are sunk perpendicularly to the surface within the stock. Seen in a transverse cut these tubular cavities are divided at intervals by horizontal partitions extending straight across the cavity from wall to wall, and closing it up entirely, the animal occupying only the outermost open space, and building a new partition behind it, as it rises in the process of growth. The structure is totally different from that of Madrepores, Astræans, Porites, and indeed, from all the Polyp corals, which, like all Polyps, have the vertical partition running through the whole length of the body, and more or less open from top to bottom." (pp. 22, 23).

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. November 22, 1865.—W. J. Hamilton, Esq., President, in the chair. The following communications were read :—1. "On impressions of Selenite in the Woolwich Beds and London Clay." By P. Martin Duncan, M.B., Sec. G. S.

Spaces formerly occupied by Crystals of Selenite having been described by the author as occurring in Woolwich Beds near Mottingham, Kent, and in the unfossiliferous London Clay of Tendring Hundred, he endeavoured to account for the phenomena to which he had drawn attention. The various facts bearing on the question, including the conditions under which the beds were deposited, their chemical composition, and the mineral condition of the fossils, having been described in detail, Dr. Duncan proceeded to discuss the explanations that could be suggested to account for the formation and subsequent disappearance of the crystals. He came to the conclusion that the mineral had resulted from the action of sulphuric acid, contained in percolating water, on pre-existing carbonate of lime, the sulphuric acid having been formed by the oxidation of sulphuretted hydrogen by the oxygen evolved from the decomposing vegetable remains occurring in the Plant-beds intercalated in the strata containing Selenite-spaces. The hydrocarbons resulting from the same decomposition would in solution be sufficient to produce the decomposition of the Selenite. In conclusion Dr. Duncan urged that if his explanations were accepted, the occurrence of Selenite in a deposit must be held to prove the former existence of organisms in it, and the removal of the Selenite to be equivalent to the loss of the evidence of such existence; therefore there can be no reason why the purest clay-slate may not have been once as fossiliferous as the Woolwich Beds.

2. "On the Relation of the Chillesford Beds to the Norwich Crag." By the Rev. O. Fisher, M,A., F.G.S.

The geological position of the Chillesford Clay has never been definitely settled. Mr. Prestwich, who first described it, left the question open as to its identity with the Norwich Crag, or with the more recent marine, freshwater, and land series which immediately underlies the great northern Clay-drift of Norfolk. Sir C. Lyell supports the former view, while Mr. S. V. Wood, jun., considers the Chillesford Clay a local member of his "Middle Drift." The author described the Chillesford Beds as they occur at Chillesford, and thence traced them northward to Aldborough. At Thorpe, north of Aldborough, the Norwich Crag is exposed, and the main object of the paper was to show that this bed probably overlies the Chillesford Clay. In order to prove that this Crag is not identical with the Mya-bed below the Clay, Mr. Fisher cited its greater thickness, its difference in lithological character, and the dissimilarity of their fossils; he also remarked that it rested upon a loamy clay, and contained a strong spring at its base, whereas the Mya-bed was always observed to rest on porous beds; he therefore inferred that this loamy clay was the Chillesford Clay, and showed that the gentle dip to the North would bring it into the required position; moreover, he had found indurated nodules of loam, resembling weathered Chillesford loam, in the base of the Norwich Crag at this locality. Mr. Fisher next noticed the occurrence of the same beds at Southwold, and stated that the well-known deposit from which the late Colonel Alexander obtained so many mammalian remains was the Mya-bed. The Norwich Crag is also seen in this neighbourhood at Wangford, differing in character from the Mya-bed, and resting on a loamy clay resembling, and probably identical with, the Chillesford Clay. The sequence of these beds is therefore, in descending order:—(1) Norwich Crag; (2) Chillesford Clay; (3) Mya-bed; (4) Red Crag.

The following specimens were exhibited:—A collection of Newer Pliocene Fossils from Chillesford, and Aldborough, Suffolk; exhibited by the Rev. O. Fisher, M.A., F.G.S. Impressions and Crystals of Selenite from the Woolwich Beds and London Clay; exhibited by Dr. P. Martin Duncan, Sec. G.S. A very fine species of *Lepidotus*, from the Wealden Beds at Sevenoaks; exhibited by Arthur Bott, Esq., A.A., F.G.S. Minerals from the North Highlands; exhibited by G. E. Roberts, Esq., F.G.S. Devonian Corals from Poland; presented by Sir R. I. Murchison, K.C.B., F.R.S., F.G.S. Specimens of Cannel Coal from New South Wales; presented by the Rev. W. B. Clarke, M.A., F.G.S.

II.—December 6, 1864.—W. J. Hamilton, Esq., President, in the chair. The following communications were read:—1. "On the Western Limit of the Rhætic Beds in South Wales, and on the position of the Sutton Stone." By E. B. Tawney, Esq., F.G.S. With a Note on the Corals of the Sutton Stone; by P. Martin Duncan, M.B., Sec. G.S.

Mr. Tawney commenced with a description of the Rhætic beds as they occur near Pyle station, west of Bridgend, and at Cwst y Coleman, north-west of that place, giving detailed sections of the beds at these localities, and showing the distribution of the fossils in them. The author then describes the characters of the "Sutton Stone," and showed its relations to the beds above and below, giving to the building stones generally called "Sutton Stone" the name "Sutton Series," and to the beds which intervene between the Sutton Stone and the base of the true Lias, and which have hitherto been considered Lias, the name of "Southerndown Series," illustrating the stratigraphical features by a general section from Sutton to Dunraven Castle, and by vertical sections at Southerndown and Luleston. From the evidence yielded by the fossils, the author was of opinion that the Southerndown series belonged to the Rhætic formation, and must be separated from the Lias; that the Sutton series is somewhat older than the *Avicula-contorta* beds, and has affinities with the Trias; and that, by the discovery of *Ammonites* in the Sutton beds, the first appearance of that genus in the British area has been proved to have occurred during a period anterior to the Lias.

In his note on the Corals, Dr. Duncan stated that, besides two species derived from the Carboniferous Limestone, he had been able to determine four species of *Zoantharia* from the base of the "Sutton Stone." These Corals are unlike any hitherto discovered in North-western Europe, and, with certain reservations, were said to indicate an horizon which, in the Alpine Triassic districts, would be deemed St. Cassian; but, as our knowledge of the vertical range of the St. Cassian Corals is at present very imperfect, their absolute age cannot be more definitely stated, their occurrence in South Wales rendering it probable that they have a greater vertical, as they are now proved to have a greater horizontal, range than has hitherto been supposed.

2, "Notes on a Section of Lower Lias and Rhætic Beds near Wells, Somerset." By the Rev. P. B. Brodie, M.A., F.G.S.

A section recently exposed at Milton Lane, one mile and a-half north of Wells, exhibited the Lima-beds passing into and overlying the White Lias and *Avicula-contorta* zone. The author described the section (which was constructed by Mr. J. Parker and himself) in detail, and showed that the Lima-series attained here a thickness of 10 feet 4 inches, and the Rhætic beds, including the grey marls, of 18 feet 6 inches; he was not able to discover any trace of *Ammonites planorbis*, nor any of the peculiar limestones indicating the "Insect" and "Saurian" zones. He found one fragment of bone-bed lying loose at the end of the Lane, and containing characteristic fish-remains; but though he searched carefully, he could not find *in sitû* the bed from which it had been detached.

The following specimens were exhibited:—A collection of Rhætic Fossils from Glamorganshire; exhibited by E. B. Tawney, Esq., F.G.S.—A series of Fossils from the zones of *Avicula contorta* and *Ammonites angulatus* from near Gainsborough; exhibited by F. M. Burton, Esq., F.G.S.—Corals from the White Lias of Watchet; exhibited by W. Boyd Dawkins, Esq., M.A., F.G.S,—A restored paddle of *Pliosaurus* from the Kimmeridge Clay near Peterborough; exhited by Dr. H. Porter, F.G.S.

Edinburgh Geological Society.—I. The annual general meeting of this Society, was held on November 2nd, 1865, David Page, Esq., F.R.S.E., F.G.S., Vice-President, in the chair. The following gentlemen were elected Officers for the session, 1865-66:—*President*, Charles Maclaren, Esq., F.G.S. *Vice-Presidents*, D. Page, Esq., F.R.S.E., F.G.S., and R. A. F. A. Coyne, Esq., C.E. *Interim Secretary*, G. C. Haswell, Esq. *Treasurer*, G. Lyon, Esq. *Librarian*, T. Smyth, Esq. *Curators*, T. R. Marshall, Esq., and A. Somerville, Esq. *Councillors*, J. R. S. Hunter, Esq.; T. Wallace, Esq.; G. C. Haswell, Esq.; D. Marshall, Esq.; Neil Stewart, Esq.; and the Rev. C. Teape.

Mr. Page, who opened the session on behalf of the venerable President, Mr. Maclaren, directed attention to some of the leading features of the Glacial epoch. He divided the epoch into three stages:—1. When the land stood somewhat higher than at present, and when land-ice was the chief agent of glaciation; 2. When the land began to sink to the extent of 1800 or 2000 feet, and when land and sea-ice were both instrumental in moulding, rounding, and smoothing the rocky surface; and 3. When a reverse action set in, and the land began to rise again, stage by stage, accompanied by a gradually improving climate, and during which mountain and bay-ice were annually the operative agents. The first stage was the period of the "lower till" of Scotland, characterised mainly by its tenacious clays, and angular blocks and boulders not far removed from their parent sources; the second stage the period of heterogeneous clays and gravels of rounded and striated boulders, far drifted from their original sites; and the third stage, the period of moraines or gravel mounds in our upper glens, of "Kaims" or sand and gravel mounds in our lower valleys, and of the stratified clays or "brick-clays" in our lower straths and sea-belts. The first and second stages he described as unfossiliferous, and the third stage as partially fossiliferous. The brick-clays (which were the sea-muds of the gradually uprising land) containing remains of whales, seals, northern ducks, shells, starfishes, etc., indicative of a colder or more boreal climate. The "lower till," resting upon *Pre-glacial* surfaces of sands, gravels, soils, and peat-earths, was fossiliferous, and contained bones of Mammoth, Mastodon, Rhinoceros, etc.; the upper clays were overlaid by *Post-glacial* beds, which also contained remains of Mammoth, Mastodon, Rhinoceros, Irish Elk, Reindeer, etc., which proved the return of these animals to the same latitudes after the glacial influences had passed away, and were restricted to their existing Arctic limits. By the subsequent removal, in some places, of the upper and second stages, the Post-glacial fossils were sometimes brought in connection with the "lower till"—hence the error of regarding the latter as fossiliferous; and by the removal of the whole of the Glacial accumulation, the Post-glacial and the Pre-glacial were sometimes brought in contact, and hence the error of confounding events separated by thousands of ages. He stated that whatever theory was adopted to account for the Glacial epoch, it must be one applicable alike to past and future, and obedient to regular periods of recurrence. There was evidence of colder and warmer periods in the earliest history of the globe, and these, like the Glacial epoch, were no doubt dependent upon some great law of secular succession. Before arriving at any correct theory, however, geologists had still much to accomplish: to examine and fix the succession of the accumulations, to ascertain the limits within which the Glaciation had occurred, to find whether it had been contemporaneous all over the higher latitudes of the Northern Hemisphere, and to determine, also, how far the Southern Hemisphere had been subjected to a similar phase, or phases, of ice-action.

II.—November 23rd, 1865.—Mr. Stedman read a paper on the Charlestown Limeworks, near Dunfermline, Fifeshire, the property of the Earl of Elgin. The lime is obtained from a quarry in the Mountain Limestone. He described the lithological character of the beds, which were much contorted, and remarked that a seam of coal had been met with seven feet below the Limestone.

The Geological Society of Glasgow.—I. The Conversazione of this Society was held on November 2; the attendance was very numerous, and a great variety of interesting geological objects was exhibited. The chair was occupied by the President, James Smith, Esq., F.R.S., of Jordan Hill.

II.—The first monthly meeting, session 1865-66, was held in the Andersonian University, on the 9th of November. Edward A. Wunsch, Esq., Vice-President, in the chair. Seventeen new members were elected. The secretary exhibited and described a new chart of Fossil Crustacea, arranged and drawn by Messrs. J. W. Salter, F.G.S., and Henry Woodward, F.G.S., &c. This chart is a most interesting and valuable one. It contains upwards of 490 figures beautifully engraved by Mr. J. W. Lowry, and not only shows at a glance, between transverse lines, the various genera of crustaceans belonging to each of the geological formations, but also, between curved vertical lines, the first appearance, gradual development, and range in time, of each of the several orders, from the Cambrian period to the present, the top transverse section containing recent typical forms illustrative of the fossil groups figured below. He also exhibited and briefly described several fossils new to the Scottish Carboniferous fauna, including one new to science. These fossils were from the Upper Coal-measures of Kilmaurs, finely preserved in clay-ironstone nodules, and identical with those found in similar nodules about Coalbrookdale, in the Shropshire Coal-field. They consist of ferns and other plant remains. There were also several specimens of the *Limulus rotundatus*, one of which showed a peculiar prolongation of the carapace (?), which Mr. Henry Woodward said he had never seen in the numerous specimens from the Coal Measures which had passed through his hands. The Secretary referred to it as a link in a curious series of the modification of an organ, as shown in some of the *Eurypterida* and *Limulidæ* in the chart. He then drew attention to a perfect and beautiful specimen of a *Bellinurus bellulus* of the family *Limulidæ*, also from Kilmaurs, which he described, and contrasted with a specimen of the recent *Limulus Moluccanus* from the Indian Ocean.—The Rev. H. W. Crosskey then took the chair, and Mr. Wunsch read a paper by himself and Mr. John Young, of the Hunterian Museum, on his "Discovery of fossil trees buried in volcanic ash in Arran" (see Geological Magazine, October, 1865, p. 474).

III.—At the monthly meeting on the 7th December, Rev. H. W. Crosskey, V.P., in the chair, Mr. John Young called attention to some interesting corals from the Carboniferous limestone presented to the Society by Mr Linn. Mr. James Bennie read a paper on the "Surface Geology of Glasgow," as illustrated by the excavations for the Windmillcroft Dock, the Mavisbank Quay, and for numerous public buildings. All information connected with the Newer Pliocene and Quartenary deposits is deserving of careful consideration, and we are glad to find the members of the Glasgow Geological Society are alive to the importance of harvesting these local way-side observations so often passed by unnoticed. Mr. Bennie's paper is full of facts and suggestions "on the Geological Revelations of the old estuary of the Clyde" (as he also styles his paper).

Mr. John Burns read a paper on the Encroachments of the Sea on the coasts of Great Britain from the Shetland and Orkney Islands on the north to the Scilly Islands on the south.

Norwich Geological Society.—At the monthly meeting of this Society, held on the 5th ult., the discussion upon the formation of flints in Chalk was revived, and several specimens were laid upon the table to illustrate the subject. Mr. Sutton read a paper "On an Analysis of the Hunstanton Red Chalk, and the Sandstone near the Tuckswood Lane, on the Ipswich Road." Mr. Sutton could not account for the colouring of the Red Chalk, nor how the iron rested in the Chalk or Car-stone, which was supposed by some to produce that colour. The Red Chalk was composed of 80 1-10 per cent. of carbonate of lime, with slight traces of sulphate of lime; $8\frac{1}{2}$ per cent. of peroxide of iron, traces of magnesia, 9 4-10 per cent. of silica, $1\frac{1}{2}$ per cent. of alumina, and $8\frac{1}{2}$ per cent. of organic matter. The White Chalk, or Chalk-marl, immediately above contained 96 2-10ths of carbonate of lime, 1 1-10th of peroxide of iron, 2 per cent. of silica, 6-10ths per cent. of alumina, and 9-100ths of organic matter. The silica was really 2·01, making it up 100. The sandstone on the Ipswich Road was peculiar, because it was the only known stone in Norfolk of that character. It was indurated, and could be used as building stone, and existed at the spot named in considerable masses. The cement in this case seemed to be simply carbonate of lime. Of carbonate of lime there was $3\frac{1}{2}$ per cent.; of peroxide of iron, 13-100 per cent.; alumina and organic matter, 29-100; pure sand, 68 38-100 per cent. The President (the Rev. J. Gunn) remarked that the colour of the Red Chalk was owing to the peroxide of iron, and in this opinion Mr. Sutton concurred. Mr. Sutton added that the quantity of silica was very large in comparison with White Chalk, and that it existed in a fine condition, and not as sand. In the sandstone it existed as coarse grains and sand, like sea sand which had been somewhat rounded.

The Ipswich Road sand was made into stone by the carbonate of lime. The Car-stone contained iron-ore, but it could only be obtained in such small quantities, that it would never yield a ton a week if worked. At least 50 per cent. of the crystalline bands of the Car-stone consisted of peroxide of iron, and in quality it was really like hematite, one of the richest iron ores that could be smelted. Mr. Gunn then referred to the Forest-beds at Holme Scarf and Bacton, remarking that they were not both of the same age, but that the former was much more modern than the latter.

The following paper, by Mr. Taylor, was then read :—" On a Disturbance of the Chalk at Swainsthorpe." The singular contortion of the Chalk at Whitlingham has obtained some attention, in relation to its connection with the general upheaval of the Norfolk Cretaceous strata. I have now the pleasure to notice a similar occurrence, to be seen in a Chalk-quarry at Swainsthorpe. The pit in question can be easily seen from the high road. It is not so large as the Chalk-pit at Whitlingham, where the contortions are seen. I have made rough sections of the right and left sides of the pit, the middle being covered up by a recent land-slip. On the left side the flint bands are nearly perpendicular, being somewhat contorted and leaning towards the right. On the right side the bands are perhaps more perpendicular still, but lean towards the left. The contorted bands, indeed, are but the flanks of an anticlinal arch, the summit of which has been denuded. The upper part is covered by a seam of gravel rubble, not more than four feet in thickness. The principal fossils are *Spantangi* and *Terebratula*. The flint bands are shattered and broken as though by the influence of some sudden force. The pit occurs at the foot of a gently-rising ground, and has evidently been deserted for some time. The Chalk is harder than at Whitlingham, although occupying nearly the same position geologically. No other pits are to be found in the neighbourhood. I have confined myself simply to calling the attention of the society to this additional example of disturbance, in the hope that its announcement in the public papers may lead to the discovery of others.—*Norwich Mercury*, December 9th, 1865.

Bristol Naturalists' Society—Geological Section.—I. The last excursion of this Society, took place on the 29th September, when several members visited a portion of the North Somerset Railway, at Whitchurch.

The President, Mr. W. Sanders, F.R.S., pointed out the junction of the Coal Measures with the New Red Sandstone, and the junction of the latter with the Lias, which is here well exposed, and yielded numerous characteristic fossils.

II.—At the evening meeting, October 26th, Mr. W. Sanders, F.R.S., President, in the Chair, Mr. A. Leipner read a communication from Mr. Spencer G. Perceval, upon two species of Devonian Corals, viz. :—*Cyathophyllum, cæspitosum*, Goldf., and *Pachyphyllum Devoniense*, E. and H. From an examination of a large number of specimens, the author concluded that the latter genus was only the astræiform variety of the former. Mr. Perceval exhibited specimens, showing both the fasciculate and astræiform characters in the same specimen.

Mr. W. W. Stoddart, F.G.S., described a series of Otoliths (ear-bones) of fishes, from the Tertiary beds of Hampshire, and explained their function, and the exquisite structure of the auditory apparatus, as seen in fishes at the present day.

III.—November 23rd.—Mr. W. Sanders, F.R.S., the President, gave a description of the Old Red Sandstone, its petrological and palæontological characters, and its general distribution in Europe and elsewhere.

Exeter Naturalists' Club.—The members of this club made their last excursion for the season on Saturday, September 23rd, 1865, to Northam Burrows. Mr. Townshend M. Hall, F.G.S., read a paper "On the Geology of Barnstaple and its neighbourhood, and on the Pebble ridge at Northam Burrows. He remarked that no geological maps of North Devon had yet represented all the beds that were to be met with there; some called the whole of the rocks Devonian, others Carboniferous, while even the Geological Survey maps gave no more than three or four varieties of rocks. He exhibited a geological map of the district, which he had constructed from his own observations, and had traced the Devonian, Carboniferous, patches of red sandstone referred to to the Trias, greensand probably Cretaceous, and Post-tertiary formations, such as drift, raised-beaches, and a submerged forest. The author then described these deposits in detail, beginning with the oldest, which he called "North Devonian," because on account of the singular mixture of its fossil-remains it is doubtful as to whether it belongs to the Old Red Sandstone (or true Devonian), or forms part of the Carboniferous system. The several members of this series are spoken of as the Linton, Martinhoe, Ilfracombe, Morthoe, Marwood, and Pilton groups, and extend from the Foreland to Marwood. The Pilton beds are regarded as Upper Devonian, although they are physically more connected with the Carboniferous; their fossils, however, render them quite distinct from both the Old Red Sandstone and Carboniferous, for they contain the same plants as the former, several characteristic shells of the latter, and numerous fossils peculiar to themselves. The Marwood group is the most constant in yielding everywhere, throughout its whole extent, fossils of the same genus and species; the author had traced it from Baggy Point to High Bray, a distance of seventeen miles; it is worked extensively at fifteen places as a building-stone, and specimens of *Cucullæa* are abundant at all the quarries. The Linton group has yielded, up to the present time, fifteen species of fossils, the Ilfracombe thirty, the Marwood seventeen, and the Pilton sixty-five.

The Carboniferous Limestone, next in order, extends in a series of alternating shales from Westleigh to Bampton, the quarries of Swimbridge and Ven afford the best sections; at the latter place it occurs in beds of unequal thickness and quality, very much contorted. *Posidonomya, Goniatites,* and *Orthoceratites,* are almost the only fossils found in these beds. Near the quarry of Ven, the Limestone is capped by Millstone-grit, which also occupies the whole coast-line from Fremington to near Tintagel. The Carboniferous district contains in many places, in faults and hollows, patches of New Red Sandstone: Greensand in like manner is found at Orleigh Court.

Mr. Hall then referred to the Post-tertiary deposits, and stated that the Drift-beds are exposed in the railway-cutting at Fremington Station, and at Baggy Point, where he had found a great many flint weapons. He next discussed the origin of the Pebble-ridge of Northam Burrows, which is a line of pebbles extending far along the coast and serving as a natural breakwater; he suggested several theories to account for it, and stated his opinion that the source was the bed of the sea, not far off the granite of Lundy Island, and that it was not a work of the past only, for fresh material was still being added to the ridge. The writer concluded by pointing out the vast degradation that was taking place on the north-eastern side of the Burrows, where there is no barrier to protect the cliffs, and said that within the last few years many acres of land had been destroyed.

CORRESPONDENCE.

FROST AND SEA *V.* RAIN AND RIVERS.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—Some observers would have us believe "that Rain and Rivers have been the principal agents in forming the present features of the land," while to me it would appear that they did the least part of the work, if we are to judge by what we see going on at the present day.

Rain, *by itself*, appears to be a *Preserver*, not a *Destroyer*, for if we go up on an uncultivated mountain, we find that rain has covered it with a mantle of Peat, and to that it can only add, unless other agencies come into force. This is well exemplified where a hill-side has been cultivated. Man, while he cultivated it, acted as the destroyer, and Rain only as a *carrier* to take away part of the soil that man had rooted up. If man ceases to cultivate that mountain side, Rain causes plants to grow, then to become *Reisk*, and eventually *Bog*, which latter, as long as only Rain acts on it, continues to increase in thickness. Rain must have some foreign help to commit destruction. Let the hot summer sun open cracks in that bog, or cattle form deep tracks, or man cut trenches in it, and what are the results? Rain continues the work that a foreign agent has begun; but even then it cannot do much work unless *Frost* comes to its aid, to expand the water that fills the cracks and small fissures, and breaks off large and small pieces, which falling into the hands of its *carrier*, Rain, are washed down off the mountain.

It is the same with rocks. Examine a mountain formed of hard compact rock, that rain has run over for ages, and you will find that the Glacial striæ are scarcely obliterated, because the sun and frost could not act on it. On the other hand, examine a mountain composed of jointed or cleaved rock, and what are the results? The summer sun opens the minute fissures, the winter frosts expand the moisture in them, and then, and *not till then*, rain has work to do in carrying away the *débris*.

Look at a river-cliff, formed of drift; what destruction does a flood to it? A mere bagatelle, unless there has been a frost previously, and then tons of *débris* fall, to be carried away by the river.

The work done by Rain and Rivers is perceptible in centuries, while the work done by Frost in this country (not to go to its large work-shop in the North) is perceptible after every winter.

The Sea acts in a similar manner. Its years' work is clearly seen —aye, even the work of a single tide. We know that Rain has done very little work in this country since the Glacial period, as the rocks forming the bottom of all the large valleys and *Cooms*, and of most *Ailles* or ravines, are Ice-dressed, and yet we are to believe that Rain has cut out those valleys instead of ice! while ice is doing exactly similar work farther North at the present day.

The same way with the sea. If we examine the work done by the sea we find that it cuts away soft or homogeneous rocks, such as shales or limestones, while hard rocks, such as traps and grits, it leaves standing as *Carrigs*, *Carrigeens*, or *Illauns*; and if we go inland we find hummocks, *Carricks*, or crags and hillocks formed of bosses of trap or some other hard kind of rock protruding out from mountain sides or standing up in undulating plains; the surrounding country in every case being of a much softer rock; and yet we are to believe that the mountain slopes and the undulating plains were formed by Rain and Rivers, and not by marine denudation.

I do not mean to say that Rain and Rivers have not done some work, but what I do say is that they are only some of the minor workers—that they do a little work on their own account—but that their place in nature is that of "Carriers" to remove the *débris* which other agents (principally the Sun and Frost) have formed.

Yours truly,

G. Henry Kinahan.

Oughterard, Ireland, *Dec. 2nd*, 1865.

A BURNING COAL-SEAM.

A Correspondent, "R. N.," states that "at Bradley, a small village near Bilston in Staffordshire, a Coal-bed has been burning for half a century," and enquires if this be true, and "whether there are no other means, except 'flooding the pit,' to extinguish the fire and arrest the useless destruction of valuable fuel."

On referring to A. K. Johnston's Dictionary of Geography (London, 1853) we find a statement to the same effect. We shall be glad if any correspondent will inform us whether the seam be still burning, and what is the depth of the mine.

We recorded (Geological Magazine, vol. ii. p. 336) an instance of an outcrop of Coal of Miocene Tertiary age on the Mackenzie River, noticed on fire, as long ago as 1785, by Sir Alexander Mackenzie, and again by Sir John Richardson, in 1849; but we did not think that such destruction was allowed to take place in England, and cannot suppose it to be irremediable.—Edit.

MISCELLANEOUS.

Note on Miolophus planiceps, Owen.

This interesting mammalian remain from the Lower Eocene formation, which was figured and described by Professor Owen in the Geological Magazine (Vol. ii., p. 339,, pl. x., fig. 1), has been claimed by Mr. W. S. Dallas, Keeper of the Museum of the Yorkshire Philosophical Society at York, as the original of Mr. Charlesworth's *Platychærops Richardsoni*, which had been lent to the late Dr. Hugh Falconer for examination, and since lost sight of by Mr. Dallas.

The only notice of *Platychærops* is to be found in the Report of the 24th meeting of the British Association (held at Liverpool in September, 1854). At p. 80 (Reports) it is there described by Mr. Charlesworth as "the skull of a new mammal from the London clay of Herne Bay, about the size of *Hyracotherium*, but quite distinct, having very prominent zygomatic processes, and the crowns of the molar teeth being furnished with one large tubercle, occupying two-thirds of the surface and several small complicated tubercles *inside*" (outside ?).

This description is very imperfect and incorrect, and not being accompanied by a figure of the specimen, sufficiently explains its having been overlooked.

The late Dr. Falconer sent the specimen to M. Lartet, in order to obtain his opinion thereon ; that gentleman returned it by the hands of the late Mr. Henry Christy, who, Dr. Falconer having died, left it (we understand), with Mr. Roberts. That gentleman, unaware of its history and ownership, submitted it to Professor Owen for description, stating that both M. Lartet and the late Dr. Falconer asserted it to be a new and undescribed mammal.—Edit.

Discovery of Remains of the Dodo.—Numerous remains of that remarkable wingless bird, the Dodo (*Didus ineptus*, Linn.), have recently been obtained from a Morass in the Island of Mauritius, by Mr. George Clark, of Mahébourg, in that island. A very complete series of the bones of this interesting creature are now in the hands of Professor Owen for examination, and they will probably be described, on the 9th instant, before the Zoological Society of London.

Obituary.—We have just received the sad intelligence of the sudden death of Mr. George E. Roberts, F.G.S., and Clerk to the Geological Society of London. During the five years which Mr. Roberts held office at Somerset House he was engaged in literary pursuits of a more or less scientific character. His name will be found in the Quarterly Journal of the Geological Society, the Geological Magazine, and numerous other periodicals. He was also the author of several original works. He died at Kidderminster, his native place, on the 20th December, at the early age of 34 years.

THE

GEOLOGICAL MAGAZINE.

No. XX.—FEBRUARY, 1866.

ORIGINAL ARTICLES.

I.—A FEW REMARKS ON THE SO-CALLED LOWER NEW RED SANDSTONES OF CENTRAL YORKSHIRE.

By E. W. BINNEY, F.R.S., F.G.S., ETC.

I HAVE lately had an opportunity of taking a hasty examination of the part of Yorkshire lying between Bramham Moor and Fountains Abbey for the especial purpose of examining the "Lower New Red Sandstone," so elaborately described by Professor Sedgwick many years ago, and lately alluded to by Professor John Phillips, in a paper read before the Geological Society.

Having of late years devoted considerable attention to the Whitehaven, Astley, and Moira Sandstones, rocks lying above all the higher Coal-measures containing the Spirorbis-limestone, on the western side of the Pennine Chain, and under the soft Red Sandstone, of Permian age, of Collyhurst, near Manchester, and Kirkby-Stephen and Hilton, and which Sandstones very much resemble some of the Millstone-grits, I was prepared to find the Bramham Moor, Plumpton, and Knaresborough Sandstones to be Permian Sandstones, such as they have been represented to be by the two above-named learned Professors; but, so far as my examination went, I was unwillingly compelled to forego the pleasure of finding what I was specially in search of, namely, a Lower Red Sandstone of Permian age, and to put up with what I really found, namely, Millstone-grit, most probably the Upper Millstone of Halifax, as described by Professor Phillips, and adopted by the Geological Survey, but more commonly known and described in Lancashire as Rough Rock, and by Mr. Farey as his "Third Grit."

The districts chiefly examined were the quarries on Bramham Moor, kindly shown me by Mr. Kell, the agent to Mr. Lane Fox, the Plumpton Rocks, the rocks lying between the latter place and the escarpment under Knaresborough Castle, and the Gritstones and Flagstones of the Skell, west of Fountains Abbey.

Before proceeding to describe more in detail the sections which came under my notice, it will be as well for me to state that I consider the Lower Red Sandstone of Kirkby-Woodhouse, in Notts, the Pebbly Dam sand in Derbyshire on the south, and the Clacks-Heugh and Tynemouth yellow Sandstones on the north, although undoubted

Permian deposits, were not of the same age as the Sandstone I was in search of. That rock certainly underlies the Kirkby-Woodhouse conglomerate and the yellow Sandstones. I was looking for a rock analogous to that described by me at Whitehaven, Astley, and Moira.

It will be well to give the views of the two authors above alluded to.

Professor Sedgwick, who may be fairly termed the father of what is now called Permian Geology, at p. 65 of his paper on the "Geological Relations and Internal Structure of the Magnesian Limestone,"[1] says: "During the time I had an opportunity of observing in a part of Yorkshire that the Magnesian Limestone, rested upon a system of beds of very peculiar character, which in some places resembled coarse Millstone-grit, and in others had more the appearance of New Red Sandstone. As, however, at that time I had no means of ascertaining the extent and continuity of this deposit, and as I found that its upper surface was in some places unconformable to the Limestone which rested upon it, I erroneously concluded that it was a peculiar formation of Gritstone subordinate to the Yorkshire Coal-field."

He afterwards altered his opinion to that of Dr. Smith,—that the rock belonged to the Magnesian Limestone; and, after tracing it from Harthill, in the south of Yorkshire, followed it through Bramham Moor, Plumpton, Knaresborough, Scara, near Ripley, and South Stainley, where he appears to have lost sight of it, and, at p. 70, says: "It is, however, difficult and perhaps impossible to determine its precise limits, as it makes no escarpment, and can hardly be distinguished from some varieties of Millstone-grit which range through the same district."

Professor John Phillips, in his "Notes on the Geology of Harrogate,"[2] says: "Few rocks are more variable in composition, while regular in sequence, than the Lower Permian Sandstones and Shales. When the sequence is immediate from the Upper Coal-measures to the Permian beds, as in Durham, North Staffordshire, and part of Yorkshire and Derbyshire, the analogy of the two sets of strata is considerable, even if they do not exchange beds. But in this part of Yorkshire the Permian beds are in no sense or manner conformed to the Coal-system, or any part of it. They are strictly transgressive, and very much so, resting on extremely different members of the great Carboniferous system, and of very different age. In this particular district the Millstone-grit probably underwent enormous waste after the anticlinal was formed, and before the Permian beds were deposited. These Permian beds of coarse and fine purple Sandstone are full of the detritus of Millstone-grit. The felspar is rolled, but quite recognizable, and the mica appears in ferruginous patches. The rock is quite undistinguishable from Millstone-grit in hand specimens; even the purple colour (due to decomposed ferruginous mica) fails sometimes; and, as at Plumpton, great and lofty cliffs of solid rock appear, such as may have yielded

[1] Transactions of the Geological Society of London, 2nd Series, vol. iii.
[2] Quarterly Journal of the Geological Society, vol. xxi. p. 234.

the Devil's Arrows, those massive monoliths of the British settlement which preceded ancient Isurium. As we proceed to the south, and reach the Leeds Coal-basin, the Permian beds lose their similitude to Millstone-grit; and as we pass to the north and encounter the Mountain-limestone, so also the resemblance to Millstone-grit is lost; nor is it recovered in Durham and Northumberland, nor does it occur in any other part of the kingdom, though quartzose pebbles and coarse sand accompany it in many parts. From this we may draw a confirmation of the opinion, very probable on other grounds, that the Lower Permian beds were of littoral aggregation, by currents operating on the waste of the neighbouring coasts."[1]

Now it is clear from both the above authors that the Plumpton Sandstone, which Professor Sedgwick thinks to be a continuation of the coarse Sandstone on Bramham Moor, as it evidently is of that of Knaresborough and Stainley, is undistinguishable from Millstone-grits, and quite different in character from the Durham Lower New Red Sandstone in the North, and the same rock in the South Yorkshire Coal-field. In addition to this I propose to show that the rock at Knaresborough contains common Coal-plants; it is confined to the Millstone-grit district, and has been found in that district alone, and lying upon the same rock; and that it has never been met with in sinking through Permian beds to profitable Coal-measures like the Whitehaven, Astley, and Moira Sandstones; and, although doubtless, like those rocks in its characters, it ought not to be confounded with them without further evidence.

The Bramham Moor Section.

The Sandstone in this district consists of a coarse-grained grit, false-bedded, composed of white quartz, mixed with large rounded pebbles of the same mineral, and an abundance of decomposed felspar. In some of the quarries the stone is so soft as to be easily crumbled to pieces between the fingers; and in others it has been wrought for a building-stone, Bramham Hall having been built, as I was informed, with stone furnished by one of the quarries.

In the quarry at the edge of the Park, the Gritstone, there moderately firm, dips to the S.S.W., at an angle of 10°, and is covered by a bed of brown shale, thinning out, and succeeded by a bed of yellow Magnesian Limestone full of Permian fossil shells. The following is a section of the beds:

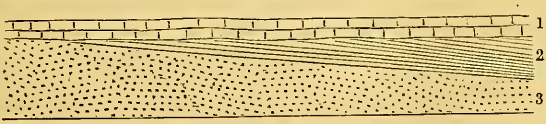


Fig. 1.—Bramham Moor Section.

1. Yellow Magnesian Limestone, 3 feet. 2. Brown Shale, 3 feet.
3. Coarse Gritstone, exposed, 5 feet.

[1] Professor Phillips, I believe, is inclined to class the Bramham Moor and Fountains Abbey Gritstones as Millstones. This appears in his Geological Map of Yorkshire.

Although only five feet of the Gritstone were exposed in the quarry, the rock is of great thickness, and graduates into the Millstones of the district, to the west of which it, in my opinion, forms the uppermost portion, or what in Lancashire would be termed the "Rough Rock," which it resembles so much as not to be distinguished from it. From Bramham Moor to Plumpton, I did not attempt to trace the range of the Sandstone; but there is little doubt that the direction given by Professor Sedgwick is the right one.

Plumpton Section.

The Sandstone at Plumpton is well exposed in the picturesque scenery for which the place is so famed, in fact, it chiefly owes its origin to this rock. The stone is here of a purplish-red colour, and is composed of coarse grains of quartz with some pebbles, mixed with decomposed felspar. It is generally false-bedded, and cannot be less than 100 feet in thickness. Its dip is slightly to the east. I did not see the rock run under the Magnesian Limestone, but it no doubt does; nor did I see it pass into the Millstone-grit of Brown Edge, on the road to Knaresborough, so extensively quarried for building purposes. From the dip of the Plumpton Rocks and the stone in this quarry, it appears pretty clear that one rock lies on the other, as follows :

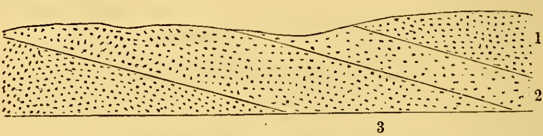


Fig. 2.—The Plumpton Section.

1. Plumpton Sandstone. 2. Carboniferous Strata, not well exposed. 3. Brown Edge Sandstone.

Section on the Nid.

From Plumpton the Sandstone can be traced to the banks of the Nid, where it forms a cliff of purple-coloured Sandstone, more flaggy and not so coarse as that seen in Plumpton, and capped by yellow Magnesian Limestone. But on passing over the Nid to the Knaresborough side, the rock becomes much coarser in grain; and in some parts the white quartz pebbles in it are so numerous as to make it a conglomerate, specimens of them being from an inch to an inch and a half in diameter. The cement is decomposed felspar, of a light colour; and the tint of the rock is more of a reddish-brown than the purple colour of that of Plumpton. No one can tell this rock, as it lies in the quarry, from an ordinary Millstone-grit. From twenty-five to thirty feet of stone is exposed, but nothing can be seen of the bottom of the rock. Over the Sandstone is a thin bed of conglomerate apparently derived from the destruction of the underlying rock, which it resembles, and over it is a bed of yellow

Magnesian Limestone. The following woodcut will show the position of the beds:

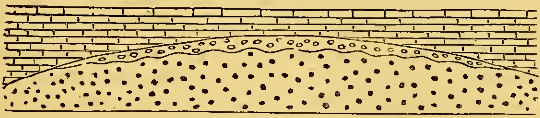


FIG. 3.—SECTION ON THE NID.

1. Yellow Magnesian Limestone. 2. Conglomerate, very irregular. 3. Coarse-grained Gritstone.

Knaresborough Section.

From the last-described section to the fine escarpment on which the remains of Knaresborough Castle stand, the Sandstone can be seen on the banks of the Nid, with one exception, where the Magnesian Limestone comes in by a fault. Under the castle the yellow Limestone graduates, as it passes downwards, into a yellow calcareous sand, much false-bedded; and this rests on a thin red parting of Conglomerate, varying from four to six inches in thickness, under which, quite unconformable to the Permian strata, lies a reddish-brown Sandstone, harder than any of the rocks before-described, but composed of similar quartz grains, cemented together with decomposed felspar. The rock contains many remains of ordinary Coal-plants, most of which have lost all their external characters. Among them are *Calamites* and a stem of a plant resembling a *Dadoxylon*, which before its compression must have been nearly a foot in diameter. The dip of the Sandstone is to the E.S.E. at a moderate angle. The position of the beds will be seen in the accompanying woodcut.

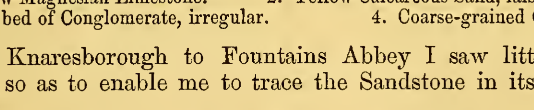


FIG. 4.—SECTION AT KNARESBOROUGH.

1. Yellow Magnesian Limestone. 2. Yellow Calcareous Sand, false-bedded. 3. Thin bed of Conglomerate, irregular. 4. Coarse-grained Gritstone.

From Knaresborough to Fountains Abbey I saw little of the country, so as to enable me to trace the Sandstone in its northern range.

Section from Fountains Abbey to Ripon.

Many years ago I remember seeing a coarse gritstone, of a brownish colour, dipping under yellow Magnesian Limestone. This Sandstone, which contained a large quantity of decomposed felspar, very much resembled the Bramham Moor Stone previously described. It dipped to the south-east, at an angle of 12°, and was succeeded by a bed of Flagstones, containing markings like the tracks of some animal inhabiting a bivalve shell. These flags reminded me of the Lower

Flags of Lancashire and Yorkshire, so generally found under the Halifax or Upper Millstone. I am not aware that either Professors Sedgwick or Phillips ever contended that these rocks were of any other than Carboniferous age; but I think it desirable to allude to them, for the purpose of showing that the Plumpton and Knaresborough Sandstone is bounded on the north and south by a very similar, if not the same, Sandstone, covered unconformably by yellow Magnesian Limestone, and resting conformably upon Carboniferous rocks. So far as my memory serves me the section of the beds was as the following woodcut.

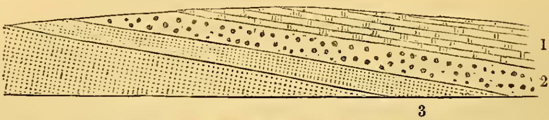
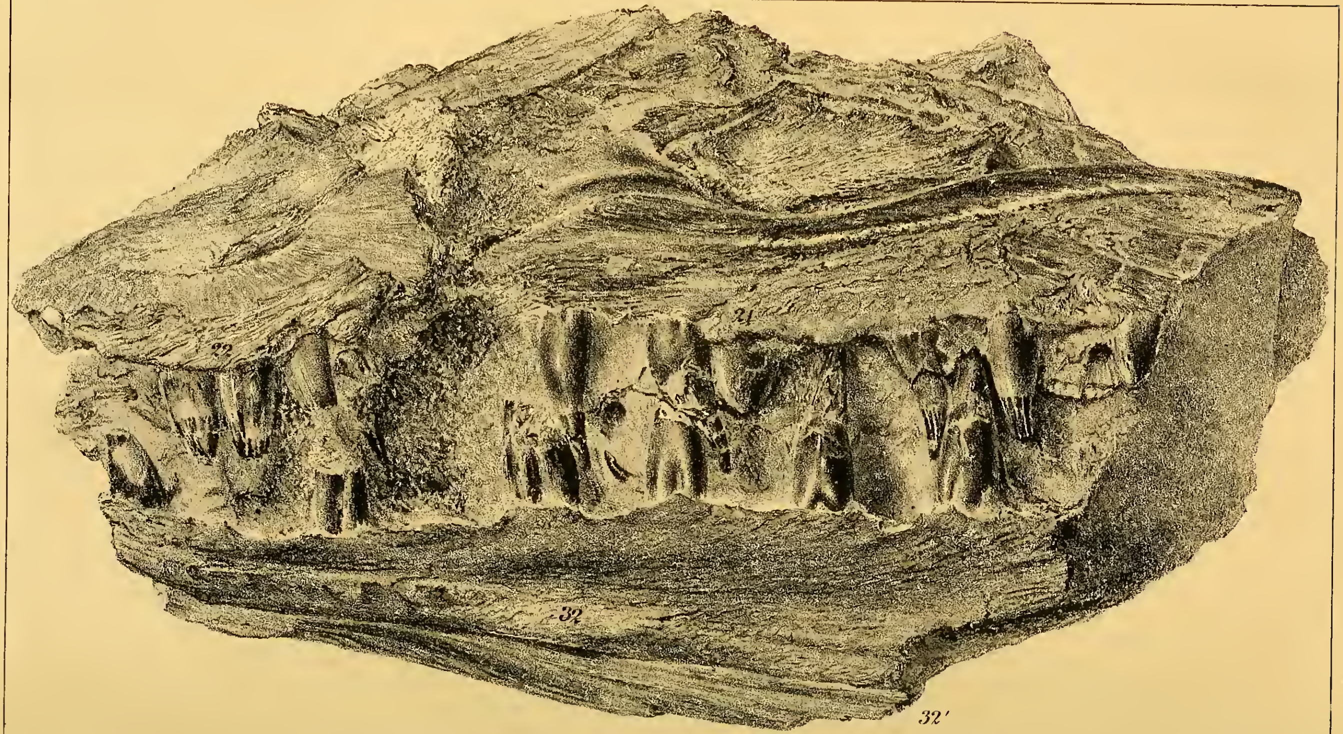


Fig. 5.—Section between Fountains Abbey and Ripon.

1. Yellow Limestone. 2. Coarse brown Gritstone. 3. Arenaceous Flags.

Both Professors give very little evidence to prove that the Lower New Red Sandstone of Plumpton and Knaresborough, which they admit is quite unconformable to the overlying Permian rocks, is unconformable to the Carboniferous rocks on which it rests. So far as I have seen, all these gritstones appear to gradually pass into, and are quite conformable to, the Carboniferous rocks on which they repose. This is the case at Bramham Moor and Fountains Abbey. I could not prove the same fact so clearly at Plumpton and Knaresborough, except that at the former place the dip of the Brown-Edge Stone was about the same both in angle and direction; but a more careful survey will probably determine this point.

I have considerable diffidence in questioning the conclusions of two such veteran geologists as the respected Professors of Cambridge and Oxford, especially on any part of the Geology of the County of York, to which they have devoted so much of their attention; still Professor Sedgwick honestly admits, in the quotation before given, that his first conclusion was that the Sandstone is a peculiar formation of Gritstone subordinate to the Yorkshire Coal-field. Professor Phillips says "the rock is quite undistinguishable from Millstone-grit in hand-specimens." I think he might also have added that they could not be distinguished in the quarries; at least I could not tell them from Millstone-grits. The last-named Professor, in his Geological Map of Yorkshire, clearly colours some Lower New Red Sandstone in the neighbourhood of Plumpton; but he, I believe, considers the Gritstones of Bramham Moor and Fountains Abbey as Carboniferous rocks; whilst the former Professor most certainly claims the Bramham Moor Stone as Permian; but whether he does that of Fountains Abbey is not so clear; but I am inclined to think he does. When these Sandstones are found to be quite unconformable to the overlying Permian rocks, and conformable to the underlying Carboniferous rocks upon which they repose, it appears to me that



E. Fielding, delt.

Day & Son (Limited) Lith.

they would be better classed with the latter than the former. As previously stated, I went to find a Lower Red Sandstone of Permian age, and was disappointed in meeting with what I, with all my bias, am convinced is Millstone-grit or "Rough Rock." The sections, on examination by any geologist, will speak for themselves much better than any description by me. I give my humble opinion, and the grounds on which I form it, with the greatest possible respect to the worthy Professors, and trust that the Geological Survey, when the gentlemen connected with it survey and map the district, will decide whether I am right or wrong in my conclusions.

In my examination of the district I had the advantage of being accompanied by my friend, Mr. J. W. Kirkby, of Sunderland, a gentleman well known for his thorough knowledge of the Permian beds of the north-east of England; and I have his consent to state that he entirely coincides with me in my opinion of the age of the Bramham Moor, Plumpton, Knaresborough, and Fountains Abbey Sandstones.

II.—On a Genus and Species of Sauroid Fish (*Thlattodus suchoïdes*,[1] Ow.) from the Kimmeridge Clay of Norfolk.

By Prof. Owen, F.R.S., F.G.S., etc.

(PLATE III.)

But little evidence has, hitherto, been had of the existence of large Sauroid fishes in the Kimmeridge Clay: indications by detached teeth had only, until now, reached me. The very useful "Systematic and Stratigraphical Catalogue of the Fossil Fish in the cabinets of Lord Cole" (now Earl of Enniskillen) "and Sir Philip de M. Grey Egerton," 4to., did not include any species from that formation at the time of its publication (1837).

To C. B. Rose, Esq., F.G.S., we are indebted for the evidence of the fine addition to the Sauroid family of Ganoid fishes figured in in Plate III.

The portion of skull, including the main part of the upper and lower jaws, with their dentition, in that gentleman's instructive collection at Yarmouth, was obtained from the Kimmeridge Clay at Downham, near King's Lynn, Norfolk.[2]

The portion of upper jaw (Plate III.), nearly 7 inches in length, contains twelve teeth, or their recesses of attachment: of which six are in the maxillary (^{21}) and as many in the premaxillary (^{22}). The teeth are strong cones, with a sharp apex and large subquadrate base, narrower in the fore-and-aft direction of the jaw: less convex transversely on the outer than on the inner side of the crown: straight or slightly convex, lengthwise, on the outer side; concave, lengthwise, on the inner side, the crown being slightly bent inwards as it descends vertically from the alveolar part of the upper jaw. The most conspicuous characteristic of the teeth in both jaws is the

[1] *θλα'ω, to bruise*; *οδους, tooth*; *συχος*, name of an Egyptian Crocodile.

[2] See "Geological Map of Norfolk," in the "Outline of the Geology of Norfolk," by Samuel Woodward, 8vo. Norwich, 1833.

longitudinal dent or notch, as if from the effect of a bruise, at the middle of the outer side of the base: and this is more marked, or is longer, in the lower than in the upper laniaries. It occurs in that part of the dentine which was covered by cement, and is, I believe, made more conspicuous in the specimen (Plate III.) through the loss of part of that outer coating. Not more than one-half of the crown is coated with enamel. This apical half gives a more circular transverse section than the cement-covered basal half. The enamel is marked by fine longitudinal striæ, with a few similar ridges. The teeth in which this part is preserved attain almost the length of an inch, with a basal breadth of half an inch; but the dimensions of all the parts are shown in the figure, accurately drawn of the natural size. The margin of the hollow base of the cement-covered part was anchylosed by that bone-like tissue to the border of the alveolar depression. The maxillary teeth are rather larger than the premaxillary ones.

The outline of the alveolar part of the upper jaw was undulated as in the stronger-jawed species of Crocodile, that of the premaxillary (^{22}) and maxillary (^{21}) describing a convex curve where the strongest teeth are fixed, with an intervening concavity. On both sides of the mouth two of these teeth are close together at the middle of the maxillary convexity (^{21}); the same disposition marks the three larger teeth at the alveolar convexity of the premaxillary. Other laniaries are separated by intervals equalling the basal breadth of the tooth, or exceeding it, as where the contiguous teeth of the maxillary and premaxiliary descend into dental interspaces of the lower jaw. The density of the bone increases as it recedes from the alveolar part. The upper convex border of the maxillary is smooth and polished, like ivory; the outer surface of the adjacent bone is roughened by raised striæ, running mostly in an oblique direction downward and forward. All the outer surface of the dentary element (Pl. III. ^{32}) of the lower jaw is finely striated, save at the irregularly thickened part of the lower border of the bone. The right dentary (ib. $^{32'}$) being slightly dislocated downward, exposes the flat inner surface, which shows the coarser longitudinal fibres of the osseous texture there. I cannot detect any evidence of an inner series of teeth, added to the outer row of large laniaries in the lower jaw of *Thlattodus:* there may have been a few small scattered ones, if these have not fallen from the palate.

A single detached tooth of the genus may be distinguished from any of those similarly-sized Sauroid Fishes which have come under my notice; as, *e.g.*, by the squarer form of the basal half, and rounder shape of the apical half, of the crown, from the tooth of the Cretaceous *Saurodon,*[1] *Saurocephalus,*[2] and *Saurichthys,*[3] from the tooth of the Liassic and Lower Oolitic *Eugnathus,*[4] from that of the Carboniferous *Megalichthys,* etc. The above-described shape and strong outer notch co-exist, indeed, so far as I know, only in the Upper Oolitic

[1] Dixon's "Geology and Fossils of Sussex," 4to. 1850. Pl. xxxii.
[2] Ibid., Pl. xxxv., fig. 5.
[3] Agassiz, "Recherches sur les Poissons Fossiles," Tab. 55*a*. [4] Ib., Tab. 57*a*.

(Kimmeridgian) genus of Saurian fishes, for which the term *Thlattodus* is here proposed, the present species being designated *suchoïdes*, from the crocodilian resemblance above noted. The references in the figure of Pl. III. are explained in the text.

III.—On the Structure of the Thames Valley and of its Contained Deposits.

By Searles V. Wood, jun., F.G.S.

The great Valley of the Thames has long been known to contain deposits of gravel intermixed with freshwater beds; but the true Geological age both of the valley and of its deposits was long in doubt. Latterly the view expressed by Mr. Prestwich (in which he was of accord both with Professor Morris and Mr. Trimmer), that the whole was newer than the Boulder-clay, has met with acquiescence. The general structure of the deposits in this valley, although they form the most extensive of the Post-Glacial series in England, has not however yet been shown in any comprehensive manner.

Mr. Prestwich, speaking of the gravel which forms the principal member of the deposits, says[1] that it stretches "in a continuous and uninterrupted sheet from the sea to Maidenhead." In his paper "On the Loess of the Valleys of the South of England and of the Somme and Seine,"[2] he identifies the brickearth of the Thames Valley with the Loess of the Belgian plateau and with the brickearth of the Valleys of the Seine and Somme; but of the Thames Valley he says, the structure is complicated by the existence, in addition to the high and low-level valley-gravels, of a wide-spread set of marine hill-gravels covering large tracts of country, but that, after eliminating the foreign element, "there remains a set of valley and terrace-gravels which, though not so marked or well characterized as in the Seine Valley, are nevertheless of nearly similar order and age."[3] He adds that the Loess "is intimately associated with all the valley-gravels and is contemporaneous with, and dependent upon, them from the beginning to the end of the series," and he conceives it to be "the result of river-floods commencing at the period of the highest valley-gravels and continued down to the end of that of the lowest valley-gravel."[4]

Although the age of the Thames Valley and its deposits, relatively to the Boulder-clay, has never been shown (Mr. Prestwich considering that the exact relation of the deposits is nowhere clearly seen, and that the question of relative age depends on a variety of collateral evidence[5]), yet the proof is readily afforded by drawing a line from the Hog-Market, Finchley, upon which hill exists an outlier of the Boulder-clay or Upper-drift (underlaid by a thin bed of the Middle-drift gravel), to the summit of Havering Hill, in Essex, upon which is another outlier of the Boulder-clay; this line will form a perfect

[1] Quart. Journ. Geol. Soc., vol. xii., p. 131. See also map in paper in Phil. Trans., 1864, Part II.

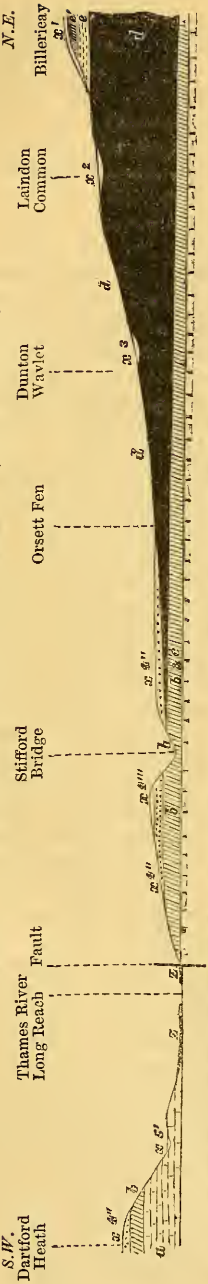
[2] Phil. Trans., 1864, Part II.

[3] Ibid., p. 255.

[4] Ibid., pp. 273-4.

[5] Quart. Journ. Geol. Soc., vol. xii., p. 133.

SECTION 1.—From the Essex heights to Dartford Heath. (Length, 18 miles.)



*x*1 *x*2 and *x*3 Gravels marking successive stages of denudation. *x*4″ Thames gravel. *e′* Bagshot pebble-beds. *e* Bagshot sand. *d* London clay. *b* and *c* Woolwich beds and Thanet sand. *a* Chalk.

section of one great branch of the valley, up which its gravel extends for many miles above the line of section.

The deposits of this valley are various, and while only some occur in the portion west of London all are present in the eastern portion, where we best find the means of testing how far the views above quoted are well founded.

The meaning usually attached to the term terrace-deposits is that, on either side of a valley, and at corresponding heights in it, deposits occur showing the valley to have been cut down from one or more higher levels to its present form, and of its contained deposits the oldest as a consequence stands at the highest and the newest at the lowest level. To see if this is the character of the Thames Valley, let us take a section from the Essex heights to Dartford Heath, in Kent, transverse to the direction of the valley at this part.

In this section we have, on the Essex summit and about 400 feet above the sea, a thin and very partial warp-gravel (x1) composed of the redeposited material of the Bagshot pebble-beds; and, occupying successively two lower levels, and marking successive stages in the denudation of the valley, the thin, angular, but extremely patchy terrace-gravels (x2 and x3); then comes the great sheet of the Thames gravel (x4″), occupying, *but on one side of it only,* the trough of the valley; resting in its more elevated part upon the London clay, but in the lower upon the Thanet sand; down to which sand the valley has in this part of it been cut. The detached mass of the same gravel (x4″) on the south side of the river has, as will be shown, been detached from the rest of the sheet covering the northern slope by dislocation and denudation. Here we have certainly nothing like terrace conditions, for the gravels (x1, x2, and x3) do not occur on the south of the river, however far the section may be prolonged in that direction; nor is there anywhere east of London, with the exception of the summit of Shooters'

Hill[1] (where the gravel $x\,1$ occurs), to be found on the south side of the river any equivalent of the gravels $x\,1$, $x\,2$, and $x\,3$ of the northern slope. Conversely, on the west of London, although there are gravels on the Richmond and Wimbledon Hills at a far higher level than the gravel of the lower ground, yet on the north side nothing occurs there to correspond with them,[2] as the gravel on that side spreads over the north slope in a continuous sheet.

Mr. Whitaker[3] speaks of partial terraces in the Thames gravel commencing and continuing for a short distance until they are again lost in the great sheet of the deposit, and has so shown them on the Geological Survey Map, such as that of Hyde Park and that of Clapham and Wandsworth Commons. The former of these, however, does not correspond to the quasi-terrace of gravel that covers so much of the Richmond and Wimbledon Hills, while the latter is on the same side of the valley. These partial terraces (which are in fact much less persistent than they are represented in the Map), although irreconcilable with any cutting down of the valley from higher to lower levels, are in no way at variance with the unequal action of an upthrow, while nothing approaching to a *persistent* terrace corresponding to another on the opposite slope can be shown to exist in any part of the valley between Richmond and the sea.

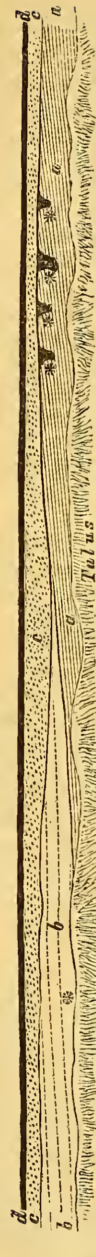
We will now take the formations that are common to both sides of the Thames river. It does not appear to have been suspected that the brickearth beds are divisible into three most distinct formations, but such is the case. The formations are the following:—

1. *The Lower Brickearth* ($x\,4'$).—The Brickearth of Ilford, both that of the Uphall and that of the London Road field, is a deposit underlying the Thames gravel, and unconformable to it. Like the much newer deposit of Grays, it contains *Cyrena fluminalis* and other purely freshwater shells, and has a thickness at Ilford of nearly twenty feet. It may be seen in the field on the London Road resting in one part direct on the London clay, while in another part it has a thin band of shingly gravel beneath it. In the Uphall field its position relatively to the Thames gravel ($x\,4''$) is best shown, the two deposits being unconformable. (See Section No. 2.) Northwards from Uphall field the brickearth disappears under the gravel, which, there denuded to a thickness of 4 or 5 feet, increases to

[1] Shooters' Hill forms an isolated remnant of the original valley, in which the Thames gravel was deposited; the valley, as will be shown, having on the east of London, with that exception, had its southern slope destroyed by subseqnent events.

[2] The gravel occupying the higher ground above the Thames gravel to the west, beyond Uxbridge, is the gravel of the Middle-drift, a formation older than the Boulder-clay.

[3] Mem. on sheet 7 of Geol. Survey. Mr. Whitaker also (p. 92) points out the discrepancy between the section given by Mr. Prestwich, in his "Ground beneath Us," of the position of the gravel of Clapham and Wandsworth relatively to that of the Wandle valley and the true position of those gravels, and I agree with Mr. Whitaker in so far as he says that the Wandsworth and Clapham gravels join in one part with the gravel of the Wandle valley, for I have traced the Wandsworth and Clapham gravels on their south-western side into inosculation with that of the Wandle valley, down Burntwood-lane, as well as on the north side into inosculation with the gravel nearer the Thames that sweeps round into the Wandle valley.



SECTION 2.—Section exhibited by the Uphall Brick-field, Ilford.

a Clayey brickearth, principally derived from the London clay, containing freshwater shells. *b* Bright yellow sand, also containing freshwater shells. *c* Thames gravel (*x*4'' of other sections). *d* Warp. The asterisks to the west of section denote potholes formed by denudation anterior to the deposit of *c*. The asterisk on the east of section indicates the place whence the remains of *Elephas primigenius* (described at vol. i., p. 241, of this Magazine) were extracted. *a* and *b* form *x*4' of other sections.

its normal thickness of 12 to 15 feet at Ilford Station, a distance of only half a mile. Eastwards from the Station, and but half a mile further, the lower brickearth again comes up from under the gravel at the London Road field where the gravel is almost wholly denuded from it. This brickearth has a very limited development, but may everywhere be distinguished from the upper brickearth by its resting direct upon either the London clay or the lower tertiary sands, and by its position relatively to the Thames gravel. It occurs in the pits near Erith; where it has a thickness of about 30 feet,[1] resting on Lower London Tertiary sand, and is almost horizontal, but it passes northwards towards the river and beyond the pits under the gravel. It occurs also in Wickham Lane Brickfield (see Section No. 2), where a thickness of 15 feet of the deposit is exposed thrown into an inclined position, the dip being very marked and amounting to 18°. With the exception of small patches on the tops of the hills west of Wickham Lane, which the denudation accompanying the violent break-up in that direction has spared, these are the only exposures of the lower and oldest brickearth. The deposit seems to have been very limited, but it is that which has furnished the chief part of the Mammalian remains that enrich several private as well as the National collections.

2. *The Thames Gravel* (*x*4'').—Next in succession comes the great sheet of gravel which, wherever not denuded, consists of a persistent well-marked deposit, reaching occasionally to a thickness of 20 feet, but usually from 12 to 15; spreading *over and far beyond* the lower brickearth, and up the north side of the valley to a height of more than 100 feet above it. There seems no reason for regarding this gravel as other than marine; but at a few places near its edge, as at Brentford and West Hackney,[2] freshwater shells have been found in a band of sandy clay, either intercalated in the gravel or underlying it. Mammalian remains, too, have been found in a few places in it, a feature common also to the marine sands and gravels of the Middle-drift.

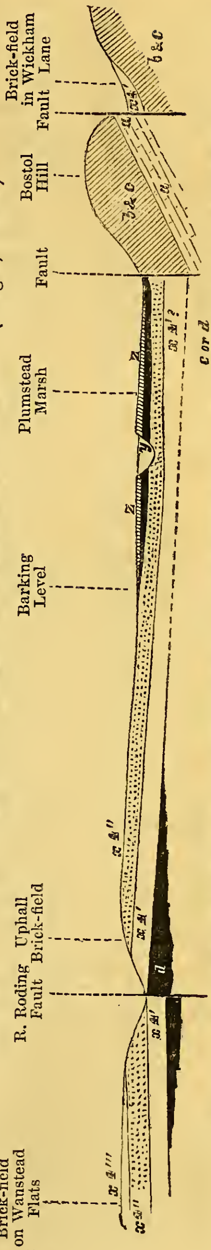
3. *The Upper Brickearth* (*x*4''').—This is the brickearth which has so large a spread in the

[1] A thin band of shingly gravel occurs in it towards the upper part.
[2] Morris, Quart. Journ. Geol. Soc., vol. vi., p. 201. Prestwich, ib., vol. xi., p. 107.

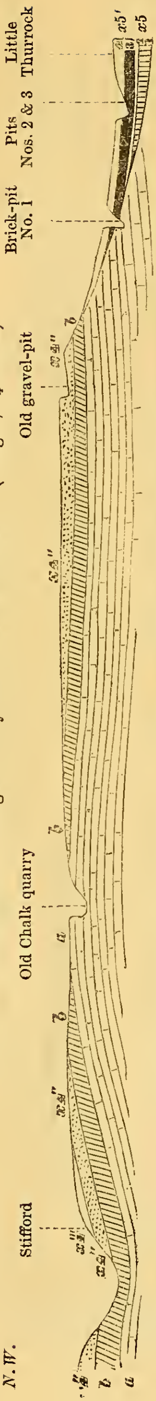
Thames Valley, and *rests on* the gravel. Consisting of a tawny loam, it is much inferior in thickness to the lower brickearth, being usually from 5 to 8 feet in thickness, and it has not furnished that rich series of fossils which has been obtained from the lower. It appears, however, to be everywhere conformable to the gravel, but does not generally reach so far up the valley as the more outlying portion of the gravel. Its chief development is in the east near Wanstead and Tottenham, and in the west around West Drayton; but it has a great extent in many places between both extremities of the valley. The next Section, No. 3, exhibits the relation of the lower brickearth to the gravel and the upper brickearth, and the dislocation by which the lower has been brought into its inclined position at Wickham.

4. *The Grays Brickearth* ($x\,5'$).—The Grays deposit is distinct from all those described. It consists of 15 feet of blue clay, containing *Cyrena fluminalis* and other pure freshwater shells, overlain by 20 feet of sand which in places is false-bedded. The clay is underlain by a few feet of flint-gravel coarser and more angular than the Thames gravel ($x\,4''$), and that again by redeposited Chalk, termed by the workmen "Bullhead." Section 4 shows the deposit, as exposed by the three pits, and its relation to the Thames gravel and upper brickearth. Here we see that the upthrow and denudation which succeeded the deposit of the upper brickearth, and preceded the Grays deposit, has along the line of section removed all but a fragment of the upper brickearth, and has in one place removed the gravel ($x\,4''$) and the subjacent Thanet sand (b), exposing the Chalk; while at one extremity of the section a newer, and subsidiary, valley in which the Grays deposit ($x\,5'$) rests, has been formed by the cutting down of the Thames gravel and Thanet sand to the Chalk, as well as of the Chalk itself. In all respects the position of this subsidiary valley corresponds to that of the valley of the Cray cut through Dartford Heath, while the gravel at the base of the Grays deposit corresponds with the gravels of the Cray valley.

SECTION 3.—From Wanstead Flats Brick-field to the Wickham Lane Brick-field. (Length, 7 miles.)



z Marsh clay. y Peat and old forest. $x\,4'''$ Upper Brickearth. $x\,4''$ Thames gravel. $x\,4'$ Lower Brickearth. d London Clay. *b & c* Thanet sand and Woolwich beds.



SECTION 4.—From Stifford Bridge to Grays Thurrock Brick-fields. (Length, 2¾ miles.)

1. Bullhead. 2. Angular flint gravel corresponding to $x5$ of Section 1. 3. Blue laminated clay, containing bands of sand abounding in freshwater shells, 15 feet. 4. Bright yellow sand, occasionally false-bedded, 20 feet. $x4'''$ Upper brickearth. $x4''$ Thames gravel. *b* Thanet sand. *a* Chalk.

5. *The Forest and Peat* (*y*).—For a few miles on the east side of London, we find a bed of peat, containing the stems of trees,[1] and resting on the gravel ($x\,4''$) or else upon the upper brickearth ($x\,4'''$). When this formation was cut through in forming the sewer through the Plumstead Marshes, stools of trees were exposed at the base of the peat, *rooted into the gravel* at a depth of some 20 feet below the surface of the marsh (see *y* in section 3). This peat is overlain by the marsh-clay (*z*) formed by the river-mud before the stream was embanked.

In the formations before described we have the following succession of events subsequent to the *complete* formation of the original valley by denudation through the Boulder-clay or Upper-drift—First, the deposit of the lower brickearth ($x\,4'$); Secondly, the deposit of the Thames gravel ($x\,4''$); and Thirdly, the deposit of the upper brickearth ($x\,4'''$). These are the deposits of the original valley. Then comes the upheaval of portions of the original valley, the dislocation of its deposits, and the extensive denudation of the uppermost of them ($x\,4'''$); with the more partial denudation of the intermediate deposit, the gravel ($x\,4''$); while of the lower ($x\,4'$) a portion was detached that eventually has become isolated by a fault behind the Chalk cliff, capped with Lower Tertiary sand and pebble, which forms the south-west side of Bostol Hill, in Kent, as shown in section 3. By the same upheaval and denudation we have the southern slope of the original valley east of London destroyed, with the exception of a remnant forming Shooters Hill, and in its place the formation of the subsidiary valley of the Cray, and of that in which we find the Grays deposit resting; both being cut through the Thames gravel ($x\,4''$) and subjacent Thanet sand down to and into the Chalk itself. Then we have the accumulation in one of these of a fluviatile deposit ($x\,5'$) some 40 feet thick, underlain by another gravel ($x\,5$) which we also find resting on the Chalk in several places in the Cray valley.

Further we find the gravel ($x\,4''$) and the upper brickearth ($x\,4'''$) where not denuded, forming after this upheaval a land surface, and supporting a growth of forest; that surface then

[1] Mostly of yew, but oak and pine occasionally occur.

cast down so as to form an intercepted drainage, giving rise to a swamp which engendered a peat growth; by the agency of which the portion of the forest so thrown down has been preserved from the destruction that by atmospheric or else human agency has overtaken the rest of it. Lastly, we have the introduction of the river over the previous land-surface and peat-swamp, bringing sediment which by its deposit has formed the marsh-clay of its former shallow bed, before that bed was reduced to its present narrow limits, and deepened by embankment.

In all this, save to the extent indicated in the *original* valley by the gravels (x 1, x 2, and x 3), we find nothing analogous to terrace-formation, or to the modification of an estuary by the successive elevation of the land and cutting down of its bed, until the estuary has become a river, as is described to us to be the case with the valleys of the Somme and the Seine.

(*To be continued in our next.*)

IV.—The Sea against Rain and Frost; or the Origin of Escarpments.

By D. Mackintosh, F.G.S.

As every part of the crust of the earth has at one time been the surface, it follows that all questions connected with the origin of the present "form of the ground" must be very important, and that on their issue the progress of Geology must in a great measure depend. But on this subject a very wide difference of opinion at present exists. According to one party, consisting of Professor Ramsay, Mr. Jukes, Mr. Geikie, Colonel Greenwood, Dr. Foster, and others, the more abrupt inequalities of the earth's surface have been produced by subaërial or atmospheric causes. According to the other school, embracing Sir Charles Lyell, Sir Roderick Murchison, Professors Sedgwick and Phillips, Mr. Edward Hull, etc., the sea has been the principal denuding or excavating agent.

The subaërialists start with the assumption that the sea tends to plane down the land, and that its newly-elevated bed presents a surface divested of abrupt heights or hollows. But this assumption is at variance with the generally-received principle of physical geography, that the bottom of the sea, at any given time, is as uneven as the dry land;[1] and it is equally opposed to the established geological fact that mountains have been islands and islands moun-

[1] There is a very extensive series of table-shaped mountains under the North Atlantic Ocean. Their comparatively level surface may be partly owing to their being covered with sand. Along their western and north-western edges the depth suddenly descends to 600 feet, and along the southern edge to 900 feet. The descent is nearly perpendicular. Besides these inequalities in the Atlantic there are deep furrows which run north and south (see article "Sea" in Penny Cyclopædia, and "Section of the Bed of the Atlantic" in Maury's Physical Geography of the Sea). The bed of the German Ocean, though very favourably situated for becoming a level surface, would likewise appear to be far from uniform in depth (see Lyell's Principles of Geology).

tains, while mountain-systems have been archipelagos and archipelagos mountain-systems. If we take a detailed chart of an archipelago, and compare the depths obtained by soundings, we shall find a striking correspondence between its inequalities and those of an elevated mountain-system.[1]

The Sea not a levelling agent.—That the sea, regarded as a *denudating* agent, does not now tend to plane down the land, can, I think, be easily shown; for on coasts and among islands exposed to the action of currents and the fury of storms, it is continually forming coves, headlands, bays, creeks, straits, etc. Mr. Jukes admits that the sea can excavate gaps or passes on the crests of islands, and that marine denudation is effective about the sea-level;[2] but this distinguished geologist leaves out of consideration that the land has risen and fallen so as to enable marine denudation to be effective at *all* altitudes. The sea, by assailing coasts at different levels, may be said to have the land more completely at its mercy than any agency which oscillates with the land. But even at a stationary level the sea can bring cliffs several hundred feet high within its direct influence, while cliffs more than a thousand feet high are often subjected to its undermining sway.

The sea can form the most abrupt inequalities along its coasts during intervals between sudden elevations and depressions; and a succession of such lines or tiers of inequalities, each consisting of vertical cliffs,[3] caves, coves, creeks, bays, promontories, and straits, would certainly not constitute a plane of marine denudation. I believe that most of the inequalities of Great Britain (so far as they are not the result of dislocation, elevation, depression, or subsequent glacial action) are unequally upheaved sea-coasts; and that while rivers have increased these inequalities, rain and frost have tended to reduce them.

Rain and Frost incapable of producing Cliffs.—The subaërialists would seem to contradict themselves in making frost and rain at one time a demolisher of the cliffs of river-gorges, and at another time a former of escarpments remote from rivers. Excepting in a case of an easily-eroded under stratum already exposed by marine denudation,

[1] Admitting that the inequalities of sinking archipelagos were partly formed by ancient subaërial causes, the sea would have an undoubted claim in the case of archipelagos which are gradually rising. But the advocates of atmospheric denudation cannot *consistently* appeal to submarine inequalities, as according to their theory the sea ought to reduce these inequalities previously to the area they occupy becoming dry land.

[2] Quart. Journ. Geol. Soc., vol. xviii., p. 391. Among the Shetland Islands the sea is now giving rise to a series of the most abrupt inequalities. The coasts even of the mainland are singularly irregular and broken, being indented with innumerable arms of the sea, called *voes*, which penetrate into and intersect the interior parts of the island in such a manner that, in traversing it, a traveller cannot find himself, at any one point, farther than three miles from one of these voes, or from the open sea (Penny Cyclopædia, "Shetland"). Among the Faroe Islands, the land close to the sea consists in general of perpendicular rocks, from 1200 to 1800 feet in height (ibid., "Faroe").

[3] Fac-similes of the highest and steepest inland precipices may be seen on our present sea-coasts.

it is difficult to conceive of rain or frost originating a cliff. But suppose these agents to have succeded in originating a cliff, they could not cause it to recede to any extent, because, in time, the fall of *débris* would put a stop to their progress, by accumulating so as to protect the under bed from farther decay. In the absence of a river to remove the *talus*, the cliff would become a slope. If, as the subaërialists admit, rivers are incapable of maintaining the vertical walls of their channels without a continual removal of the *débris*, how can rain, frost, or even springs, wear back an escarpment in the absence of an agent of sufficient power to carry away the fallen fragments or blocks.

It is not true that rain and frost are possessed of a regular or systematic undermining power. Suppose a soft and yielding bed under a hard stratum of rock. By the time the former is worn backwards so as to cause the latter to project, it ceases to be accessible to rain (and, in the absence of springs, to frost), unless it be situated on the windward side of a declivity. With regard to frost, it seems to be forgotten that it would be less likely to influence clay or shale than the overlying jointed sandstone or limestone rock. The subaërialists would likewise appear to forget that there are many cliffs and escarpments the bases of which do not consist of comparatively yielding materials.[1]

But one of the most striking proofs of the inadequacy of atmospheric action to originate or alter the configuration of cliffs is to be found in the fact that many lines of cliff in limestone districts present little or no *débris* along their bases. Some of them appear as if the agent by which they were formed had swept away nearly all the traces of its undermining action, while under other cliffs we find deposits consisting of matter which could not have been derived from the rock above. Among the limestone cliffs, which present few indications of atmospheric waste, may be mentioned the more compact and mural cliffs of the Mendip Hills, in Somersetshire; of Derbyshire, especially near Matlock; of the Eglwyseg range, especially the upper terraces, near Llangollen; of the neighbourhood of Abergele and Cefn, North Wales; and of many parts of Craven, in Yorkshire.

Marine Débris under Cliffs—I believe that in most instances an attentive examination would show that the majority of the blocks and fragments found scattered under cliffs have not fallen since the last emergence of the land. They either exist in too great numbers, at too great a distance from the parent cliff, heaped up, apparently thrown back, or arranged in such a manner as to point to the laterally-operating and revulsive action of the sea. At Wharncliffe, near Sheffield, and other parts of the West-Riding of Yorkshire, we may see the neighbourhood of Millstone-grit escarpments strewn with blocks, both angular and rounded, some of them isolated and at a considerable distance from any cliff, while others are arranged in

[1] The chalk escarpments above the terraces of upper greensand, in West Sussex, Hampshire, etc., furnish striking examples of the effects of an *unconditional* undermining agent.

rows or ridges, which can only be explained by reference to similar accumulations now thrown up by the sea on the coasts of Caithness, or among the Shetland Islands.

Rain incapable of abrading hard Rocks.—Mere rain, before it has assumed the shape of running water over incoherent materials so as to furnish it with solid artillery, is possessed of very little abrasive power on hard rocks. Rain comes from the atmosphere quite unprovided with the means of abrasion. Mr. Geikie,[1] admits that *uncharged* water, even when it dashes with the force of the waves and currents of the sea, is unable to abrade rocks. This accounts for many inland rocky projections and pillars retaining the forms with which they rose above the sea. In an article on the Brimham Rocks,[2] and in a paper read before the British Association at Birmingham last year, I showed that the Millstone-grit rocks of Yorkshire have in many instances not been abraded by rain or weathered by any kind of subaërial agency since the last emergence of the land. It is true that the windward side of certain kinds of sandstone and other rocks frequently present the appearance of recent atmospheric decay. But a little experience will enable one to distinguish between a chemically-corroded, frost-eaten, or rain-worn surface of rock, and a rock abraded by the sea. The former is rough, pitted, exfoliated, or fretted (as may be seen in the walls of our New Red Sandstone churches), without any determinate shape being produced; the latter (with the exception of limestone rocks chemically acted on by the sea) comparatively smooth with more or less of a regular form or continuous outline. In most places the Millstone-grit of Yorkshire and Derbyshire presents few or no signs of pluvial abrasion. On the contrary, the joints and crevices are often filled up (as at the Black or Stonnis rocks, near Matlock) with a deposit distinct from powdered grit, and resembling the drift of the neighbouring valley. Mr. Hull has found that the Millstone-grit projections of the Peak District retain their wave-worn forms; and if, at an elevation of about 2.000 feet above the sea, rain and frost have not been able to lower the rocky surface many inches since the close of the last submergence, would it not be rash to assign to them a power equivalent to the denudation of the surrounding area?

But rain has not only been powerless among the rocks of the north of England. Among the granitic tors of Dartmoor, what is commonly called *weathering* would appear to be very limited in its effects. In *many* instances one side of a tor would appear to have been stripped bare by a very powerful laterally-operating cause, whilst the blocks and fragments were scattered on the other side.

[1] Scenery of Scotland in connection with its Physical Geology. The descriptive powers of this accomplished geologist render him as worthy to be an illustrator of Playfair, as Playfair was of Hutton.

[2] Geol. Mag., vol. ii., No. 4. After the reading of the paper at Birmingham, the President of the Section, Sir R. I. Murchison, expressed his entire concurrence with the author's views in reference to the sea-shore origin of the Brimham Rocks, and the resistance they have o ered to the atmosphere. He likewise referred to the preservation of glacial-markings on rocks as a proof of limited atmospheric denudation.

Not one out of a hundred of these blocks could have *fallen* into the places they now occupy, and they must therefore have been carried by a strong current of water, unless it can be shown that they were dispersed by glacial action. In the south and south-east of England the newer sandstones would appear to be able to resist atmospheric denudation, as may be inferred from the present form of the stones composing so-called Druidical Circles or temples, such as Stonehenge.[1]

Limited Atmospheric Denudation proved by Glacial markings.—It is admitted by all geologists that ice-marks on rocks, and moraines in valleys, have resisted atmospheric denudation to such an extent that many parts of Wales and Cumberland retain the same general features which they presented at the close of the Glacial-period. It is not necessary to show that very delicate scratches have been preserved in exposed situations. The mere fact that the smoothed and rounded surfaces of rocks, many of them of considerable extent, have been perpetuated, is a clear proof that they have not been subjected to any process worthy of the name of *weathering.* But if these rocky areas have retained their ice-worn shape, have we not reason to believe that neighbouring areas, and indeed all areas equally unsusceptible to atmospheric action, have likewise retained their ancient surface-configuration? The same consideration applies to moraines, which in most valleys have only been visibly interfered with, and that to very limited extent, by the action of streams. The subaërialist's answer to all this will probably be in the sublime language of Playfair: "It affords no presumption against the reality of the progress of decay that, in respect of man, it is too slow to be immediately perceived. The utmost portion of it to which our experience can extend is evanescent in comparison with the whole." But the Post-glacial period is so very much longer than the period of human experience, that the subaërial geologists may be fairly called upon to establish a good claim in favour of rain and frost during that period before proceeding to speculate on what may previously have occurred. The last few thousand years furnish sufficient exemplifications of the denuding power of the sea, and of its capacity to produce inequalities which are fac-similes of those found in inland districts.

Denuding Power of the Sea.—It would be difficult to exaggerate the battering, disentangling, undermining, excavating, upthrowing, and transporting power of the sea; and it is worthy of remark that while it is *mainly* a laterally-operating and undermining agent, the atmosphere is *mainly* a vertically-operating and degrading agent. The sea, therefore, has the first claim to be considered the cause of all phenomena which on any considerable scale show traces of having been produced by undermining. The subaërialists ought to assign a reason why they make a distinction between a cliff now washed by the waves and a precisely similar cliff a few miles inland, or a fac-simile of both at a greater distance from the sea.

[1] Though I have not lately had an opportunity of visiting the spot, I have no doubt that the rocky projections (including the Toadstone) and cliffs, near Tunbridge Wells, could be shown to be the work of the sea.

But with the subaërialists resemblance has little weight. They virtually ignore one of the fundamental principles of inductive reasoning—similar effects must be referred to similar causes. The inductive geologist is not required to explain the absence on any particular spot of certain minor indications[1] of the former presence of the sea, which may never have existed, or which may have gradually disappeared, while he can point out not only the strictest resemblance between new and old sea-coast rocks, but a peculiarity about the latter which the sea only could have formed. Among the peculiar shapes communicated by the sea may be mentioned the arched buttress, which may be found projecting from many inland cliffs. There is one near Torquay, on the right-hand side of the lower road leading to Teignmouth; another behind Mrs. Weatherhead's house at Brimham, near Harrogate; a third near the base of the Cefn cliff, near Denbigh, and many others which might be mentioned.

Remarks on the Cotswold Escarpment.—Sir Roderick Murchison has not only added a new geological world to that previously known, but he has evoked from the grave of bygone time a sea rolling through the "Straits of Malvern," dashing against its south-eastern Oolitic barrier, and scooping out its shores into "combes and bays, beautifully rounded."[2] In the neighbourhood of Cheltenham and Gloucester, the escarpment has been quarried at various periods, and it is difficult to ascertain which parts have retained their natural forms. The same difficulty applies to the *débris* under and on the sides of the escarpment. In the neighbourhood of Crickley there are some rocks which present no trace of their having ever been quarried, and which look very much like sea-coast rocks. Certain parts have been worn into holes, and between them the rock has been smoothed and rounded. To the south of Mr. Odell's house, above Crickley, the smooth part runs along in the form of a groove, or nearly horizontal depression.[3]

[1] Rounded pebbles are not a necessary indication of the former presence of the sea. The degree of roundness, or angularity, will depend on the nature of the stones, the distance they have rolled, and the length of time the area they occupy remains at a stationary level. In the Midland Counties, drift composed of rounded pebbles, and drift composed of angular flints, graduate into each other on the same horizon. There, also, drift, interstratified with beds of sand containing sea-shells, may be seen on the same horizon with and graduating into drift in which no sea-shells have yet been discovered.

[2] Buckman's Straits of Malvern.

[3] See Lyell's Elements of Geology. In the two lines of cliff (Inferior Oolite) which have been more or less quarried above and beyond Leckhampton, one may see a very striking illustration of the way in which atmospheric action tends gradually to obliterate a precipice. The weathering, so far as it affects the compact rocks, is chiefly limited to parts that overhang, which are gradually falling down, one block or fragment from under another, thus tending to convert an overhanging into a vertical cliff. The next stage of the process is not connected with the cliff itself, but consists of streams of oolitic fragments from the loose incoherent bed on its upper surface. These streams give rise to ridge-like buttresses in front of the cliff, the tendency being to conceal the cliff under a slope of *débris*. In this way, in all probability, a great part of the ancient sea-wall of the Cotswolds has been converted into a grass-covered slope, and quarrying operations have in some places been equivalent to

Limited Atmospheric Denudation in the Chalk Districts.—The influence of rain in the Chalk as well as Oolitic districts of England, must be very considerable. But it acts more as a solvent than transporting agent. The matter dissolved is re-deposited.[1] It becomes covered with grass, and not one-hundreth part of it ever finds its way beyond the nearest valley or depression. That rain has not altered the general contour of the Chalk districts since their rise above the sea, can be proved by the fact that thousands of raised beaches, many of them only a few feet in height, may be found in Wiltshire, Dorset, and other counties. These beaches generally conform in inclination to the surface of the neighbouring ground. In valleys they often descend very near to the bottom, thus proving that these valleys have not been excavated since the beaches were formed. One of the most remarkable assemblages of these terraces may be seen undulating along the side of a valley to the east of Mere. On the south-eastern escarpment of the vale of Blackmore they may be seen curving round headlands in successive tiers. *These terraces are so intimately associated with the valleys, combes, and escarpments, as to render it evident that all have had a common origin.*

On the Denudation of the Weald.—I think it cannot be doubted that the Weald district of Sussex and Kent has undergone some complicated revolutions since the escarpments acquired their general outline;[2] and to these revolutions we may partly attribute the obliteration of certain particular traces of the former action of the sea. But that the sea has been there, and that the escarpments are old sea-coasts, cannot be doubted by any one who does not ignore the validity of analogical induction. If we begin with what the sea is now doing at Beachy Head, and then follow the windings of the inland cliffs in a north-westerly direction, we cannot resist the conclusion that they have been shaped by the sea. Beachy Head, and its accompanying combe, may be regarded as a living monument of the denuding power of the waves—the headlands and combes, which stretch into the interior, as dead monuments; but though dead, they yet speak, in language that cannot be misunderstood by any mind not deaf to the voice of analogy. A great part of the escarpment of the South Downs (to which I shall at present confine attention) consists of a succession of headlands, bays, and combes. The latter point most unequivocally to the peculiar action of the sea. Towards the western boundary of the Weald district many of them have been *excavated in the chalk quite irrespectively of any relation between soft or*

laying bare the original sea-worn rocks. But in all this we see a tendency the reverse of that ascribed to the atmosphere by subaërialists; for, instead of rendering more abrupt the inequalities of the earth's surface, it operates in the contrary direction. Among the Cotswold valleys, springs have given rise to landslips (Mr. Witchell, Quart. Journ. Geol. Soc., vol. xx., Nov., 1864); but these landslips can never tend to increase, and far less to originate, the continuous and smooth regularity of a line of escarpment.

[1] Sometimes the re-deposited Chalk-rubble becomes compact enough to to be mistaken for Chalk itself. See Mr. W. Whitaker's paper in Quart. Journ. Geol. Soc., vol. xxi., 1865.

[2] See Sir R. I. Murchison's elaborate paper, "On the Drifts of the South-East of England," in Quart. Journ. Geol. Soc., vol. vii., 1851.

hard materials. A hollow excavated by rain-torrents would assume more or less of the V form, and would necessarily shallow out towards the summit of the escarpment. But in many of these combes the innermost part of the surrounding cliff is the steepest, showing that they must have been formed by an inwardly-directed cause. They frequently display a geometrical regularity, combined with other unmistakeable indications, that they were literally scooped out by a sweeping, undermining, and gyratory action. These semi-cup-shaped hollows are not confined to the escarpment. They exist, though in smaller numbers, on the south side of the Downs. About two miles, on the left-hand side of the road leading from Brighton to Lewes, a very deep and striking combe gradually opens to the view of the traveller, which is as much a sea-cove as if it were still washed by the spray. There is another called Kingley Bottom, in the neighbourhood of Chichester. In forming an opinion relative to the origin of combes, it is advisable to retire to some distance, so that their entire outline and connection with neighbouring phenomena may be embraced at one view.[1]

In a future article I intend to consider the indications presented by river-channels and valleys, of the limited extent of *fluviatile* denudation in England and Wales. From what has been already said I think it must follow that rain and frost can only be justly regarded as *supplementing* the denudation effected by the sea; that their capacity to lower the earth's surface is comparatively small, unless immediately assisted by streams of sufficient transporting power; that the sea, by its laterally-excavating agency, and by uniting in itself, at the same time and on the same spot, a power of detaching and removing, can alone prove equivalent to the production of such a series of escarpments, cliffs, mural precipices, rocky pillars, terraces, headlands, and combes, as those composing the more abrupt inequalities of the surface of the earth.

[1] I think it is difficult to conceive of an explanation more perfect, simple, harmonious, and convincing than Sir Charles Lyell's marine theory of the denudation of the Weald. That the same cannot be said of the atmospheric theory will, I think, appear from the following extracts:—"The rate at which the escarpment will be worn back will depend on the rate at which the *river* deepens its valley. . . . . The *excavating power* of the stream in the longitudinal valley will depend on that of the transverse valley, and if the sea-level remains constant, the transverse stream will go on deepening its bed and lessening its excavating power, until at last it ceases to have any at all. A slight elevation of the land would once more give the transverse stream an excavating power, which in time would be communicated to the longitudinal streams. . . . . It must not be inferred, however, that we consider escarpments to be *river-cliffs*. The longitudinal streams, though running parallel to these escarpments, do not run immediately below them, but often, as with the Medway itself, at a considerable distance. No *river*-gravel in this area is ever found on the face of the escarpment, nor can we discover thereon any traces whatever of river-action" (Foster and Topley, Quart. Journ. Geol. Soc., vol. xxi., No. 84, 1865, pp. 471, 473). I do not think that Dr. Foster and Mr. Topley have succeeded in showing that the gravel-terraces in the basin of the Medway (containing Tertiary pebbles and Greyweather fragments, and dipping lower than the inclination of the river) are of fluviatile origin, or that a vertical extent of 300 feet has been scooped out by rain and rivers; but admitting a considerable amount of denudation along the courses of rivers, the bays and combes of the great Chalk escarpments would still form a distinct class of phenomena, and require a separate explanation.

ABSTRACTS OF BRITISH AND FOREIGN MEMOIRS.

I.—On the Structure of Mont Blanc.

By Alphonse Favre.

Sur la Structure en eventail du Mont-Blanc, par Alphonse Favre. (Tiré de la *Bibliothèque universelle et Revue Suisse* de Novembre 1865.)

M. FAVRE here describes a peculiar arrangement of the stratification, called the fan-like ("en eventail") structure, seen in most of the Alpine massives formed of Crystalline rocks; and discusses the aqueous origin of Protogine and Granite.

The structure, "en eventail," as explained by M. Lory, is "the remains of a large vault formed by Protogine rocks under the influence of lateral pressure," and M. Favre agrees with this view. It, however, requires that the aqueous origin of Protogine be admitted, for if the Protogine had burst forth in a molten state, it would have run out and settled down without forming any considerable elevation. When the rocks took their present position, their hardness must have been nearly complete. M. Favre, therefore, considers Protogine as having been deposited under water, not as an ordinary sedimentary deposit, afterwards altered by metamorphism, for then the stratification would have been obliterated, which is not the case; but in seas whose temperature was very high, and whose conditions and properties were quite different from those of the present time. M. Rose, he observed, had determined that quartz was formed solely by the agency of water; and it was evident that the crystals of felspar, disseminated in great abundance in the Magnesian Limestones of the Alps, must have been similarly deposited. Talcose and micaceous substances must also have owed their origin to reactions in which water was the most important agent. He stated that impressions of fossil plants from the coal of Petit-Cœur, in Tarentaise, were covered with a fine pellicle of white glittering material, which, on analysis, proved to be mica; this could not have been deposited otherwise than by water.

If, therefore, Protogine and all granitic rocks had an aqueous origin, whence were they derived? From a recent observation of Dolomieu, in Auvergne, Lava (taking the word in its broadest sense) was seen to pierce Granite, which has been supposed to form the basement of all other known rocks; he concludes that, as Lava is proved to be older than Granite, the latter, as well as other rocks, may have been derived from it, and that, consequently there is but one true igneous rock, namely, Lava.

H. B. W.

II.—Notes on the Palæozoic Bivalved Entomostraca, No. VI. Some Silurian Species (*Primitia*). By Professor T. Rupert Jones, F.G.S., and Dr. H. B. Holl, F.G.S. (*With a Plate of* 14 *New Species*).

[Annals and Mag. Nat. Hist., sec. 3, vol. xvi. December 1865.]

IN this communication, Professor T. Rupert Jones, and Dr. H. B. Holl, propose an improved classification for certain forms of Silurian Bivalved Entomostraca, hitherto placed in the genus *Beyrichia*. This genus comprises three types of carapace-valves, namely, "simplices," "corrugatæ," and "jugosæ." The first of these groups, the simple or unisulcate, seems to the authors to be deserving of generic distinction, since, among all the forms, they find a persistent occurrence of the chief features, with a passage towards *Leperditia*, by the complete loss of the furrow, rather than towards the two-furrowed, or real *Beyrichiæ*.

The authors explain the several difficulties presented, in attempting a critical examination of these minute crustaceans, such, for example, as their tendency to variation in form and ornament, their alteration by pressure and chemical change, and many other causes.

They have, nevertheless, been enabled to collect 11 species and 4 varieties of *Beyrichia*, 2 species of *Cythereopsis*, and 14 new forms for which they propose to establish the new genus *Primitia*.[1]

III.—British Association.—Section C: Geology.

A New Crustacean from the Moffat Shales.

MR. HENRY WOODWARD described and exhibited specimens of a new Phyllopodous Crustacean from the Moffat shales (Lower Silurian), Dumfriesshire.

These anthracitic shales abound in the remains of Graptolites, but other fossils are extremely rare. Two phyllopodous crustacea have been described from them by Mr. Salter, namely, *Peltocaris aptychoides* and *P. Harknessi*.

The new form closely resembles a *Discina*, but has a sector of 1-6th of its arc removed in nearly every specimen, the segment being separated from the rest of the disc-shaped shield by a line of suture. The shield is slightly conical, and ornamented with fine concentric lines; there is no dorsal suture as in *P. aptychoides* A specimen from the cabinet of Mr. Carruthers shows the wedge-shaped rostral portion *in situ*.

The most perfect example measures seven lines in diameter. The caudal portion is not preserved. As this form is quite distinct from any other fossil shield-bearing crustacean yet met with, the author proposed for it the generic name of *Discinocaris*, with the specific appellation of *Browniana*, after Mr. D. J. Brown, of Edinburgh, who first drew attention to it.

[1] With some additional details, the diagnosis for "Beyrichiæ simplices," given in the Ann. Nat. Hist., ser. 2, vol. xvi., p. 85, serves for *Primitia*.

REVIEWS.

I.—The Dublin Quarterly Journal of Science, containing Papers read before the Royal Dublin Society, the Royal Irish Academy, the Royal Geological Society of Ireland, and the Natural History Society of Dublin. Edited by the Rev. S. Haughton, M.D., F.R.S., etc. Nos. 19 and 20, July and October 1865.

Mr. W. HARTE'S "Notes on the Physical Features of the County of Donegal" contain very much that is of interest, both to glacialists and to general geologists. The probable condition of the ice-covered region of Donegal in the Glacial Period, the direction of the ice-worn valleys, regulated by the geological structure of the country, and the characters and sources of the local drifts, are carefully noted. Land-ice has left its marks, as groovings and moraines. At 1275 feet above the sea-level, granite blocks from Blue Stack occur, which appear to have been left by floating ice when the country was about 1300 feet lower than it is now; the rising of the land to that level having taken place at the close of the Glacial Period. Mr. Harte believes that both a greater height of land and a lower snow-line than exist at present, must have concurred in the earlier part of that period. He also well describes the circumstances that prove one large patch of submerged forest to have originally grown behind a high coast-line of mica-schist, subsequently breached by the sea, and to have been afterwards covered by shingle and sand-dunes, and to have been since exposed by the removal of these by the waves; and all this has taken place without any sensible alteration in the elevation of the land. Mr. Harte calls special attention to this; for he thinks that oscillations of the land are too freely called in to account for the position of submerged forests, which often have grown on flats, behind natural sea-walls, at the mouths of valleys, and on flat coasts.

Mr. M. H. Ormsby describes a polished and striated surface on the Limestone of Ross Hill, Co. Galway. The polish and principal striæ, he thinks, to have been due to a glacier coming from high ground on the east; and the cross, N.E. and S.W. striæ to have been subsequently caused by "the action of the Drift."

The "Doctrine of Characteristic Fossils" seems to be as much a trouble to Mr. J. Kelly as it is to many other thinking Geologists, who are even less old-fashioned in some of their notions than he is. As a step towards clearing up the difficulty, Mr. Kelly shows its magnitude by a long table of 269 so-called "Devonian" fossils, of which 35 stand also as Silurian, and 164 as Carboniferous, if Mr. Kelly has adopted correct palæontological determinations. But surely the Corals and the Brachiopods, at least, have been revised of late years. The "Devonian" is certainly a fine field for doubt, —it has long been debateable ground between the Silurian and Carboniferous; and he will do most good who works out the limits and relationship of the different beds, and catalogues their fossils when these have all been carefully revised. Mr. Kelly says that a fossiliferous band of Silurian grit and flags, yields at some half-dozen places in Galway, certain groups of fossils, differing in their proportions of Corals, Trilobites, Gasteropods, Bivalves, etc., just as a sea-bed differs in its local shell-banks, coral-reefs, etc. Hence Mr. Kelly seems to get a reason why the vertical succession of Lingula-flags, Llandeilo beds, Bala, and Caradoc, etc., cannot hold good! We do not feel the force of his argument. In truth, this is but one point in the study of Homotaxis of Strata; and though such a fact as that produced by Mr. Kelly is of use so far as it goes, yet it bears but little on the migration of ancient faunas, their continuance during oscillations of level, and so on. Mr. Kelly does good by reminding us of the present inexactitude of palæontology, the loose notions afloat as to the distribution of fossil species, and the necessity of close attention to the relative position of the strata themselves; and he does a friend's part well in standing up for Professor M'Coy's determinations of the Irish Carboniferous Fossils, and in explaining how some seventy of his typical forms were lost in the removal of Sir R. Griffith's collection to and from the Dublin Exhibition of 1853.

The geology, state, and prospects of the New Zealand Gold-fields in 1862 are described by Dr. W. L. Lindsay; and the amount of gold exported from Otago, down to the autumn of 1864, is quoted as 1,499,512 ounces.

Mr. J. Wright describes a new *Palæchinus* (*P. quadriserialis*); and Mr. W. H. Baily defines and illustrates the structure of *Palæchinus*, from specimens of *P. ellipticus* and *P. elegans*. Mr. W. Harte describes and figures an anomalous and probably new Echinoderm from the Yellow Sandstone of Donegal. Dr. J. M. Barry communicates some interesting notes on the Icebergs of the Southern Hemisphere in No. xx. Mr. G. Waller points out the Silurian Hydraulic Limestone of Courtown Harbour, Co. Wexford, as a peculiarly valuable manure for grain, turnips, grass, etc. A new table and formula for determining Altitudes with the Barometer (both aneroid and mercurial) is supplied by Mr. S. M. Yeates.

Lastly, as regards geological papers, comes Mr. J. B. Jukes' "Comparison between the Rocks of the South-West of Ireland, those of North Devon, and those of Rhenish Prussia in the neighbourhood of Coblentz." Referring to the published "Explanations of the Sheets of the Geological Survey Map" for details of proof, Mr. Jukes insists on the contemporaneity of the Carboniferous Limestone with the Carboniferous Slates and their included "Coomhola Grits;" or, in other words, that in the Carboniferous period there were deposited sands and clay-beds in one area, whilst Encrinites and Shells formed limestone at another, according to the recognised nature of sea-beds.[1] The "Lower Limestone-Shale" (overlying the Old Red Sandstone) is continuous beneath the grits, slaty-shales, and limestone; and the Lower Coal-measures uniformly overlie them. Carrying out the principle that varying deposits must necessarily occupy different parts of the sea-bed, Mr. Jukes finds the Marwood and Pilton beds

[1] See also GEO. MAG., vol. ii. p. 275.

of North Devon to be equivalents of the "Carboniferous Slate;" the beds above them (at Hele) being Coal-measures; and those below them (at Swinham Down) being Old Red Sandstone (or perhaps a part of the Carboniferous series). So also he finds that Baggy Point is formed of "Coomhola Grits in Carboniferous Slate," and that the same beds occur at Knowle and Kittywell in the Braunton Valley. For these conclusions, moreover, he finds *fossil* evidence,—taking good modern determinations with the assistance of his palæontological friend, Mr. W. H. Baily. Near Coblentz Mr. Jukes found a family-resemblance to the Irish and North-Devon strata above mentioned; and he thinks that the Spiriferen-Sandstein, Orthoceraten-Schiefer, Stringocephalen-Kalk, and Cypridinen-Schiefer, will be found to be the German equivalents of the "Carboniferous Slate" and their "Coomhola Grit;" the Posidonomyen-Schiefer being the base of the Coal-measures above, whilst the Old Red Sandstone lies below. The fossils of these several localities in Ireland, Devon, and Germany are, he believes, as closely allied as can be expected of varying "habitats" and different "marine provinces;" and they appear, perhaps, more distinct than they really are on account of having been determined by Palæontologists of different views and habits of observation. Mr. Jukes clearly points out that Sedgwick and Murchison endeavoured to correlate the rocks of Devonshire with different members of the Old Red Sandstone, on the sound argument of difference of lithological structure in different sea-areas; but that he applies this argument to a comparison of the strata in question with the Carboniferous Shales and Limestone, leaving the Culm-measures (similar to the Coal-measures of South Ireland) above them, and the Old Red Sandstone below. The conclusions he arrives at are—1st, that it was a mistake to include under one designation the Old Red Sandstone and the beds containing marine shells, to which the name "Devonian" has been applied; 2nd, that these latter are merely geographical representatives of the beds commonly known as the Carboniferous deposits; and, chronologically, are identical with them." The author says he is still ready to revise these opinions if facts of different tendency are proved. Herein is wisdom,—knowing the imperfection of our best conclusions, he will not be dogmatic, but waits for further proofs of his own views, or stronger evidence of other hypotheses. At all events, there is much more to be done with the so-called "Devonian" rocks. Godwin-Austen regards some of them at least as the southern equivalent (separated by an old land-barrier) of the Upper Silurian; and in Bohemia "Devonian" and Upper Silurian fossils are said to be commingled. Shall we have to fall back on the great "Kohlen-Periode" of Bronn, or will both "Devonian" and Upper Silurian hold their own after all; the latter because it clearly underlies the great Carboniferous Limestone, the former because the Limestones of Plymouth, etc., are unattached in Mr. Jukes' scheme? At all events the students of "Homotaxis" may work with advantage on these palæozoic fields; where Mr. Kelly (see above), puzzled with their rough and weedy appearance, began picking the loose stones;

and Mr. Jukes has set to work, draining and trenching, determined to get the truth out of them.

II.—Quarterly Journal of Science.

In the January number of this Journal there is an interesting paper by Mr. R. E. Alison on the Peak of Teneriffe, which notices some of the volcanic phenomena of the Island; it is illustrated by two chromo-lithographs. There is also a note by Prof. Ramsay on the recurrence of species in geological formations, in reference to some remarks by Mr. Jenkins "On Strata Identified by Organic Remains," printed in the previous number. Mr. Jenkins had stated that in his anniversary address to the Geological Society for 1863, Prof. Ramsay had denied a recurrent fauna in the Silurian, Devonian, and Carboniferous formations of England and America; while in his address for 1864 he had acknowledged a recurrent fauna in the Lower Oolite. In reply to this, Prof. Ramsay states that by the fauna of a province or formation is meant its collective species, not a small per-centage of them. In the case mentioned, that forms living during the Inferior Oolite period had migrated during the Fuller's earth sea, and returned when the Great Oolite was being deposited. Only about eighteen or twenty per cent. of the Inferior Oolite species were recurrent. Prof. Ramsay adds that the Oolitic sub-divisions ought not to be compared with the great Silurian, Devonian, and Carboniferous series, each of which contains several groups of formations, some of which are comparable to the whole British series of Oolites together.

III.—Reliquiae Aquitanicæ: being Contributions to the Archæology and Palæontology of Perigord and the Adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Part I. December 1865. 4to., pp. 16, and 6 plates. London: H. Baillière.

It is with a somewhat melancholy pleasure that we look on the first part of this extremely interesting work, which presents to us some of the results of a new Anglo-French Alliance, as full of promise for science as any ever contracted. It is sad to think that our countryman (Mr. Henry Christy) should not have lived to see the record of his persevering labour published; but death cut short his useful career on the 4th May, 1865.[1]

We are glad to learn that M. Lartet intends to persevere in carrying out, as far as psssible, the original intentions of Mr Christy regarding this book; and that M. Penguilly l'Haridon, Mr. John Evans, F.R.S., Mr. A. W. Franks, Dir. S.A., Mr. W. Tipping, F.S.A., and Professor T. Rupert Jones, F.G.S., have promised their assistance: that the last-named gentleman will edit the work, and finally that Mr. Henry Christy's brothers are resolved to give every assistance in producing the book in the style he had contemplated.

[1] See Obituary Notice in Geol. Mag. vol. ii., p. 286.

Part I. contains an explanation of the Geographical position of the ancient district of *Aquitania*, and the physical features of the special district of Dordogne. The Caves of the Vezère, their contents, mode of infilling, and relative chronology.

These few pages contain much interesting information, in addition to the explanation of six very effective tinted plates, comprising illustrations of flint cores and flakes, lance- and spear-heads, barbed instruments formed of Reindeer-horns (probably used as harpoons for spearing fish), and lastly a plate of very interesting illustrations, carved on pieces of bone and horn, representing the heads of Deer, Horses, Bulls, Fish, etc., and displaying no mean amount of artistic feeling in their execution. We shall refer to this work again.

IV.—Geology and History; a Popular Exposition of all that is known of the Earth and its Inhabitants in Pre-Historic Times. By Bernard von Cotta (Professor of Geology at the Academy of Mining, Freiberg, in Saxony.) Translated by R. R. Noel. 1865. pp. 84. London: Trübner & Co.

In this little book we have a succinct account of the evidences hitherto discovered and recorded of the early traces of Man on our planet, followed by observations on the Darwinian theory. Dr. Cotta remarks—"If Darwin's theory is correct, it must find its confirmation in Geology;" he therefore adds some observations on the organic remains found fossil in sedimentary rocks. We fully agree with the author when he cautions us (p. 64) "that it will not do to attribute the negative evidence in regard to higher organisms in the older formations merely to accident, (or) to fortune not having yet favoured their discovery," and suggests that, "as some of them are just as well suited for preservation in a fossil state as the lower," "it seems but natural to conclude that they did not exist at the time the older strata were formed." But when (at p. 69) he asks us to concur with him that "the strata containing recognizable organic remains, *i.e.*, the entire series of recent formations, up to the Silurian and Cambrian, represent a part only, *at the most the half*, of the time that the Earth has been inhabited by organized creatures," we must beg to demur. If fishes do occur in Silurian Strata (p. 64), they are but represented by fragmentary remains in the *Upper* Silurian, chiefly from the Ludlow bone-bed, as it is called, a deposit largely composed of *Crustacean spines;* and a single example from the the Lower Ludlow, of Church Hill, near Leintwardine, Shropshire (a *Pteraspis*), *below which*, in age, we have 73,000 feet, or considerably more than half the entire thickness of fossiliferous and sedimentary deposits, involving a sufficient lapse of time (we think) for all the lower forms of life to appear in succession. Surely we need not, even on the Darwinian theory, ask for another life-period, equal to that actually known, and represented by about 24 miles in thickness of stratified deposits.

We cannot conclude this notice without remarking that there is much more useful information in this book, *small as it is*, than in many a more pretentious volume.

V.—The Resources of California: Comprising Agriculture, Mining, Geography, Climate, Commerce, etc., and the Past and Future Development of the State. By John S. Hittell. Second Edition. With an Appendix on Oregon and Washington Territory. 1866. 8vo., pp. 494. London: Trübner & Co.

PERHAPS no country in the world has risen in importance in so brief a space of time, or obtained for itself so much notoriety, as California. Before 1846 California was held under grants from Mexico by about 800 rancheros, or grazing farmers, occupying on an average 12,000 acres each; but suddenly, by the greatest immigration ever witnessed in modern times,—its population, which in 1848 did not exceed 15,000, in 1860 attained a total of more than 380,000, 325,000 of whom were emigrants or miners, composed of Americans, Irish, Germans, Canadians, Britons, and a miscellaneous assemblage from all countries of the earth. It will not seem so astonishing that this distant country should have attracted so many settlers, when we state, upon the authority of Mr. Hittell, that the yield of gold alone, in 1848, and the twelve years which followed, amounted in the aggregate to 700,000,000 dols. But the resources of California are not confined to Gold-mines, valuable as these are. California possesses mines of Silver, Quicksilver, and Copper ore, whilst Platinum, Iridium, and Osmium are also obtained associated with the Gold. The general Geological structure of California is Palæozoic. The scarcity of stratified rocks is plainly discernible, only Primary, Eruptive, and Metamorphic Rocks make such steep hill-sides. Many other rocks beside Granite appear in irregularly distributed patches, such as Basalt, Lava, Trap, and Trachyte. Some very remarkable hills of Basalt, called "Table Mountains," are found in the Sierra Nevada. A Tertiary Sandstone, some of which is metamorphic, underlies the valleys of the Sacramento, the San Joaquin, and the coast, and is seen in the Coast Mountains, the Great Basin, and Colorado Desert. Granite occupies all the higher portions of the mountainous districts, the Great Basin, and the borders of the Colorado. No other country comprises within so small a space, scenery so various, or so strongly marked. "Mountains the most steep, barren, and rugged; valleys the most fertile and beautiful; deserts the most sterile; spacious bays, magnificent rivers, unparalleled waterfalls, picturesque lakes, extensive marshes, broad prairies, and dense forests,—all these are hers." The author gives us descriptions of the *Chorography* (physical geography), Climate, Geology, Scenery, Botany, Zoology, Agriculture, Mining and other branches of industry, Constitution, and Society of California. To those desirous to obtain a knowledge of this interesting country we cannot recommend a more suitable work.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. December 20, 1865.—Sir Charles Lyell, Bart., in the Chair.—The following communication was read:—"On the Conditions of the Deposition of Coal, more especially as illustrated by the Coal Formation of Nova-Scotia and New Brunswick." By J. W. Dawson, LL.D., F.R.S., F.G.S.

In several former papers Dr. Dawson has endeavoured to illustrate the arrangement of the Carboniferous rocks of Nova Scotia, and to direct attention to their organic remains, the structures found in the coal, and the evidence which they afford as to the mode of accumulation of that mineral. In this paper the author summed up and completed his researches, adding some new facts resulting from the study of the microscopic structure of more than seventy beds of coal occurring in the South Joggins section, and of the fossil plants associated with them.

Some general considerations relating to the physical conditions of the Carboniferous period in Nova Scotia were first given, the author dividing the strata representing that period into (1) the Upper Coal-formation, (2) the Middle Coal-formation, (3) the "Millstone-grit" formation, (4) the Lower Carboniferous marine-formation, and (5), the Lower Carboniferous Coal-measures, describing the characters of these divisions in detail, and giving a sketch of the physical conditions which prevailed during their deposition. He was of opinion that we must regard each of the above-mentioned divisions as the evidence of a period presenting during its whole continuance the diversified conditions of land and water, with their appropriate inhabitants, and as forming a geological cycle in which such conditions were to a certain extent successive.

As in previous publications, so in this, Dr. Dawson contended that the occurrence of *Stigmaria* under nearly every bed of coal proves beyond question that the material of the coal was accumulated by growth *in situ*, while the character of the intervening strata proves the abundant transport of mud and sand by water; in other words, the conditions implied are such as prevail in the swampy deltas of great rivers. He also stated that the coal consists principally of the flattened bark of sigillaroid and other trees, mixed with leaves of ferns, *Cordaites*, etc., and other herbaceous débris; and that the Cannel Coal and Earthy Bitumen are of the nature of the fine vegetable mud which accumulates in the ponds and shallow lakes of modern swamps.

In the succeeding portions of the paper the author gave details of the character and contents of the several beds of coal in the Joggins section, arranged in the order of Sir W. E. Logan's sectional list, and made some remarks on the genera of animals and plants, whose remains occur in the coal, and on their evidence as to the mode of its accumulation.

The following objects were exhibited:—A new Form of Goniometer; exhibited and explained by Prof. N. S. Maskelyne, M.A., F.G.S. Bone from a Peat-bed near Wareham, Dorsetshire; exhibited by the Rev. J. H. Austen, M.A., F.G.S. Fossils from Trinidad and Anguilla; exhibited by R. Lechmere Guppy, Esq.

II.—January 10, 1866.—W. J. Hamilton, Esq., President, in the

Chair. The following communications were read:—1. "On the Origin and Microscopic Structure of the so-called Eozoönal-Serpentine." By Prof. W. King and Dr. T. H. Rowney. Communicated by Sir R. I. Murchison, Bart., F.R.S., F.G.S.

Taking the Grenville Rock as its type, "Eozoönal Serpentine" was defined by the authors to consist essentially of variously formed granules of Chrysotile, or some other allied mineral, imbedded in, or intermixed with, Calcite. Although differing from the type in some respects, the varieties of Serpentine which they have examined from Connemara, Donegal, the Isle of Skye, India, Bavaria, and the State of Delaware, are considered as belonging to the same section. The Serpentine from Cornwall, the Isle of Anglesea, and Saxony, which appears to be devoid of "Eozoönal" structure, they were disposed to look upon, but with considerable doubt, as an eruptive rock. The authors stated their conviction that every one of the presumed organic structures of "Eozoönal" Serpentine is purely and primarily mineral or crystalline. The "skeleton" they held to be identical with the calcareous matrix of certain minerals, notably Chondrodite, Pargasite, etc. They adduced various considerations and evidence to show that the "proper wall" cannot have resulted from pseudopodial tubulation; and, instead of being an independent structure, in their opinion it is no more than the surface-portion of the granules of Chrysotile crystallized into an asbestiform layer. The dendritic and other forms, considered to represent the "canal system," were shown to be tufts of Metaxite, or some other allied variety of Chrysotile; while the resemblance they bear to some which are common in crystalline limestones, also their identity to the imbedded crystallizations of native silver, moss agates, etc., and the total dissimilarity between them and the foraminiferal structures with which they have been homologued, are points which the authors held to be conclusively fatal to the view which contends for such forms being of organic origin; in their opinion they are no more than imbedded "imitative" crystallizations. What have been taken for "Stolons," they were convinced are for the most parts crystals of Pyrosclerite. The "chamber casts" were considered to be identically represented among both minerals and rocks,—in the former by the grains of Chondrodite, Pyrallolite, Pargasite, etc., and in the latter by the segmented kernels of Native Copper, Zeolites, etc., in eruptive rocks; also by the remarkable botryoidal and other shapes which occur in the Permian Limestone of Durham. The authors concluded by offering it as their opinion that "Eozoönal" Serpentine is a metamorphic rock; and they threw out the suggestion that it may in many cases have also undergone a pseudo-morphic change, that is, it may have been converted from a gneissoid calcareous diorite by chemical introductions or eliminations.

2. "Supplemental Notes on the Structure and Affinities of *Eozoön Canadense*." By W. B. Carpenter, M.D., F.R.S., F.G.S.

In this paper Dr. Carpenter stated that a recent silicious cast of *Amphistegina* from the Australian coast exhibited a perfect representation of the "asbestiform layer" which the author described in his former communication on the structure of *Eozoön*, and which led him to infer the Nummuline affinities of that ancient Foraminifer,—a determination which has since been confirmed by Dr. Dawson. This "asbestiform layer" was then shown to exhibit in *Eozoön* a series of remarkable variations, which can be closely paralleled by those which exist in the course of the tubuli in the shells of existing Nummuline Foraminifera, and to be associated with a structure exactly similar to the lacunar spaces intervening between the outside of the proper walls of the chambers and the intermediate skeleton, by which they become overgrown, formerly inferred by the author to exist in *Calcarina*.

Dr. Carpenter then combated the opinion advanced by Professor King and Dr. Rowney in the preceding paper, and stated that even if the remarkable dendritic passages hollowed out in the calcareous layers, and the arrangement of the minerals in the Eozoic limestone, could be accounted for by inorganic agencies, there still remains the Nummuline structure of the chamber walls, to which, the author asserts, no parallel can be shown in any undoubted mineral product.

In conclusion, the author stated that he had recently detected *Eozoön* in a specimen of Ophicalcite from Cesha Lipa in Bohemia, in a specimen of gneiss from near Moldau, and in a specimen of serpentinous limestone sent to Sir Charles Lyell by Dr. Gümbel, of Bavaria.

The following specimens were exhibited:—Serpentines from Canada and Connemara; exhibited by Prof. T. Rupert Jones, F.G.S.

Liverpool Geological Society.—I. October 10, 1865.—The following papers were read:—"On a Wooden Implement found in Bidston Moss." By Dr. Ricketts.—"Notes on a recent Earthquake in the Neighbourhood of Ulverston, February 25, 1865." By R. A. Eskrigge, Esq., F.G.S.

The author read a letter from Mr. John Bolton, published in the Ulverston newspaper, and commented thereon. The effects of the earthquake were felt over a very limited area, at Rampside, only seven miles in extent. The shock was accompanied by the outburst of several hundred springs of water on the shore, and many houses were so damaged as to require to be taken down.

II.—November 14, 1865.—The President (Henry Duckworth, Esq., F.L.S., F.G.S.) delivered "The Opening Address of the Session." He gave a general *resumé* of the progress of Geology during the last few years, and referred at considerable length to all the recent discoveries that have been made. The most important works that have been lately published were also noticed, with the proceedings of Societies, and the progress of the Geological Survey. At the conclusion of the address a cordial vote of thanks was passed unanimously.

Mr. George H. Morton, F.G.S., the Honorary Secretary of the

Society, read a paper "On the Position of the Public Wells for the Supply of Water in the Neighbourhood of Liverpool." The introductory portion of the paper referred to the conditions under which water exists in the rocks beneath the surface, with especial reference to the Triassic strata around Liverpool, which yield an abundance of pure water. The author described, by means of diagrams, the way in which water sinks through porous strata, and accumulates so as to form great subterranean reservoirs, that overflow into the ocean above the tidal range. He also explained the means employed to raise it to the surface.

Whatever opinion may be entertained regarding the great porosity of the Triassic strata, and their universally containing large quantities of water, the intimate connection of the faults and subdivisions of the rocks must of necessity always have an important bearing on any attempt to obtain it by artificial means. Sections through the strata, showing the position of the wells, indicate how far these petrological conditions have been studied, while the quantity of water ultimately obtained must tend to show the value of such considerations in selecting the site of any future well. To the Geologist, the examination of the respective sections, with the position of the various public wells indicated thereon, is of sufficient interest, without any application to the water supply of the district. From data in his possession, it appeared that the well at Green-lane was the last that was sunk (1845–6), and that it was completed eight years before the Geological Survey of the district, and several years before Mr. Edward Hull, F.G.S., had described the succession of the Triassic rocks of Cheshire. In 1845 the order of the stratification in this district was unknown, the occurrence of the most important faults unsuspected, and the supposed position of the beds so confused, that beyond the mere dip of the strata, and the contour of the surface, there was nothing to guide the engineer in selecting a proper site for a well. The whole of the strata around Liverpool was considered to be the Bunter Sandstone, and it was said to consist of three subdivisions,—the Lower Red, the Middle Yellow, and the Upper Red,—and the district was said to be broken up by a network of fractures and dislocations at right angles to each other. Later investigations, principally by Mr. Hull, proved the opinions then held to be very incorrect. On consulting the Geological Maps of the Government Geological Survey, and several sections published more recently by the author, we find, that instead of the whole of the sandstone in the neighbourhood belonging to the Bunter, a part belongs to the Keuper formation, and that the Yellow Sandstone of the latter constitutes a higher portion of the series than the Red beds of the Bunter, instead of being a central band or subdivision. Besides this great error, there was then entire ignorance of every important fault in the district bounded by the Trias on both sides. A regular succession of the strata was supposed to occur where nothing of the kind exists, and there was no suspicion of the great dislocations which traverse the district from north to south. Under these circumstances, it was by mere chance if a well was sunk in a proper site, although no blame can be attached now to individuals who, no doubt, did their best under the circumstances.

The author then exhibited sections of the strata at Green-lane, Windsor, and Bootle, and described the general dip of the strata as being towards the east, with great faults at intervals of a mile or two. The Green-lane well was indicated upon a section as being a little to the west of one of these great faults, with the strata dipping to the fault, and cropping out to the west, in which direction, and considerably to the north and south, no other fault was known to exist. Several reasons were given to prove that this well was in the best possible situation. The yield is 3,000,000 gallons daily, almost equal to that of all the other wells put together. The sections of the strata in which the Windsor and Bootle wells occur, show the wells to be differently placed. They are situated on the eastern sides of faults, with the strata dipping to the east; and as the Bootle well is nearer the fault than the Windsor well, the quantity of water obtained is less. The site of the wells in the town does not seem to have been selected according to any definite rule. Mr. Morton quoted the opinion of Mr. Cunningham and Mr. Hull with regard to the passage of water through faults, and stated his own opinion to be that, though water would find its way through them, they certainly presented a great hindrance to its doing so, and considered the site of a well should generally be on the downthrow side of a fault, when the inclination of the strata would be towards it; and concluded that the Green-lane well is the only one belonging to the Corporation that is in a proper situation; that the supply of water might be largely increased by sinking from one to three additional wells; and that the neighbourhood of Childwall or Woolton would be a desirable locality for one of them.

III.—December 12, 1865.—The following paper was read:—"On Granite and other Metamorphic Rocks." By Mr. G. H. Morton, F.G.S.

The author favoured the igneous origin of Granite, but considered it to have been subsequently altered by metamorphic action. With regard to the occurrence of stratified Granite and Gneiss, as at Malvern, St. David's, etc., he stated that a Sandstone, containing the necessary element,—Silica, Alumina, Magnesia, Lime, Potash, etc.,—would, in certain cases, form a rock exactly resembling the crystalline strata referred to. Schistose rocks are no doubt altered shales and slates, and they consequently retained the original laminæ of the rock. Sandstone being coarser, formed Gneiss; and, if it did not possess any lamination, it is improbable that metamorphism would cause foliation of the new minerals, and consequently a rock like Granite would result; but it would be a bedded-rock, and of aqueous origin. The author showed specimens of Sandstones that possess little or no lamination, and considered that such kinds accounted for the origin of beds of Granite, or Syenite, which under such conditions, should be called Gneiss; and referred to Professor Jukes' statement that Granite and Gneiss cannot be always identified by hand-specimens, observation in the field being necessary.

IV.—January 9, 1866.—The following papers were read:—"Notice of a Submarine Forest-bed at Rhos, near Colwyn, North Wales." By Mr. H. F. Hall, F.G.S.—"Introductory Remarks on the Geology of the Country between the Vale of Clwyd and the River Dee." By Mr. G. H. Morton, F.G.S.

This communication was but an introduction to the subject, which is now engaging the author's attention. The physical features, formations developed, and mineral resources of the district were referred to; but the chief interest was stated to arise from the great development of the Coal-measures to the N.E. of the Mountain Limestone ridge along the Dee, while to the S.W. they are absent altogether, the Limestone resting upon Silurian rocks. With regard to the Mountain Limestone of the Vale of Clwyd, the author was satisfied that it suffered great denudation before the Permian and Triassic rocks were deposited. In the neighbourhood of Holywell, the upper beds of the Limestone are mostly black; but at the depth of 500 feet from the summit, the adits of a mine are driven through white Limestone, which lower strata crop out to the surface at Caerwys, and many patches remain on both sides of the vale of Clwyd: that the upper dark portion has been denuded is the only reasonable conclusion that any geologist can arrive at. The author concluded by advising the members of the society to examine this very instructive district so near home, and replete with such great interest.

CORRESPONDENCE.

THE RECENT DISCOVERY OF FOSSIL REPTILES IN THE COAL OF THE SOUTH OF IRELAND.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—It would appear from Mr. Etheridge's notice of the discovery of Labyrinthodont Reptiles in the Coal-measures of Ireland. in the last number of the GEOLOGICAL MAGAZINE (p. 4), that their Sauro-Batrachian character had not been detected by any person before Professor Huxley's visit to Dublin in the latter part of last November.

Such, however, is not the case. The first specimens were collected by Mr. W. B. Brownrigg, and submitted to me for examination; they were afterwards exhibited by that gentleman at the meeting of the Royal Geological Society of Ireland on June 14 of last year. I was not present on that occasion; but at a subsequent meeting, held on November 8, other specimens collected by Mr. John Edge and Mr. H. P. Wall, and presented by those gentlemen to the Museum of Trinity College, were brought before the meeting, and at the discussion which followed the reading of Mr. Wall's paper, I distinctly stated my opinion that the majority of the fossils then collected were the remains of Air-breathing Reptiles of Sauro-Batrachian type, some of the forms appearing to resemble *Archegosaurus*, one of the Labyrinthodonts.

The very perfect specimen procured by Mr. Charles Galvan,[1]—

[1] Incorrectly spelt *Galton* in Mr. Etheridge's notice of these fossils.

one of the Fossil Collectors of the Geological Survey of Ireland,—(since named by Professor Huxley *Keraterpeton Galvani*), was, at the same meeting, for the first time, brought before the Society by me, on which occasion I alluded to it as being a form of lizard, allied to *Apateon pedestris*, of H. von Meyer, a fossil reptile, which Professor Goldfuss, of Bonn, afterwards included in his genus *Archegosaurus*, stating also that these interesting Reptilian remains appeared to me to be comparable with those described as occurring in the Coal-field of Saarbrück, between Strasburg and Trèves. These fossil reptiles were accompanied by fish, of which I had previously identified the following species :—*Megalichthys Hibberti, Holoptychius Portlocki*, and spines of *Gyracanthus formosus* or *tuberculatus* (the two latter being probably identical).

My opinion was asked and freely given on these fossils, both to Mr. Brownrigg and others, and a list of the associated plants and fish then collected was supplied by me to that gentleman before the meeting in June of last year, which he duly acknowledged. I was also requested to examine the fossils collected by Mr. Wall and Mr. Edge, and gave my opinion upon them, which was also acknowledged at the meeting of the Society of November 8. It was difficult, however, to offer more than a conjectural opinion as to the precise character of several of the fossils in that early stage of the collection; though, from the additional specimens since collected, these difficulties were cleared up, some of them proving to be new forms, and others serving to elucidate those which were before obscure.

Professor Huxley has since, in conjunction with Dr. E. P. Wright, read a paper on these fossils before the Royal Irish Academy; and as the part I took in first pointing out their true character was not alluded to on that occasion, I consider myself justified in stating the facts as they occurred.

As the concluding paragraph of Mr. Ethridge's notice of this important addition to the fauna of the Coal period may induce the belief that the remains of such forms of Reptilia in the true Coal are of unusual occurrence in that formation, it may be useful to cite the principal instances extant of the discovery of such fossils, according to the date of their publication. We find then, quoting Sir C. Lyell,[1] that as early as 1844, H. von Meyer described the *Apateon pedestris* as the first skeleton of a true Reptile from the Coal of Münsterappel, in Rhenish Bavaria[2].

Three years later, in 1847, Professor Von Dechen found in the Coal-field of Saarbrück the skeletons of three distinct species of air-breathing Reptiles, described by Professor Goldfuss under the name of *Archegosaurus*, a form of reptile which he considered to be transitional between the fish-like Batrachians and Lizards.

Since then, in our own country, Professor Owen has given, in the Quarterly Journal of the Geological Society, vol. ix. (1853), p. 67,

[1] Manual of Elementary Geology (1855), p. 400.

[2] Herman von Meyer, *Apateon pedestris*, aus der Steinkohlen formation von Münsterappel, in Leonhard and Bronn Neues Jahrb, 1844, p. 336, and Paleontographica Bd. 1, Lief. 4, 1848, p. 153, 154.

a notice of a Batrachoid fossil, which he observed in the Earl of Enniskillen's collection (then Lord Cole), from British Coal-shale, the exact locality from which it was obtained being doubtful, but probably from Carluke, in Lanarkshire, named by him *Parabatrachius Colei*; and in the same volume *Dendrerpeton Acadianum* (Wyman and Owen) is described from the Coal-shale of Nova Scotia.

In January 1854 (Journ. Geol. Soc., vol. x., p. 207), Professor Owen described under the name of *Baphetes planiceps*, a Sauroid Batrachian of the family Labyrinthodontia, from the Pictou Coal of Nova Scotia; and in March 1857, Professor Wyman, in the American Journal of Science and Art, describes a species of *Raniceps* found in Cannel Coal at Yellow Creek, Ohio, United States.

Other Reptilian remains, amongst them *Hylonomus Lyelli*, etc., found with terrestrial mollusca, and an insect in the hollow trunk of an erect *Sigillaria*, from the same Coal formation, and a new species of *Dendrerpeton* are alluded to in vols. 16 (1860) and 19 (1863), Quarterly Journal Geological Society, by Dr. J. W. Dawson. In the same, vol. 19 p. 56, Professor Huxley describes *Anthracosaurus Russelli*, a Labyrinthodont from the Lanarkshire Coal field. Lastly, Professor Owen described a new genus of air-breathing reptiles from the Coal Measures of Llantrissent, Glamorganshire, discovered by Mr. John E. Lee, F.G.S., of Caerleon, which he named *Anthrakerpeton crassosteum*, in the Geological Magazine, vol ii., p. 6, pl. I. and II.

It will be seen, therefore, that in accordance with the progress of Palæontological knowledge during the period of the Coal formation in Ireland, we have further confirmation only of what was previously known as to the existence of a peculiar group of Reptiles adapted to the conditions of living in marshes, or amidst the vegetation of a humid climate, such as the Flora of the Coal period discloses to us, consisting of large succulent Arboreal Plants and Ferns, accompanied by Sauroid Fishes and amphibian Reptiles.

At a subsequent period, we find a distinct type of Labyrinthodonts come into being, adapted for a less aqueous existence, represented by the *Labyrinthodon* or *Mastodonsaurus* of the Trias or New Red Sandstone.

We see, therefore, that the laws which governed the creation and distribution of Animals and Plants in the past, remain still the same, each being adapted to its peculiar conditions of life: and, remembering this harmony of existence as displaying the perfection of wisdom in the Great Creator, we should not be led to expect, neither do we find, any departure from such laws in these records of the past which Palæontological discovery discloses to us.—Very truly yours,

William Hellier Baily.

Dublin, January 16, 1866.

THE EFFECTS OF WEATHERING ON ROCKS.[1]

To the Editor of the Geological Magazine.

Sir,—Some kinds of rocks waste freely under the influence of

[1] See the January number of the Geological Magazine, p. 46.

atmospheric agencies. Various Traps weather freely, also some kinds of Limestone; Granites generally waste, more especially some of the Granite Porphyries and Vein Quartz, which, when exposed, usually split up and crumble away.

If the atmospheric agencies (that is *Chemical action, the Sun's rays, Wind, ordinary Frost, Rain and Rivers*) have formed the features of this country, should not these kinds of rocks be those on which they acted most? I should answer "Certainly;" but this is not the case. The plain of Limerick is diversified by *Carrigs*, Ridges, and *Doons*, most of which are composed of the Traps and Ashes that are associated with the Limestones of that country. These Traps and Ashes weather much more freely than the Limestones; why, therefore are the hills formed of Trappean rocks? Should not the Limestones that are less affected by the atmospheric agencies be found in the hills and the Trappean rocks in the low ground?

Most of the rocks in the hills that occupy the north-west part of the County of Galway are dressed and scratched by Glacial action, therefore the effects of weathering since that period can be well observed. The Schist Quartzite and some of the Gneiss retain the scratches well, but the scratches are rare on the other kinds of rock. From this we see that the Limestones, Vein Quartz, Altered Traps (*Hornblende rock, Epidote, Granite, etc.*), and Granites, weather most, and therefore ought principally to have been eaten away, when the features of the country were being formed by atmospheric influence. This, unfortunately is not the case, as in most of the summits of the hills Granite or Altered Traps are found. Besides, associated with the Quartzite is Vein Quartz, full of minute joints, which causes it to break up with each winter's frost, while the Quartzite remains intact; and yet when the features of the country were formed, the former must have resisted better than the latter, as the Vein Quartz now stands out in marked reefs and projecting courses.

The Limestones of the N.W. of the County of Galway, when exposed, are deeply scored by the atmospheric agencies; and as they occur frequently in the large valley that extends from Oughterard to Clifden it might be said—"This feature is due to the wasting away of the Lime rock." However, I believe their occurrence here is purely accidental, as the Limestones are not found in the whole length of the valley, and in those parts of it where they do occur, they are often in hummocks above the associated Gneiss and Schist. A mass of Limestones strike across the hills N.W. of Oughterard, and if the existence of the valley just mentioned is due to the waste of the Lime-rocks, then Limestone ought also to have wasted away and formed another valley. Moreover, on the north slope of the hills that lie south of the Maum branch of Lough Corrib, there is an isolated boss of this Limestone, forming a well marked *Carrig* on the hill side. Ought not this Lime-rock to have disappeared before the surrounding Gneiss and Schist?

These facts which I have mentioned, and that seem to me to be against atmospheric agencies, would be in favour of marine denudation and ice action. The Trappean rocks of the County Limerick are naturally harder than the associated Limestone, therefore, as the land rose, and came under the influence of Marine denudation, the Limestones would have been much more rapidly worn away, leaving the Trappean rocks standing up as Skerries, Carricks, and Carrickgeens; and also when the country was covered with ice, they would have resisted its grinding action much more than the Limestone. Similar results would occur in the hills of the N.W. of the County Galway, as the Granites and Altered Traps are naturally harder than the Gneiss and Schist, and the Vein Quartz than the Quartzite. Some of the Limestones were naturally harder than the Schist and Gneiss, but not all; therefore some parts of it project above the other rocks, while other parts were cut away equally with the Gneiss and Schist.

Yours truly,

G. H. Kinahan.

Oughterard, Ireland.

ON THE DENUDATION OF SOUTH AFRICA.

To the Editor of the Geological Magazine.

Sir,—That part of the interior of South Africa extending from the eastern slopes of the Zwartebergen and Zuurbergen, and the continuous chain of hills which dies out on the sea-coast, near the mouth of the Qualana River, to beyond the Vaal River, and from Bean, far west to some undetermined line a long way to the north of Fauresmith, is occupied geologically by a series of nearly horizontal beds of hard Sandstone, Clays, and Marls, intersected by numerous dykes of Greenstone, Syenite, and Basalt. These strata contain, throughout their whole extent, as far as it is known at present, numerous bones of Reptiles, stems of *Calamites*, leaves of *Glossopteris* and other ferns; shells of a species of *Iridina*, and some Fish with heterocercal tails have been found at Fort Beaufort, Spitzkop, and elsewhere. All these remains concur to prove that Mr. Bains' conjecture that these beds were of lacustrine origin is correct. No fossil of any kind, even possibly marine, has yet been found in them. Professor Owen inferred, from a pretty extensive series of reptilian bones and fish remains, that the age of the formation corresponded nearly with the Triassic of Europe.

Now, with the exception of a few beds of Recent or Tertiary Limestones, where the Lacustrine strata reach the sea-coast, there is no evidence of any part of this formation having been covered by the sea at any time since the desiccation of the lake; and, therefore, it is clear that the denudation which the country has undergone is not due to marine action. It may, I think, be safely inferred, that had the ocean rested upon these strata sufficiently long to produce any serious amount of denudation, some beds of rock, containing sea-shells, would have been left. The action of Glaciers may, I think, be left out of our estimate of denuding forces, considering the latitude, and probably not very great elevation of the country. The denudation undergone, then, is probably due to that series of causes comprised in the term subaërial, and into which the action of sun and wind, rain, ice, and the erosion by river and streams, enter as principals. I will proceed briefly to describe the amount of this denudation, and to notice some facts bearing upon its cause, more especially with reference to the action of rivers and the formation of their valleys.

It has been stated that these "Lacustrine strata" reach the sea at the Qualana mouth; and, as everywhere they are nearly horizontal, and we have at no place been able to discover faults of any considerable extent, the elevation of the higher ranges of mountains will give the thickness of the formation. This, unfortunately, we can only give approximately, as there is no reliable survey of the Quathlamba Range that I am acquainted with. Where I saw the continuation of it, the Wittebergen, it is about 3,000 feet above the elevation of the great plateaux among which the Kei and Tsomo take their rise; but I believe the more northern parts reach a still greater elevation. The Wittebergen are 6,000 to 7,000 feet above the sea: the highest point of the Quathlamba is said to be 10,000 feet. The plain through which the Orange and Caledon Rivers run is about 5,000 feet above the sea; and a series of plains, of various elevations, interrupted by mountains, reach thence to the sea on the north, and to the Karoo plains, bounded by slopes of the Zwartebergen and Zuurbergen. The heights of these plains above the sea is probably, on an average, about 1,200 to 1,500 feet, and they vary from 30 to 20 miles in breadth. The whole of this denudation must have been due to subaërial agents; and that the large periodical torrents must have borne the chief part in it, the following facts will, I think, show. The Orange, the Caledon, and the Krasi Rivers, traversing the elevated plains, have all their sources in the same ranges, whose geological structure is but imperfectly known at present; but it is certain that a large mass of amygdaloid, containing agates, cornelian, and other silicious minerals, forms part of it. The rivers carry numbers of pebbles of amygdaloid and its agates, and as these are wholly unlike the rocks and minerals of the country they traverse, it is easy to find their traces; and these I have seen on the plains and hills many miles (certainly five or six) distant from, and 300 to 500 feet above, their present course. Now these minerals, though comparatively imperishable, must be subject to decay, and to be washed away by the heavy rains of these regions, so that, when found in the sites indicated, they must prove that amount of denudation by the river within a recent date. The manner in which these rivers travel over the plains is shown by the presence of the *Iridina,* which inhabits them in all parts. This is the case, for instance, in Graff Reinett. In whatever part of the plain a well is sunk, the river-alluvium and pebbles, with the *Iridina,* will be found. The courses of the valleys in which the rivers flow show, as I think, incontestibly, that they have been made by the rivers themselves. Those which run down the steep mountain-sides of the Katriverberg have an extraordinarily sinuous course. A stream, two or three feet in breadth, will take its course in curves, bearing something like its relation to its breadth of the sketch,—

the stream being perhaps 10 or 12 feet deep in the alluvium of its valley,—and its course through the alluvium must be continually changing, as the silt is deposited in the receding angle, and the bank worn away on the salient one. The Kromme and Diep Rivers, larger tributaries of the Kat, take the same course, as their names indicate, only with wider sinuations. These latter seem to have some definite relation to the steepness of the course and the volume of the rivers. With allowance for the different degree of erosion exerted on the various rocks, this character seems to be common to all the rivers of the country, and makes it impossible to believe that they originated in channels formed by oceanic currents, or in cracks by earthquakes, or the upheaval of land. As the rocks of the "Lacustrine," or, as they are locally called, from a genus of Reptile common in them, "Dicynodon formation," are supposed by Professor Owen to be referable to about the Triassic Age, it would seem that the time which has elapsed since the desiccation of the lakes is sufficient to account for the vast denudation that I have shown to exist. Some years ago I took advantage of a three days' detention by a freshet of the Sunday's River to collect evidence with a view to the calculation of the approximate amount of denudation affected by it. The data, particularly with the imperfect surveys of the country at our disposal, which are extremely unsatisfactory, led me to a result of about ·8000 inch in a century over the area drained by the river. I have little doubt that the estimate is much too great, for it would require little more than 100,000,000 years to effect the amount of our denudation.

A better guide to the denuding power of our rivers is offered by the Bushman's River. Its circumstances are similar to those I have described of the Orange and Caledon, in that it conveys in its bed a quantity of pebbles of agates (from a layer of amygdaloid in the Zuurberg) over a formation in which they do not occur. After passing through the Zuurbergen, its course to the sea lies through a basin of Devonian Schists and Sandstones, on which rest 300 feet of Sub-Cretaceous Sandstone, Clays, and Marls, and these are surmounted by 50 to 80 or 100 feet of Limestone, which is called "Tertiary" by Mr. Bain, but which, so far as I am aware, does not contain any shells different from those now living in the Indian Ocean,—certainly, if any of its species are extinct, they are but few, though the *Ostreæ*, *Pectunculi*, and *Pectines* are much larger than any I have seen living. These strata of the three formations I have mentioned have been cut through by the river to the depth of 500 feet, and a width of many miles; and all this since the deposition of the Tertiary or recent limestone; and the proof that this has been done by the river is that the agates, evidently rolled by its action, are found all the way up its banks to nearly the level of the plain.

I was struck with this fact of the occurrence of the evidence of the existence of the river-beds in all parts of the Bushman's and

Sunday's River Valleys, and on the overlying recent rocks especially, many years ago, long before the subject had attracted much attention from European Geologists, and I brought forward in a letter to Sir Charles Lyell most of the facts here given.—Yours truly,

R. N. Rubidge.

Port Elizabeth, South Africa.

ON THE GLACIAL CONDITION OF THE MOON'S SURFACE.

To the Editor of the Geological Magazine.

Sir,—Allow me to send you the following results of some researches into the surface of the Moon. Viewed by the naked eye, the colour of the lunar disk is uniform, or nearly so, presenting to the spectator at night a disk or mirror of light, reddish-yellow when seen near the horizon, and in a hazy atmosphere, but of a much paler yellow, or almost white, when seen high up in the horizon under a clear atmosphere; and on a bright day, and in a blue sky, as white, or whiter, than the fleecy clouds which float past it. Seen with a telescope, the Moon loses much of its yellow appearance, which is due to our atmosphere, and has an apparent liquid electrum colour, still uniform, but revealing the mountains, with their apparent craters, and shadowy and dark patches, or non-reflecting surfaces. Neither of these visual observations are sufficient as yet to determine the nature of the surface; and, although the most powerful instruments bring it within 240 miles of the eye of the astronomer, even that distance does not seem sufficient to deprive the disk of its reflecting power, so as to enable the observer to distinguish the relative colours of which its surface is composed. Now, an inspection of the photographic and stereoscopic views of the Moon offer what I consider as a revelation of its condition, and demonstrate it to be completely Glacial. Of this I am firmly convinced, from a minute and careful examination of the lunar stereograph of Mr. H. De la Rue, and a careful comparison with a great number of Alpine photographs and stereographs in the possession of Mr. F. E. Blackstone. For not only does the former exhibit unequivocal proof of being taken from an object of which the dominant colour is white, but the surface exhibits all the peculiar transparency in textures of Snow, Ice, and Glaciers, seen in the latter. I cannot be deceived on that point, and I feel the more confident, since a great portion of my time has been spent in the examination of surfaces.

Now, although the stereoscope does not supersede the actual observation by the eye, it is a powerful aid to the determination of this question. The stereograph of Mr. De la Rue is $2\frac{1}{2}$ in. diameter, and gives 2,161 miles of the Moon's diameter, offering to the eye an optical model of the luminary about the size of a billiard ball, on which all the elevations of the mountains appear in relief. When looked at attentively, all the luminous parts of the Moon present the appearance of a Glacial country such as the wintry Alps or the Polar regions. Portions of it appear as extensive plains and ranges of elevated ground covered with snow and ice, while others consist of elevated ranges and mountains, partly denuded, but having their summits strewn with snow and ice. Now, the reason for determining this Glacial condition is this whiteness of all the elevated portions, especially of the Polar regions, and of the peaks of the highest mountains; for if the Moon's surface were composed of plutonic rocks, such as Granites, Basalts, Traps, or covered with volcanic products, such as cinders and lavas, this state would be represented in the stereoscope by tints more or less neutral, and the Moon's surface would not present that general white appearance in the luminous portions which can only be due to reflection from an uniform surface. The photograph, in fact, were the Moon's surface composed of rocks uncovered by snow, or if it were clad by vegetation, would not come out white at all. The stereograph of Tycho is remarkably white, as much so at the base as at the summit. Now, the peak of that mountain, which lies near the lunar pole, is far above the snow line on the earth's surface; and if there existed any apparent atmosphere in the Moon, snow and ice would be naturally looked for at that elevation, and the same would be expected at the summits of our high mountans, as *Copernicus* and *Eratosthenes*, and at the lunar poles. No one, in fact, whose eye has been trained to the study of stereoscopic views of Snowy and Glacial regions could, I think, fail to recognise the presence of the same in the stereographs of Mr. De la Rue. The value of photography appears to me to be this, that it determines, within certain limits, the presence or absence of colour, and is to it what chemical tests, or the spectrum analysis, are to matter. The materials for comparison of the Moon's surface with the earth even exist. Monte Viso, one of the Alpine range, has been seen by the naked eye at a distance of 200 miles and the distinction between snow and rock clearly made out. The Bernese Oberland has been photographed by Braun, of Dornach, 60 miles off, and the elevated chain of snowy peaks not only exactly resemble in colour those of the elevated lunar mountains, but the distinction between rock and snow is clear on the stereograph, and what is more, it is possible to detect, at great distances, the difference between rock and shadow. Tycho resembles a diminished Chimborazo, and although it is not at present possible to bring Tycho nearer, it is available to remove Chimborazo optically as far off by taking stereoscopes of that and other glacial mountains with diminishing lenses so as to place them at the same relative distance, and they might then be usefully compared with the lunar ranges. I have not gone into the question of the black spots or patches about the lunar equator, which may be chasms, frozen seas, or formations not having a reflecting surface, they require to be the subject of future investigation; but not only are there glacial patches on them, but one of remarkable brilliance, with light streaming in all directions, about the centre of the Moon's equator, has a distinct crescent-shaped glacial ridge surrounding it. Nor do I here propose to enter into the reasons why the Moon is glacial, whether owing to the cooling of its internal heat or the unchecked radiation from its surface reflecting the sun's rays like a mirror. But that this Glacial condition is constant, and maintained by conditions unaffected by the revolution or rotation of the Moon, is evident, because no important visible change of colour takes place either at the bases or summits of the mountains or plains which lie, like our polar regions, wrapped in eternal snow. To the geologist, as an analogous condition to the Glacial period of the earth, this condition of the Moon is of the highest interest.

Some of these Glacial appearances have not escaped the notice of observers. Professor Frankland, in a lecture delivered at the Royal Institution,[1] states that, after long observations of the lunar surface, he thinks he has detected evidences of former glacial action and the presence of moraines in the Moon. In 1842, on an occasion of a lunar eclipse, Arago saw at Perpignan, on the edge of the Moon's black disk, a fiery protuberance like "an Alpine Glacier" illumined by the setting sun. S. BIRCH.

BRITISH MUSEUM, January 19, 1866.

CARBONIFEROUS FOSSILS FOR EXCHANGE.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—On the part of the Bolton Scientific Students' Association, who are about forming a small collection of Geological Fossils, I wish to ask your assistance in enabling our Society to exchange fossils of the Carboniferous system for characteristic fossils of other formations. By this means, collectors who have, it may be, a superabundance of fossils from their own immediate neighbourhood, but who have no facilities for obtaining Carboniferous specimens, by making a mutual exchange, will be conferring a favour, at the same time they receive a consideration in return. I shall be glad to correspond with any collector on the subject, if, by means of your MAGAZINE, we can be put in communication.—Yours respectfully,

WILLIAM WALCH, *Hon. Sec.*

29, HEATON TERRACE, ST. GEORGE'S PLACE, BOLTON, *Jan.* 6, 1866.

THE EARLY APPEARANCE OF MAN IN THE EAST.

WE have just received (January 19th) a most interesting letter from Mr. Henry F. Blanford, F.G.S., Secretary to the Royal Asiatic Society, and of the Geological Survey of India, dated Calcutta, 22nd December, 1865, in which, after referring to the recently-published discoveries of Stone Implements in Lateritic Formations in various parts of the Madras and North Arcot Districts, by Messrs. R. Bruce Foote and William King, jun., he proceeds to say: "Poor Lieut. Irwing discovered worked agates shortly afterwards, in the alluvial deposits of the Nerbudda. Mr. Canne sent a couple of specimens to the Asiatic Society, and they turn out to be 'cores,' very small, but identical in form with that shown in Pl. I., fig. 6, of Sir J. Lubbock's work.[2] At the last meeting of the Asiatic Society it was announced

[1] See Chemical News, 1864, p. 116.

[2] Pre-historic Times, as illustrated by Ancient Remains, and the Manners and Customs of Modern Savages. By J. Lubbock, F.R.S. London: Williams and Norgate. 8vo. 1865.

that Mr. Bynne, of the Geological Survey of India, had discovered worked agates in the Bone-beds of the Upper Godavery, which are, there is little doubt, of the same age as those of the Nerbudda, which contain *Elephas* (*Stegodon*) *insignis*, *Elephas* (*Loxodon*) *Namadicus*, *Hippopotamus palæindicus*, *Bos palæindicus*, *Bos Namadicus*, etc. I am endeavouring to stir up the interest of the public in the matter of Ancient Man, and to get some one to investigate the Limestone Caves of the Khansas, Birmah, etc.; but most of our limestone caves are in remote provinces, and I am afraid we shall have to wait a few years yet."—Edit.

MISCELLANEOUS.

Royal Society of Edinburgh.—The Council have awarded the Neill Prize for the triennial Period 1862–65 to Andrew Crombie Ramsay, F.R.S., Professor of Geology in the Government School of Mines, and Local Director of the Geological Survey of Great Britain, for his various works and memoirs published during the last five years, in which he has applied the large experience acquired by him in the Direction of the arduous work of the Geological Survey of Great Britain to the elucidation of important questions bearing on Geological Science.

Geological Society of London.—The Council have decided to award the Wollaston Gold Medal this year to Sir Charles Lyell, Bart., F.R.S., in acknowledgment of the eminent service he has rendered to the science of Geology by his published works and researches.

The Council have further decided to award the Wollaston Donation-fund to Mr. Henry Woodward, in aid of his further researches in the Fossil *Crustacea.*

Her Majesty has been pleased to advance Sir Roderick Impey Murchison to the dignity of Baronet, "in recognition of distinguished merits and attainments."—*Reader, Dec.* 30, 1865.

OBITUARY.

Nicholas Wood, F.R.S., F.G.S., Mem. Inst. Civ. Eng. This eminent mining engineer, was a native of Tyneside, and the intimate friend and companion of the late George Stephenson, many of whose discoveries he assisted in bringing before the public notice. For more than forty years he has been actively engaged in mine-engineering, and was justly regarded as the greatest authority upon every branch of the subject, whether scientific or practical. In 1852 he was elected President of the Northern Institute of Mining Engineers, when he delivered the inaugural address, and he has since considerably promoted its success by devoting to it all his influence, talent, and much of his time. He contributed a number of very important papers on Geology and

Mining, which are printed in the Transactions. He died, after a short illness, on the 19th December, 1865.[1]

PROFESSOR FORCHHAMMER.—WE have to announce the death of Professor Forchhammer, the eminent Geologist, and Secretary of the Copenhagen Academy of Science, to which office he succeeded in 1851, on the death of Oersted. He was born at Husum, in Schleswig, in 1794, and in 1818 he became Orsted's secretary, and accompanied him on a mineralogical expedition to the island of Bornholm. He subsequently made several journeys in Great Britain, France, and Denmark, at the expense of the Danish Government. In 1825 he was elected a member of the Academy of Sciences at Copenhagen, and a Foreign Member of the Geological Society of London. Ten years later he was chosen Professor of Mineralogy at the University of Copenhagen. He was the author of several works on Geology and Chemistry, and he also contributed many papers on these subjects to the Academy. It is to be regretted that these memoirs, being published in Danish (a language not generally understood), are to some extent inaccessible to scientific men. Professor Forchhammer studied with great care the physical effects of ice in producing geologic changes, and also the composition of sea water at different parts of the earth's surface.—*Reader, Dec.* 30, 1865.

DR. K. A. OPPEL.—Science has to deplore the death, at Munich, on December 22, 1865, of this young and accomplished geologist, who has been removed from us at a period when his energies were in full activity for the advancement of science, to which he was firmly devoted, and for the interests of the University of Munich, to which he was attached as Professor. Great as must be the loss to his relatives and colleagues at Munich, it will be almost equally felt by those friends to whom he was known in this country, and by whom he was personally esteemed.

Dr. Oppel's labours were devoted chiefly to the investigation of the Jurassic rocks, and his researches were especially interesting and important to English geologists, to the advancement of whose knowledge his monographs have contributed, enabling them to coordinate the zones of Jurassic life with those tabulated in his work on the Jura formation of England, France, and south-western Germany (published in 1856). This work appeared subsequently, and was perhaps partly in consequence of an extended tour Dr. Oppel made, more than ten years since, in the Oolitic districts of this country, over some portions of which he was accompanied by the well-known French engineer and geologist, M. Triger, and Professor Morris. He visited Dorset, Somerset, Bedford, Gloucester, Lincoln, and Yorkshire, carefully examining all the sections exposed, collecting a large series of fossils, and studying the private cabinets of some of our best authorities on the Oolites, as those of Mr. Leckenby, and Drs. Lycett and Wright, by whom he was kindly received. The rich stores accumulated on this and other excursions, and the trouble

[1] See also Biography, in Colliery Guardian, vol. x. p. 333; and Obituary *idem* pp. 489 and 493. 1865.

he took to identify species, enabled him, upon his return, to compare them with the continental published and unpublished forms, and thus increased the value of the work above noticed, and unfolded his notions of the co-relations of the English strata,—a subject which had received the attention of Dr. Oscar Fraas in a previous essay.[1]

The later labours of Dr. Oppel were equally important, bearing as they do on Jurassic Palæontology. The Palæontologische Mittheilungen is a work intended to comprise descriptions and figures of the new or little known fossils contained in the fine collection of the Royal Museum at Munich. The parts published consist of the descriptive text and eighty-eight plates, thirty-nine of which are illustrative of twenty-four genera, and seventy species, of *Crustacea* from the Lias, Dogger, Oxfordian, and Kimmeridge strata. The remaining plates are chiefly of *Ammonites* and some other forms, amongst which may be noticed an interesting Cirriped, the *Pollicipes Redenbacheri*, from Solenhofen, a form somewhat resembling *Mitella*. The following are the new genera established by Dr. Oppel in this work:—*Stenocheirus*, *Pseudastacus*, *Etallonia*, *Pseudoglyphea*, *Acanthochirus*, and *Udorella*. Many of these are from the rich deposit of Solenhofen, the fossils of which locality in the Munich Museum are probably unrivalled, although the British Museum now contains the Häberlein collection, which includes many beautiful specimens, and among the rest, that remarkable form, the *Archæopteryx*.

An attack of typhus fever terminated Dr. Oppel's useful labours at the early age of 34 years. He leaves a widow and infant son to deplore his loss.

During Dr. Oppel's geological researches, he had amassed a very extensive and complete collection of Ammonites, consisting of several thousand specimens, which, it is hoped, will be purchased by some European or American Museum for the benefit of his family.

The following is a list of Dr. Oppel's published works:—

Ueber einege Cephalopoden der Jura formation. Württemberg, 1856.

Die Jura formation Englands, Frankreichs und des Süd-westlichen. Deutschland, 1856.

Weitere Nachweise der Kössener Schichten in Schwaben und in Luxemburg.

Acanthoteuthis antiquus zu Gammelshausen bei Boll. 1856.

Pterodactylus in Lias Würtembergs. 1858.

Classification de la Formation Jurassique d'après les Caracteres Paleontologiques. 1859.

Die neueren Untersuchungen über die Zone der *Avicula contorta*. 1859.

Ueber die Brachiopoden des untern Lias. 1861.

Uber die weissen und rothen Kalke von Vils in Tyrol. 1861.

Palæontologische Mittheilungen aus dem Museum des Koenigl. Bayer. Staates. Parts I.–III. Stuttgart 1862. Parts IV. and V., 1865.

Die Tithonische etage. 1865.

[1] Translated in the Quarterly Journal of the Geological Society, 1851, vol. vii. part ii. p. 42.

THE

GEOLOGICAL MAGAZINE.

No. XXI.—MARCH, 1866.

ORIGINAL ARTICLES.

I.—Oxford Fossils. No. 2.

By Professor John Phillips, M.A., LL.D., F.R.S.

(PLATE VI.)

NO complete list of the Stonesfield Fossils has been drawn up since 1855, when some remarks of mine on the Geology of the vicinity of Oxford appeared in the first series of Oxford Essays. During the last eleven years we have received from that rich locality many additional specimens, but not many species new to the University Museum. One has lately reached my hands which I hope will be of interest to the readers of the Geological Magazine, as adding something to the knowledge of a prevalent group of water-side insects, which has left witnesses of its existence through a very large range of Geological Time, viz. the *Neuroptera*, and specially the *Libellulidæ*.

On Plate VI. figs. *a*, *b*, *c*, are representations of the specimens, *c* being an enlargement of the area about the large triangular cell of the wing. Only one wing is really preserved; but by the splitting of the stone along its plane, the structures are traceable in both specimens, and some help is thus gained for the study of the minuter parts. The state of preservation is good, so that a large part of the network of the wings, between the main somewhat radiating "veins," can be examined, and the whole of the wing-space is coloured nearly of the tint of the yellow-bodied and yellow-winged living species (e.g. *Libellula depressa*, *L. rufescens*). This tint is deepened along the main "veins," and serves to mark them very plainly.

The wing is one inch and three-quarters long, and three-quarters of an inch wide in the proximal part, which is the widest. But it appears to me that a portion of the tip of the wing is concealed in the stone, possibly also a small portion on the posterior edge near the body. The outline to fig. *b* (Plate VI.) expresses my idea of the full extent of the wing, or nearly so; for perhaps it is not quite complete at the proximal edge. By these measurements it deserves to be regarded as a broad-winged species, the length of the wing being thrice its width; while in the large Liassic *Aeshna* (Brodie, Fossil Insects, plate x. fig. 4) the length is almost four times as great as the width. But that is the anterior wing, and ours appears to be the posterior. If, with this in view, we compare it to the ordinary *Libellula depressa,* we shall find agreement; for in that insect the hind wings are only three times as long as wide, and are broadest near the body, but the front wings are four times as long as wide, and are broadest near the middle.

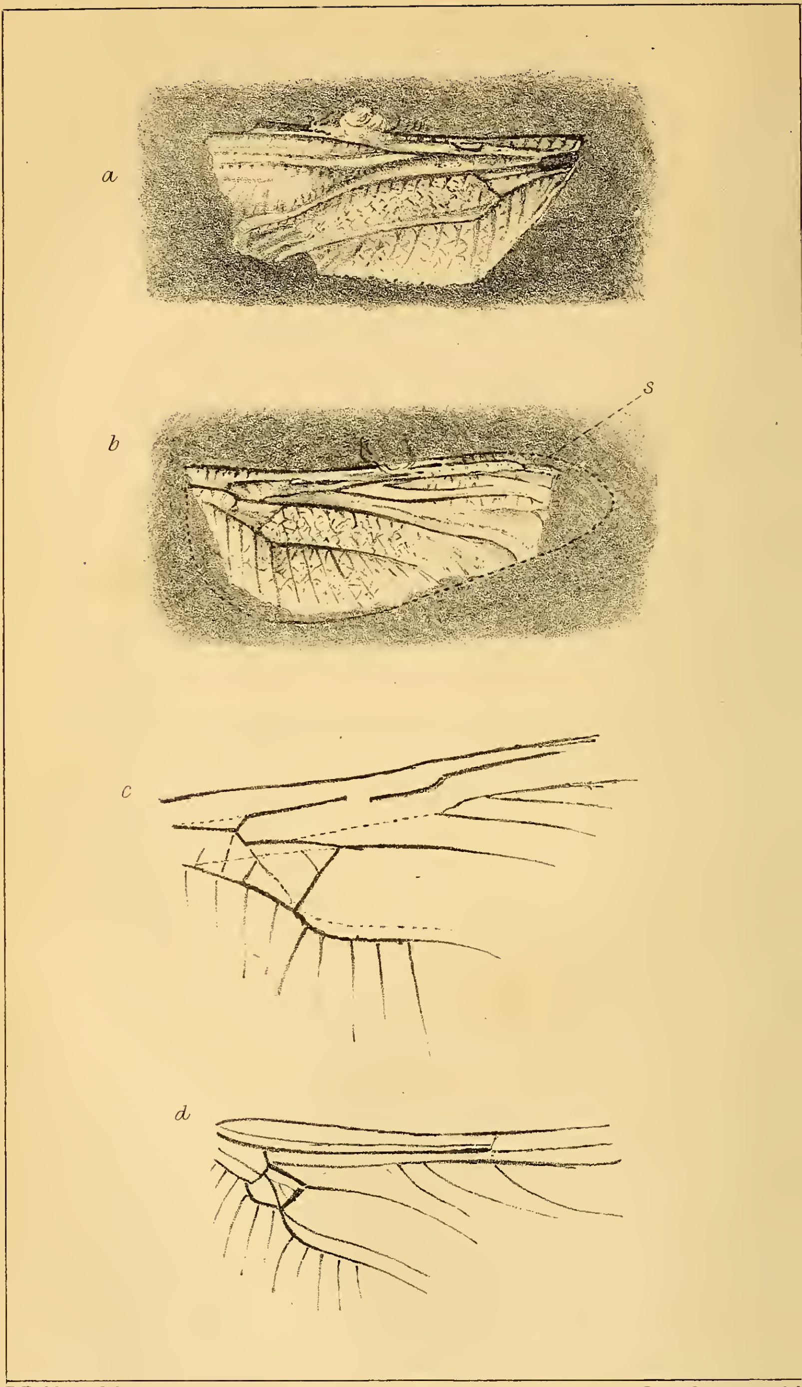
On the front edge, about two-thirds of the length of the wing from its origin, appeared what resembled the "stigma;" such, at least, at first it appeared to me to be, but this position is much farther from the tip than is usual in living *Libellulidæ;* though it agrees with that assigned to the stigma in *Aeshna liassica,* by Professor Westwood, in plate x. fig. 4, of Brodie's Fossil Insects. Upon clearing away a small piece of the enveloping stone, I found it was certainly formed by the approximate marginal *costæ,* and not the stigma, whose true place was at *s* in fig. *b.* (See Plate VI.)

The general plan of the principal veins and the intervening cells can be understood by inspection of the drawing; but for the sake of comparison with other specimens it may be well to call attention to two points. The smaller veins which branch out from the posterior large vein, and proceed towards the margin, constitute a series of nearly parallel and nearly equidistant nervures, somewhat irregularly connected by less conspicuous threads in different directions. This is not a common feature in the wings of living *Libellulidæ;* but may be traced in some fossils, as in plate viii. fig. 1, of Brodie's Fossil Insects, which represents a smaller specimen from the Upper Lias (*Aeshna Brodiæi,* Morris). The analogy which thus appears between that Liassic and our Oolitic specimen, is confirmed by a comparison of the principal veins; for these take very similar directions and separate spaces much in the same proportions, and, as far as appears, filled by cells in a similar way. The second peculiarity worthy of notice is in the arrangement of the main veins about the triangular area which is so marked a feature in the wings of *Libellulidæ.*

In Plate VI., fig. *c,* this arrangement is sketched from the Stonesfield Fossil, and in fig. *d* the same parts are seen enlarged from Mr. Brodie's work, plate viii. fig. 1, which represents the Lias fossil.

Reference may now be made to the important paper on Fossil Insects, by Professor Westwood, in the tenth volume of the Quarterly Journal of the Geological Society, and especially to the figure of a *Libellula* from Eyeford, in Stonesfield Slate, part of the unrivalled collection of the Rev. P. B. Brodie, F.G.S. (plate xvii. fig. 20). A pair of wings is here seen, "apparently the anterior," as Professor Westwood remarks; but the state of the specimen did not permit of any examination of the anal angle of the wings, or the precise form of the cells. Regarding them as anterior wings, they appear to me decidedly allied to the fossil of which I give the posterior wing; and as the author of the excellent paper referred to deserves, more, perhaps, than any other man of our country, the thanks of Palæontologists for his labour on fossil insects, let us call this species, now in some respects clearly illustrated, *Libellula Westwoodii.*

One who knows the value of the Stonesfield fauna in questions of



F. Fielding, del[t]. Day & Son, Limited) lith

a–c. LIBELLULA WESTWOODII, *Phillips*.

Stonesfield Slate.

d. AESHNA BRODIEI *Morris*. LIAS, DUMBLETON the succession of life on the land and in the waters, will welcome every additional fact which may tend to clear up the history of that remarkable deposit. A lagoon with bordering marshes, and dryer land; the water full of marine life—Corals, Mollusca, Crustacea, Fishes, Turtles, and Teleosaurs;—the land occupied by Cycadaceous and Coniferous plants, and traversed by the huge Megalosaur and the tiny *Phascolotherium;* while over land and water the Pterodactylian Harpies stretched their filmy wings.

Semel insanivimus omnes! Most of us have been fly-catchers in our day. I was myself a zealous student of insects; and remember nothing with more pleasure than the chase of *Agrion, Aeshna,* or *Libellula,* by the side of some Yorkshire water. No doubt such waters were haunted "in the Oolitic days" by the insects we are now considering, and it becomes an enquiry of some interest in the further study of them, whether they manifest any special affinity with congeneric forms now visible in Australia, as do the Cycads, *Waldheimia, Trigonia, Cucullæa,* and *Phascolotheria,* which are their companions in the deposits of Stonesfield, with the plants, shells and mammals of that old-fashioned corner of the earth.

EXPLANATION OF PLATE VI.

Figs. *a* and *b*. Impression and counterpart of the wing of *Libellula Westwoodii,* Phillips. Natural size. From the Stonesfield Slate.

b. *s* marks the position of the "stigma."

c. Enlarged view of central portion of wing.

d. Enlarged view of *Aeshna Brodiæi,* Morris. From the Lias of Dumbleton· (Placed for comparison with *Libellula Westwoodii.*) Figured in "Brodie's Fossil Insects," *Tab.* 8, fig. 1.

II.—On the Structure of the Thames Valley and of its Contained Deposits.[1]

By Searles V. Wood, jun., F.G.S.

WHILE we have in the deposits described no signs of any line of drainage conterminous with the valley through which the Thames now finds its way from London to the sea, until after a series of diverse conditions, and until a most recent date,—that of the Marsh clay, we shall find, in the physical structure of the valley, evidence corroborative of that afforded by the deposits; and showing that the *present* valley of the Thames is a creation subsequent to all the deposits which it contains that are older than the Marsh clay.[2]

So far from the Thames gravel extending "in a continuous and uninterrupted sheet from the sea to Maidenhead," it stops entirely

[1] Concluded from our last number (p. 63).

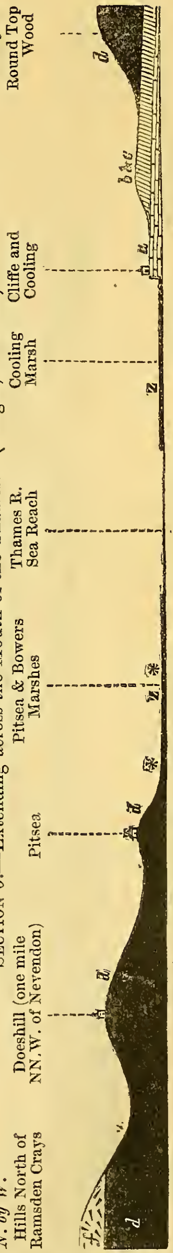
[2] It has been contended that the Thames was once a tributary of the Rhine, but this argument can only have been supported by those who have not studied the structure of the valley, and of the East of England, with the minuteness that would show such a view to be at variance equally with the mode in which the valley was first formed, and with the conditions which it subsequently underwent, *i.e.*, with its excavation through the Drift by denudation on emergence from the Upper Drift sea, and its subsequent history as given here in outline.

on the northern side, at a point *thirteen miles west of Shoeburyness*;[1] while, on the southern side, its limit is Higham, twelve miles west of Sheerness and Shoeburyness, where a most remarkable and isolated fragment of the deposit remains, having been saved by a fault, which threw it down, with the London clay on which it rested, into the midst of the Chalk which now forms the surrounding country. This detached fragment occurs, too, several miles east of any other portion of Thames gravel now existing on the southern side of the Thames. Beyond these points, not a vestige of the Thames gravel, *or of any other*, appears for many miles. On the northern shore, at Hadleigh Common, on the top of a hill, and at a distance of eight miles to the eastward of the point of absolute stoppage of the formation, we meet the first signs of gravel in the form of a small patch that does not correspond with the Thames gravel ($x\,4''$), but does so with the denudation gravel ($x\,2$); while to the north of Hadleigh, at a distance of a mile, there is about a square mile of summit gravel ($x\,1$) at Daw's Heath and Great Wood. Two miles east of this, and at a distance of ten miles from the easternmost edge of the Thames gravel ($x\,4''$), another gravel sets in, which, although it may be

[1] As the Ordnance Sheet, No. 1, which comprises the entire valley of the Thames, from London to the sea, has not yet been mapped by the Geological Survey, I subjoin the eastern and northern boundary of the Thames gravel through it: all the names of places being those on the Ordnance sheet. Starting from a point about midway between Cheshunt and Broxbourne, the eastern boundary of the Thames gravel follows the course of the Lea on its eastern side very closely, and at a distance varying from a furlong to one mile from that stream itself as far as Walthamstow, at which place it turns abruptly to the east, and passing through Forestside, bends for two miles up the Roding valley, for a mile above Woodford Bridge, whence it descends due south for an equal distance; then, turning round Clay Hall, it stretches E.N.E. to Fairlop plain. Then sweeping S.E., the boundary curves round Lawn Farm at a distance of six furlongs on the west and south sides of it, and bending E.N.E. again to (the northernmost) Collier Row, it curves from that place southwards passing through "Priests," eastwards, but with a slight northerly curve, to Hare Hall. It crosses the railway at Hare Lodge to New Readingcourt; then, turning abruptly, it runs S. by E, to Upminster Bridge, whence it stretches E.S.E. to (Orsett) Fengate, passing in its course, and immediately south of them, the villages of Upminster, Cranham, and North Ockendon. It then bends close round the north side of Orsett to Rotten Row, whence it turns north to Horndon-on-the-Hill, which it touches on the south side, then trending east, it crosses the Vange Road half a mile N.E of Stanford-le-Hope; then bending N.E. for a mile it curves again, and crossing the road from Corringham to Laindon, six furlongs W.N.W. of Corringham, passes to Fobbing, crossing that village one furlong north of the church, when it abruptly bends south, and keeping close to the village, passes in a S. by E. line to the Marsh, a furlong east of Fobbing Wharf, where it stops; but as it appears at the bottom of the dock there, it is probably continued under Corringham Marsh to the river, a mile west of Thames Haven. This boundary, which I have tested minutely, will, after quitting the Lea, be found to be almost identical with the line of the Thames River, except in those reaches which have been formed subsequently to the gravel by the faults described in the text, viz., Sea Reach, Gravesend Reach, Erith Rands, and Woolwich Reach, with the lines of which, however, it shows not the remotest coincidence. The Geological Survey Sheets, Nos. 7 and 8, purport to show part of the formation west of London; the gravel of Wimbledon and Richmond Hills, however, is not included as any part of it; but sheet No. 13, which should contain the westerly extremity, including the great expansion of the formation around Reading, has been published without any delineation of the greater portion of the formation comprised in it.

contemporaneous with the Thames gravel, is manifestly no part of the once continuous and persistent sheet which filled so large a proportion of the *original* valley of the Thames, and which, on the north side of the river, still remains in a continuous sheet. This gravel (much of which is capped by brickearth) extends only a little way west of Southend, although it runs northwards along the coast for nearly 20 miles, in a strip varying from 2 to 5 miles in breadth. So also on the south side there is an interval of several miles wholly destitute of gravel in any form, extending eastwards from Higham to High Halstow; but east of the latter place a gravel sets in, which is found at several places between it and the Medway; and which, although, like the Southend gravel, it probably is coeval with the Thames gravel, is also manifestly no part of that formation itself. On both sides of the Thames, therefore, we have the Thames gravel ($x\,4''$) entirely cut off from the sea, into which the Thames river discharges, by a breadth of several miles of land; and Section 5, drawn across the entire valley forming the mouth of the Thames, and directly transverse to the course of the Thames river east of the boundary of the gravel ($x\,4''$), shows both the absence of the gravel and the mode in which (long subsequent to the gravel and brickearths) the river has been opened through this gravel-less area to the sea. It also shows distinctly the cutting down of the valley on the north side of the river from the Upper Drift or Boulder-clay (which at this part overlaps the Middle Drift gravel by several miles). This north slope, it is to be borne in mind, is a part of the original valley beyond the limit to which the Thames gravel ($x\,4''$) reaches; on the other hand, the slope forming the south side of the valley through which the river Thames runs has been materially modified by the causes which brought Sea Reach into existence, and does not, in its present form, represent any portion of the original Thames Valley. The fault which at Sea Reach opened the Thames river to the sea indicates a throw of between three and four hundred feet.

SECTION 5.—Extending across the Mouth of the Thames. (Length, 14 miles.)

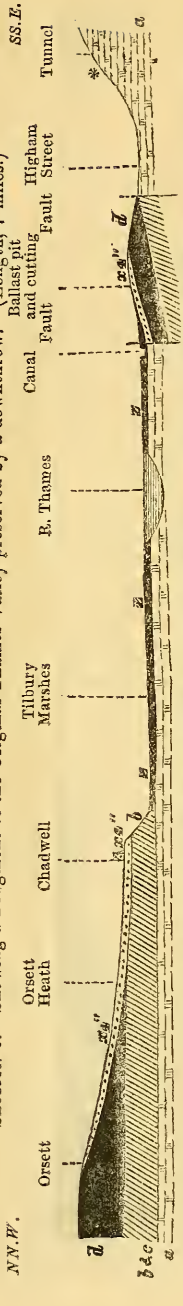


a Chalk. *b* & *c* Thanet sand and Woolwich beds. *d* London clay. *f* Boulder-clay, or Upper Drift. *z* Marsh clay.

* The asterisks indicate wells in the Marsh, passing through a thickness of 270 feet of London clay, immediately underlying the Marsh clay.

N.B.—On the slope of *f* there is a patch of $x\,2$ gravel, too small to be shown, being less than 100 yards square. If the section were drawn from the Upper Drift hills over Ramsden Crays, in a south-west direction, it would show the Thames gravel lying in a trough cut down some 300 feet from the Upper Drift.

SECTION 6.—Showing a Fragment of the Original Thames Valley preserved by a downthrow. (Length, 7 miles.)



a Chalk. *b* & *c* Thanet sand and Woolwich beds. *d* London clay. *x*4'' Thames gravel. *z* Marsh clay.

* The asterisk marks Higham Station, at which place a brickearth (too limited to be shown in the section) occurs, of *x* 5 age, and resting on a thin bed of Lower Tertiary sand.

I will now endeavour to show more distinctly the destruction of the eastern part of the original valley. Section 6 (drawn at right angles to Section 1) shows the Higham fragment and fault. From this it will be seen that the trough of the *original* valley, before it was broken up, passed by Chadwell (near Tilbury), where it was cut down to the Thanet sand; the sides of it rising again towards Higham, where the gravel fragment, underlaid by London clay, indicates the slope of the valley in that part, before it was destroyed, to have corresponded with that on the opposite side towards Orsett, where the gravel, still remaining in an unbroken sheet, spreads up from the Thanet sand, on which it rests more in the trough, till, at Orsett, it rests on a thickness of London clay. The section does not cut the original valley at right angles, but takes a slice off its edge only, this being unavoidable, in order to catch the most crucial of the evidences which have been spared to us, and the centre of the trough is therefore not quite reached in this section; that centre passing more to the west, by Grays, where it cuts almost through the Thanet sand, so that, in that neighbourhood, the Thames gravel is divided from the Chalk by a very small thickness of the Lower Tertiary sands.

It is not, however, in the eastern part of it alone that we find evidence of the connection of the original valley with the sea over the Weald. The Thames gravel, although thinned, can be followed in places, without a break, up the gradual slope which forms the north side of the Richmond and Wimbledon Hill from the great sheet that lies on both sides of the river at the lower level, until it joins the expanse of gravel covering the hill top; but on the other three sides, as well as on part of the fourth, the expanse on the hill is detached from the sheet of the low ground by lines of denudation that are in some parts gradual, but in others, as on the west of Richmond Park, so sharp as to amount to almost a cliff; while, as before observed, the hill has no counterpart on the opposite slope of the valley. Let us take a section from the Thames over this hill to the Chalk in Surrey, forming the northern edge of the tract of denuded Chalk through which the Weald valley is cut. (See Section 7.)

In this section we see that the denudation has acted principally to the south, *i.e.*, *in the opposite direction from the river*, the hill having been cut down and a newer gravel (x 5) corresponding in position (relatively to the Thames gravel, $x\,4''$) with that of the Cray valley, formed below it; the denudation also is equally decided on the east and west sides of the hill. The gravel x 5 extends in a continuous sheet from Mitcham, where it rests on 100 feet of London clay, to the Chalk at Carshalton. It is unlike the Thames gravel, being composed of very angular flints, and is of inferior thickness, becoming whiter and more chalky as the Chalk is approached, being nearly white over that formation itself.

If this section be prolonged it will reach the north scarp of the Weald to which the Carshalton Chalk extends continuously, and there is nothing by which this gravel (x 5) can be disconnected from the sea that denuded the Chalk, and covered the Weald area, prior to the excavation of its valley. It would, therefore, appear from this section that the Thames gravel, prior to the convulsions which destroyed so much of the south side of the valley, had, in addition to its exit by Dartford and Gravesend, another opening to the Weald towards Carshalton, from which it was eventually cut off by the upcast of the country there, and the gravel (x 5) formed. The gravel of Mitcham (x 5), however, mingles, towards the north-east by the Tootings and in the Wandle valley, with the Thames gravel ($x\,4''$), so that it would appear that the sea continued to have access to a part of the area occupied by the Thames gravel after the elevation of the Richmond and Wimbledon Hills and the denudation of their southern sides.[1]

SECTION 7.—Extending from the Thames to the Northern edge of the Wealden denudation. (Length, 7 miles.)

a Chalk. *b* Lower London Tertiary. *d* London clay. $x\,4''$ Thames gravel.

[1] Although when the gravel at Beddington or Carshalton is compared with that near the Thames the contrast is considerable, yet from the flatness of the intervening country it is impossible to say where one begins and the other ends; indeed, if the partial continuity with the sea remained, the two must have blended. The railway cutting at Peasemarsh, near Tooting, shows the same coarse gravel as the Mitcham cuttings; but it is too shallow to disclose whether this rests on any different gravel.

Could the whole subject of the denudation of the Upper and Middle Drift be discussed here, it could be shown, by a variety of collateral evidence, that the Cliffe fault, forming Sea Reach, was part of a series of movements subsequent to the formation of the original valley in which the Lower Brickearth was deposited. The sections given will, however, show that this fault is due to a line of rectilinear movements that has thrown down the bed of the old forest at Plumstead, and brought up, by faults, the gravel of Dartford Heath, and the range of the Erith, Bostol, and Plumstead Hills; and which has isolated the Wickham Lower Brickearth behind that range.[1] To these movements, and to the denudation contemporaneous with them it is, that the south-easterly extension of the Thames gravel has been destroyed, except the fragments isolated at Dartford Heath and Higham. While we have thus evidence of the former extension of the gravel in this direction, we have also evidence of its being shut off from the sea on the east by a tract of land several miles broad, and we are thus driven to trace its extension to the sea, at its eastern end, in a direction that carries us over the now-elevated Chalk country lying north of the eastern part of the Weald of Kent. So also, on the west of London, we are met with evidence of its original extension by another channel in the direction of the same elevated Weald country.

It is quite impossible, within the compass of a short paper, to show adequately the movements which brought into existence the original valley, and those which afterwards so materially altered it, and dislocated the formations within it; far less to show the relation which that valley and its deposits bear to the general question of the formation of England since the elevation of the Upper Drift. As to the former, the sections given must, as far as they go, speak for themselves; and if the reader will (after marking the northern boundary of the gravel given in the note to page 100) carefully follow their direction in the map, and, while bearing in mind that one great branch of the valley and its gravel cuts through the line joining the Upper Drift outliers on the Finchley and Havering hills, correllate these sections with each other, they will—while at variance with any extension of the Thames gravel to the present sea; with the formation of the Brickearth by floods, commencing at the period of the highest valley gravels, and continued down to that of the lowest,—bear out, I think, the following conclusions, viz.:

1. That there is no *widespread* set of hill gravels within the area of the Thames Valley; the only gravels older than the Thames gravel ($x\,4''$) being the extremely partial and thin denudation gravels, $x\,1$, $x\,2$, and $x\,3$.[2]

[1] If the places of the Plumstead fault in Section 3, and of the Cliffe fault in Section 5, be marked on the map, and a ruler laid through them, it will indicate the direction of a rectilinear line of throw extending from the Cliffe fault, and passing exactly through the faults of Little Thurrock, Purfleet, Erith, Plumstead, and Lower Charlton.

[2] The extensively-spread gravel of the Middle Drift, which partially underlies the Boulder-clay, lies without the brow of the Thames Valley, except for a small distance in the western part of it.

2. That the *original* valley, formed subsequently to the deposit of the Upper Drift or Boulder-clay, and by denudation during emergence from the Upper Drift sea,[1] began (after passing through the Bagshot sand and London clay alone, between Windsor and London) to cut down on the east of London to the Lower Tertiary sands in the central line of its trough; and that the line there curving south-eastwards, and passing across the extreme south-west of Essex, made its way to the sea in the direction of the eastern half of the Weald; the London clay forming only the higher slopes of the trough on this side of London.

3. That in the trough so formed, *and after its complete excavation,* the fresh-water deposit of the Lower Brickearth ($x\,4'$) was accumulated, having a very limited extension. That after this the valley underwent a considerable depression, by which the sea was admitted, rising up the sides of the valley to a height very far above the limits of the Lower Brickearth, and covering that deposit, by which an uniform sheet of closely bedded fine gravel ($x\,4''$) (composed of material brought mostly from other areas than those draining into the valley,) was deposited; while changes of level occurred during this depression that gave rise to the bands of clay and sand, yielding fresh-water shells, which occur in a few places near the margins of the deposits, and are intercalated in the gravel. And that, after the completion of this formation, a change ensued by which *the sources furnishing the gravel* were cut off, the mud brought down by the surrounding streams—instead of being, as heretofore, carried off by the tide that brought the gravel-freighted ice—being intercepted and allowed to subside in deposit.[2]

4. That the south side of the valley was then subjected to violent convulsions, which broke up the surface, and caused an extensive denudation of all the three deposits; eventually converting the valley north and west of Grays into land upon which a forest sprang up; while at Grays, and south of it, the denudation, cutting through the Thames gravel and subjacent Thanet sand of Dartford Heath and Grays Hill down to the Chalk, formed the valleys of the Cray and Darent, the waters of which passing by Purfleet and Grays, flowed to the sea, then occupying the Chalk area of the Wealden denudation, and in which the later gravel ($x\,5$) and the fluviatile deposit of Grays ($x\,5'$) were accumulated.

5. Then, but after what interval cannot be shown, probably a long one, a part of the forest was subjected to a downcast, and the swamp, with its peat, formed over it; and, finally, the river Thames found its way through the swamp, covering the peat with its mud, and having an access to the sea provided for it by the downthrow forming Sea Reach; a downcast which, although then completed to the extent

[1] I confine the term Drift to the English Glacial beds that are older than the valleys existing in strata which are newer than the Trias, and lie south of Flamborough Head; using the term Post-glacial for such as are newer.

[2] That the climatic conditions producing gravel were not changed, is shown by the formation of the later gravels ($x\,5$); and I have seen in the Upper Brickearth at Wanstead large angular chalk flints, apparently ice-borne.

of admitting the North Sea, had, like that which threw down the forest, and, by its interception of drainage, originated the peat, probably begun in the convulsions mentioned in conclusion 4.

6. That, while we have no set of terrace-gravels marking the *present* valley, the condition of the northern slope east of London does point to the formation of the *original* valley in a manner bearing some analogy to terrace formation; but the corresponding part of the southern slope of the original valley having, with the exception of the solitary remnant of Shooters' Hill, been destroyed,[1] there now remains nothing resembling such a terrace condition as the valleys of the Somme and the Seine are represented to possess.

These are all the conclusions which the sections and facts submitted here justify; but, could the whole phenomena relating to the denudation of the drift, and to the formation of the Post-glacial gravels in those counties lying south of Flamborough Head, which are occupied by formations newer than the Trias, be presented to the reader, it could, I think, be made to appear that the water depositing the Thames gravel was that of a strait connecting the Post-glacial sea of the west, beyond Reading, with the same sea over the Weald, which was then denuding the Wealden area prior to the excavation of the Weald Valley between its Chalk escarpments;[2] and

[1] It would incumber the paper to show why, since the original valley was cut through the drift, no outlier of drift should occur on the top of Shooters' Hill, corresponding to that on Havering Hill; but it is capable of a very clear and interesting explanation. To give it, however, would require a description of the position which the Upper and Middle-drift occupies in Essex, Middlesex, and elsewhere.

[2] To make this view intelligible, it is perhaps necessary to explain that I regard the gravel of Southend (which, separated from the Thames gravel by several miles of gravel-less country, extends in the form of a narrow strip behind the marshes bordering the North Sea for nearly 20 miles in a NN.E. direction along the coast of Essex, and is capped in places by Upper Brickearth, and which, although it is the same as that fringing the estuary of the Medway between Rochester and the Nore, I will distinguish as the "East Essex gravel") as a remnant of a great sheet of gravel that was deposited in an estuary whose mouth joined (near Rochester) the sea, then extending over the Wealden area prior to the excavation of the Weald Valley. This estuary, starting from the point where its mouth, inosculated with that of the Thames gravel channel, south-west of Rochester, extended in a NN.E. direction through what is now the mouth of the Medway, and traversed a land-tract, of which the greater part occupied the area now represented by the mouth of the Thames, and by that part of the North Sea which is known as the Swin, such tract having been submerged by the convulsions giving rise to Sea Reach. The mouth of this estuary discharged into the sea over the Weald, in contiguity to the south-eastern mouth of the channel of the Thames gravel, the subsequent elevation of the Weald and submergence of the North Sea having reversed the direction of the drainage through the valley of the Medway, so that it now flows northwards into the North Sea, instead of southwards, as it did during the Thames gravel period, and for several stages subsequent to that period, into the Weald. To show the grounds for this view, however, it would be necessary to describe the condition of the valleys of the Alde, Deben, Orwell, and Stour, and especially the condition and structure of the valleys of the Blackwater and Crouch. It must be obvious, however, that if the Thames gravel were the deposit of the *present* valley at a time when the country generally stood at a lower level (whether accompanied by floods or not), then, not only should that gravel extend to the Thames mouth, but these six valleys, which open, like that of the River Thames, into the North Sea, and are all, in some part of them, cut either through the Boulder-clay, or else the Middle Drift, should, like the Thames valley, contain a sheet of gravel similar

Fig. 1.

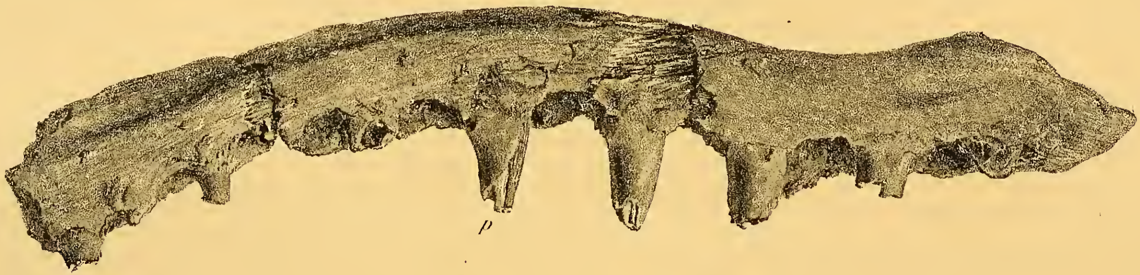
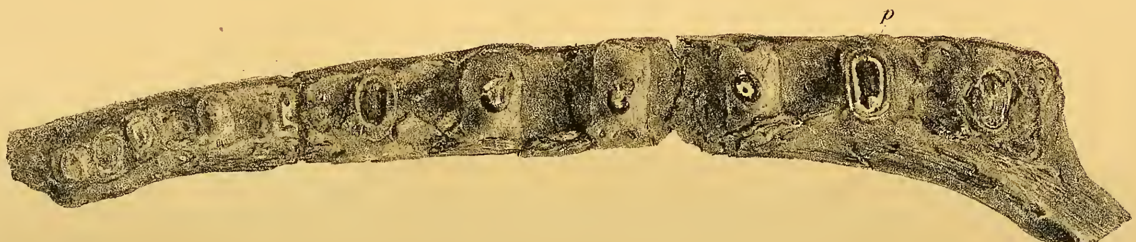
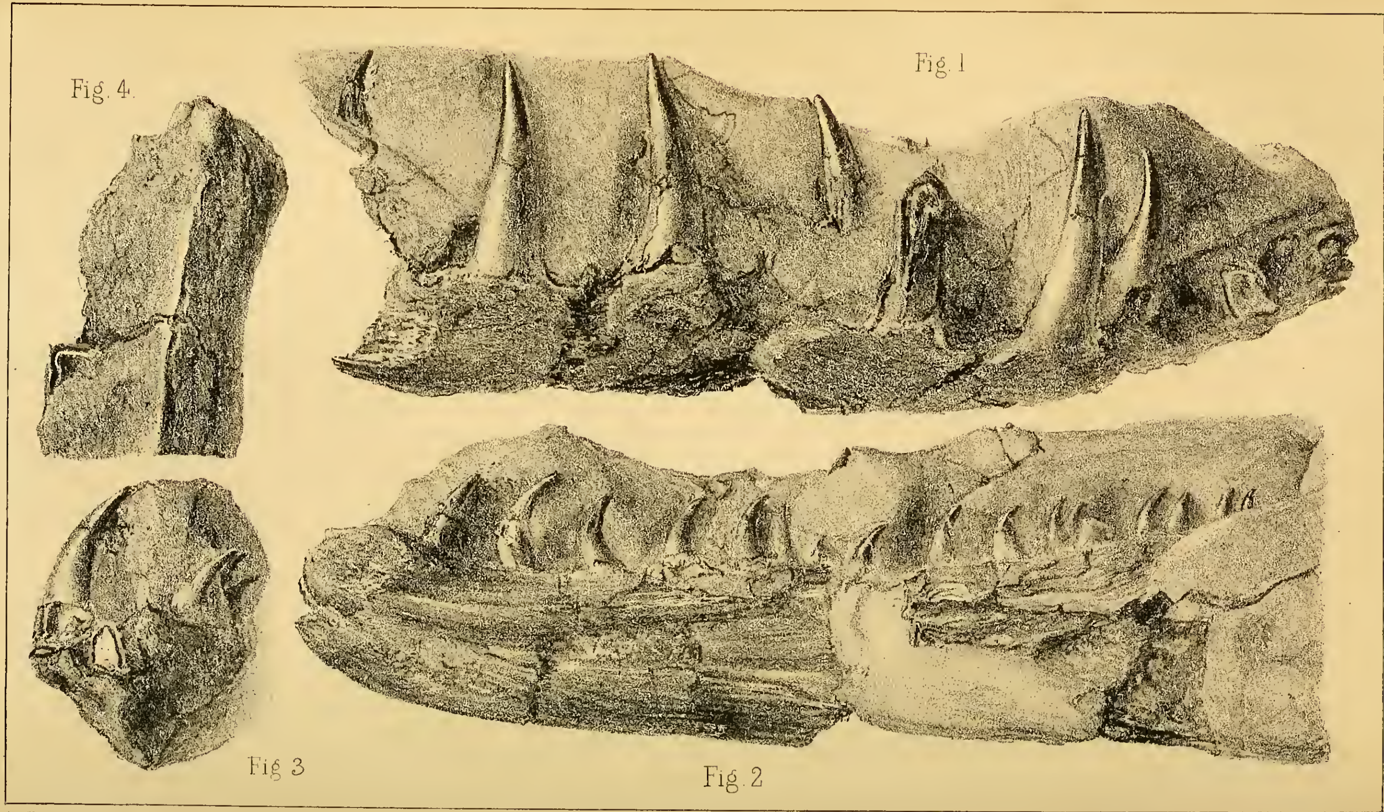


Fig. 2



E. Fielding del^t

Day & Son (Limited) Lith



E. Fielding delt Day & Son, (Limited) lith

DITAXIODUX IMPAR *Owen.*

that it was not until after the upheaval and denudation of the deposits (x 4′, x 4″, and x 4‴), that the denuded Chalk of the south of England, and of the north of France, was laid dry, and the valleys of the Weald, of the Somme, and of the Seine were cut through it. We should also see that the great convulsions which, exerted in a rectilinear direction, thus broke up and destroyed the original curvilinear valley of the Eastern Thames, were equalled, and even surpassed, by others of contemporaneous date and like rectilinear character, which in other parts also broke up or modified the curvilinear troughs of denudation into which the surface had been furrowed by the elevation and denudation of the Upper Drift sea-bed.

ERRATUM.—In the first part of this article, which appeared last month, at page 60, line 23 from top, for "west," read "*east.*"—S. V. W., JUN.

III.—ON A GENUS AND SPECIES OF SAUROID FISH (*DITAXIODUS IMPAR*,[1] OW.) FROM THE KIMMERIDGE CLAY OF CULHAM, OXFORDSHIRE.

BY PROFESSOR OWEN, F.R.S., F.G.S, ETC.

(PLATES IV. AND V.)

THE generic name of the Sauroid Fish, here indicated by portions of jaws, relates to the unusually well-marked arrangement of the teeth on the dentary bone in two almost parallel ranks along the whole of its alveolar border. The outer rank (Plate V. fig. 1) consisting of few and large teeth; the inner rank of small ones in greater number.

It is by no means uncommon in, and is almost peculiar to, the class of Fishes, to have two or more teeth on the same transverse parallel of the dentigerous surface of the same jaw-bone; but I have not, hitherto, observed two such ranks, so extensive, well-defined, and differentiated in regard to size and curve, as in the present Sauroid genus.

This additional and very interesting example of a destructive order of Ganoid, from the Kimmeridge Clay, was obtained from

to x 4″; whereas, although the four first-named valleys contain occasional patches of gravel analogous in position to that described as x 2, nothing in any way corresponding to the Thames gravel (x 4″) exists in them, while, in the case of the gravel-less valleys of the Crouch and Blackwater, it can be distinctly shown that both of these valleys, for two or three miles of their course (but in the case of the Blackwater on its south side only), cut like the Thames mouth at *right angles* through the "East Essex gravel." The terracing down of this East Essex gravel into the valley of the Weald; first to beds analagous to x 5 and x 5′, then to the gravels of the Lower Green Sand terrace, around Maidstone, and, lastly, to the gravels of the Weald Clay bottom, prior to the reversal ensuing on the formation of Sea Reach, may be distinctly shewn; as the terracing of the Thames gravel, may, in like manner, be traced through the Darent and Cray Valley beds, to the gravels of the Lower Green Sand terrace near Sevenoaks.

[1] δίς, double; τάξις, rank; ὀδούς, tooth.

that member of the Upper Oolite series at Culham, Oxfordshire, and now forms part of the choice collection of William Cunnington, Esq., F.G.S., of Hillworth, Devizes.

The most instructive and characteristic specimen consists of the chief part of the dentary element of the left ramus of the lower jaw (Plate V.) It is unusually broad above in proportion to its depth, for the purpose of due provision of space for the attachment of the two ranks of the dental array. The outer and inner sides of the bone meet at almost a right angle (fig. 3), and form a sharp ridge, which there defines the lower contour of the mandible. The outer side of the dentary is slightly convex vertically, 1 inch 2 lines deep, smooth, and with a polish at some well-preserved parts of the surface. The outer margin of the alveolar tract rises where it forms that part of the base of attachment of a tooth, and the surface sinks slightly below this part. The dentary is gently bent to this short symphysis, producing a corresponding degree of convexity of the outer, and of concavity of the inner, surface, lengthwise. The inner surface inclines at its upper border toward the inner rank of small teeth, which are attached a little way from the convex border so formed, not close to the edge, like those of the outer rank to the outer border. Below the inner border the surface is slightly concave vertically, and deepens to form the angular depression (fig. 2) for the attachment of the splenial part of the angular element of the mandible.

The number of teeth of the outer rank, indicated by wholes or parts, in place and use, at the same time in the present portion of the dentary, is 9. The first and second have been broken away by recent-looking posthumous fracture from their places of attachment. An empty depression of corresponding size between them, indicates a tooth that has been naturally shed,—a like depression intervenes between the second and third tooth. This is entire, as is also the fourth in close contiguity therewith. Then follows an interspace of an empty socket, and the succeeding five teeth are separated by such intervals equalling at their bottom the antero-posterior extent of the teeth in place. These are conical, very slightly curved inward and backward, and sharp pointed: they are seen of the natural size in Plate V. The transverse exceeds the fore-and-aft diameter of the attached base. The outer side of the base does not show the impression characteristic of such teeth in *Thlattodus*. The enamel is laid upon the upper half of the crown; it is smooth and glistening. The cement slightly thickens where it coats the lower or basal half of the tooth.

Of the inner rank of mandibular teeth fifteen are preserved in the same extent of the alveolar tract as supports the nine outer teeth. These, as is shown in fig. 2, are more recurved and also incurved than the outer rank, and generally, though slighly, decrease in size as they are placed further back.

The two ranks of teeth come pretty close together at the symphysial part of the mandible, but soon diverge, showing the extent of transverse interspace, for example, between the third tooth of each row, delineated in fig. 3. This distance the two ranks maintain to near their rear end, where they again slightly approximate. I have seldom seen a more effective and formidable array of laniary teeth in the jaws of a Sauroid Fish.

Of such a fish the bone, of which two views are given in Plate IV., from the same formation and locality, is part of the superior maxillary. From similarity of size; but more especially from the similarity of number, size, and arrangement of the laniary teeth; from the corresponding degree of antero-posterior compression of the base of the tooth, as shown in Plate IV., fig. 2; from the proportions of the enameled and cement-covered parts of the crown, and from the shape and degree of curvature thereof, so far as is shown in the least-mutilated teeth (Plate IV., fig. 1), I am disposed to refer this specimen to the same genus and species as the mandible (Plate V.). In one of the large maxillary teeth I found, on scraping away the cement, a slight depression on the outer side of the base, as in the antepenultimate tooth in fig. 1; but this is neither so deep or so constant as in *Thlattodus*. In both the upper and lower teeth of *Ditaxiodus* a large pulp-cavity remains, partly filled by a lighter-coloured matrix than the outside petrified clay, as shown at Plate IV., figs. 1 and 2.

Most probably the inner rank of small mandibular teeth were opposed by a similar rank of teeth on the palato-pterygoid jaws parallel with the maxillary rank of laniaries.

The figures in Plates IV. and V. are of the natural size, and are explained in the text. My best acknowledgements are due to Mr. Cunnington for this and former opportunities of adding to the facts of Palæontology.

EXPLANATION OF PLATES IV. AND V.

Plate IV.—Portion of superior maxillary bone and teeth of *Ditaxiodus impar.*
Fig. 1. Outer side.
2. Alveolar surface.

Plate V.—Portion of dentary element and teeth of lower jaw of *Ditaxiodus impar.*
Fig. 1. Outer side and rank of teeth.
2. Inner side and rank of teeth.
3. Anterior or symphysial end.
4. Under view of part of the dentary.

IV.—On an Ancient Beach and a Submerged Forest, near Wissant.

By E. C. H. Day, F.G.S.

(PLATE VII.)

Mr. PRESTWICH has, in two valuable papers, published by the Geological Society,[1] given a very detailed description of a raised beach and associated recent accumulations, upon the coast in the vicinity of Sangatte, a village about five miles from Calais. In the second of these papers, the author mentions that he proceeded

[1] Quart. Journ. Geol. Soc., vol. vii., p. 274, 1851; and vol. xxi., p. 440, 1865.

round the headland called Cap Blanc-nez, for the purpose of ascertaining whether any traces of a similarly recent formation were to be observed in the bay of Wissant, and that his search, as far as he went, was fruitless; "but," he adds, "owing to the extent of the dunes around Wissant, such a beach might be entirely hidden by the sands."

During a recent trip to this locality, I was more fortunate than Mr. Prestwich, for after having first noticed the raised beach north of Cap Blanc-nez, I met with what appeared to me to be a second one beneath the Sand-dunes, above referred to, in the neighbourhood of Wissant; and, still more happily, I discovered, at low-water level of the adjoining shore, a striking example of a "submerged forest." Unfortunately, however, for the reader of this article, I was at that time unaware that these formations had escaped the notice of Mr. Prestwich, and as I was also more particularly interested in the examination of the underlying Secondary rocks, I did not pay such attention to the details of the more recent deposits as they deserve to have bestowed upon them. My object in laying the very scanty notes that I did make before geologists, is therefore only to draw their attention to the existence of these phenomena, and to suggest further enquiry into their characters and into the conclusions to which they seem to point, so that others may be induced to supply my deficiencies.

Before describing the formation near Wissant, I must beg the reader's attention to a few words upon that near Sangatte; premising, however, that my own notes amount to a mere summary of Mr. Prestwich's most exact description. This recent accumulation (Plate VII. Fig. II.) strikes the observer at once as consisting essentially of three parts: a shingle-beach of well-rounded flints and fragments of ferruginous sandstones; a mass of Chalk-rubble; and, thirdly, an accumulation of angular flints. The raised beach (Fig. II. 6) rests partly against a former cliff and partly upon a former sea-bed of Chalk, and at its most south-westerly extent it is situated about 12 or 15 feet above the present high-water level. From that elevation it dips gradually in the direction of Sangatte, until it passes out of sight beneath the shingle of the existing shore. The large well-rounded flints which compose it are firmly cemented together in a chalky matrix, and blocks of this conglomerate are to be seen scattered on the beach. Resting upon this shingle-bed is the mass of chalky *débris* (Fig. II. 4): many of the fragments of chalk are more or less rounded either by gentle water-action or by long-continued exposure to the atmosphere during a period of very gradual accumulation. Here and there in this I noticed collections of small quartz gravel (4′), which seem to me to favour the idea that it is at least partly of subaqueous origin. Somewhat nearer to Sangatte than where the ancient beach disappears, green and brown sands (Fig. II. 5), stratified in beds, one or two feet in thickness, occur below the Chalk-rubble, and with these also I noted the presence of the small quartz gravel. The junction of the sands with the shingle below is concealed by the crumbling away of the loose beds above, yet their connection with the raised beach is so clearly suggested by their relative position, that I was altogether bewildered when I found, on reference, that D'Archiac[1] assigned them to the older Tertiary. The third component of the group is, in character, an excellent example of what De la Beche,[2] in his description of raised beaches, termed a "head;" in position, however, it is far removed from any cliff or steep elevation whence the angular fragments could have fallen, whilst they also seem too large to be a "rain-wash;" so that, in spite of its appearance, the observer is forced to the conclusion that the materials of which it is composed have been transported from a distance; but, by what agency?

Whilst the appearance of this raised beach and its accompaniments was still fresh in my mind, I chanced to be examining the coast between Wissant and Cap Blanc-nez, when I was much struck by the peculiar appearance of a recent formation, which forms part of a low cliff between the former place and the little hamlet of St. Pol. North of a stream that descends from Sombre-Haute and finds its way through the Sand-dunes to the sea, at about half a mile from Wissant, large blocks of grit, resting upon dark-green sands, and some underlying dark clays, indicate the presence of the Lower Greensand Formation beneath the shore. The higher part of the "between-tide-marks" is here covered by flint-shingle, and at high-water level a bed of shingle, of ancient origin, begins to crop up into sight, from which evidently the flints of the present beach are derived. At first the characters of the old beach are not distinctly seen; but as the observer proceeds in a north-easterly direction, and the Greensand and the Gault form a gradually-rising, low cliff, he will perceive the recent accumulation well exposed, capping the Secondary strata and interposed between them and the Sand-dunes. At the time of my visit it could be clearly traced for 500 paces, and beyond that distance I do not think that it exists; though it may do so, and be concealed by the fall of sand and *débris* from above. At the point where it ceases to be visible, its base is at least 15 feet over the highest shingle of the shore; so that it rests upon a gradual slope, having a regular inclination of about 1 in 64, in a south-westerly direction. Where it is best exposed, the formation presents the following sequence of characters, and displays the section given in the accompanying figure (Plate VII. Fig. I.).

A bed six feet in thickness of chalk pebbles and rolled flints (Fig. I. 6) rests directly upon the Cretaceous strata; towards the northern end the chalky element rather predominates, the flints being here most thickly packed in the middle of the bed, and more scattered above and below; where, however, it comes down towards the present beach, there is less of the Chalk, and the bed is more exclusively composed of flints. As far as I noticed, the materials are not cemented together; and this, at first sight, led me to think that the accumulation was an equivalent of the Chalk-rubble or

[1] D'Archiac Histoire des Progrès de la Geologie, T. 4, p. 200.

[2] Report on Geology of Cornwall, etc., p. 432.

débris of the Sangatte example (Fig. II. 4); but, on examination, the well-rolled character of the Chalk-pebbles especially, convinced me that it was a genuine ancient beach. In places the shingle is capped by a bed (Fig. I. 5) six inches thick of greenish sand, greatly resembling the sand occurring above the beach, north of Blanc-nez, and this fact confirmed my impression that the whole was of subaqueous origin. I now regret, however, for a reason given in the sequel, that I did not examine the sand more closely.

Resting upon the patches of greenish sand, or where this is absent directly upon the shingle, is a stratum so largely composed of vegetable remains as to appear to be a layer of bog-earth. This bed (Fig. I. 3), a foot in thickness, throws out much water, which strongly marks the beds below with ferruginous stains; it would seem, however, to contain a considerable proportion of fine greenish-grey sand. Its dark colour renders this deposit a conspicuous object in the low cliff, contrasting as it does so strongly with the lighter-coloured beds above and below. Brown sand rests upon the last stratum, and is apparently the same as that of the dunes, but it is separated from the latter, in places where the cliff is sufficiently preserved to show the complete sequence, by a second but much thinner layer of vegetable *débris* (Fig. I. 2 and 1). Such is the series of deposits that here intervene between the older formations and the Sand-dunes.

On a subsequent visit to the same locality, whilst availing myself of low-water to search for the nethermost beds of the Lower Greensand exposed on this coast, I came upon a most instructive example of an ancient and partially submerged forest. Black patches (Fig. I. 7), which I mistook from a distance for secondary rocks, stood up out of the sand of the shore at low-water level, about 200 yards seaward of the raised beach. On examination, I found them to consist of a peaty formation embedding numerous stumps of trees of various sizes, still standing upright and with their roots running down into the mass below. I traced these trees for a considerable distance along the shore opposite to the raised beach, but time did not allow me to examine the stratum as closely as I wished to do. I noted, however, that the black peaty bed, in the lowest part that I could find exposed, contained numerous white Chalk pebbles scattered through it; and I was further successful in obtaining from amongst the roots of a tree a single bone, the larger portion of the metatarsal of a ruminant, which had every appearance, from its dark colour and great weight (apparently due to an infiltration of iron), of being coeval with the forest. As, however, it contained all or nearly all its animal matter, and I found the colour to be superficial, and as I am, moreover, inexperienced in these recent reliquiæ, and there was every possibility of its being a modern intrusion into the ancient deposit, I was glad on my return to have an opinion upon its antiquity. Mr. Wm. Davies, of the British Museum, who kindly compared it for me with corresponding bones in the national collection, tells me that, in his opinion, it may be assigned to the Aurochs (*Bison priscus?*), which puts its contemporaneity with the forest pretty well beyond all doubt. Subsequently, on examining this bone in the presence of Mr. Etheridge, some of the greenish grey sand contained in it fell out, and we observed in this a specimen of a small *Planorbis* and one of *Bithynia tentaculata,* which show the freshwater origin of this infilling. I have little doubt, from the presence of the Chalk pebbles in the bottom of the peat bed, but that this is a continuation of the similar deposit overlying the raised beach, although I observed no stumps of trees in the latter. The sand contained in the bone is very similar to that overlying the shingle, and I now am sorry that I did not examine the latter to see if it be not also of freshwater origin. Should it prove to be so, its very close association with the bed below would possibly lead to the conclusion that the latter was not a marine but a freshwater beach, formed upon the shore of a lake or estuary. I merely suggest the possibility of this, as the present conformation of Wissant Bay is such as to remind us that an elevation of this district would, in past times, when all the hard rocks were more prominent than now, have had the effect of converting it into an almost basin-shaped depression; the Portland beds to the westward and the Chalk to the north forming part of an elevated rim round a hollow scooped out in the Kimmeridge and Oxford clays and the Gault and Greensands. The correlation of the formations just described with those near Sangatte must be dependant upon the determination of this question; for if the Wissant beach is of lacustrine origin, then it is probably contemporaneous with the Sangatte Chalk-rubble, and the "head" of the latter with the forest, the Sand-dunes being more modern than either. On the other hand, should both beaches be of the same date, then the forest would have been coeval with the accumulation of the Chalk *débris* and the formation of the "head" probably with that of the Sand-dunes. I do not believe, however, that the latter are of the most modern date, for the configuration of the coast, and the fact that the raised beach and the ancient forest are now being laid bare, show clearly that the sand is being cut away on its seaward edge, and that, consequently, it is but a remnant of a more extensive series of dunes.

The consideration of this question has suggested another enquiry to my mind. Why has Wissant ceased to be a port? for formerly it was one of some little importance, and now it can scarcely be called a fishing village. The answer generally given would probably be that the *growth* of the Sand-dunes had obliterated its harbour; but if it be true that the sands are being cut away, this explanation will not hold, and I myself think that a far more tenable view is to be based upon the geological structure of the subaqueous part of the bay. If we look at the map (Pl. VII. Fig. III.) we see that a shoal having less than a fathom of water on it at lowest tides, extends from Cap Gris-nez, in a north-easterly direction, in such a manner as to cut off a channel about half-a-mile in width, and having a depth of from two to three fathoms of water in it, directly abreast of Wissant. The shoal is probably owing to an accumulation of masses of grit, the remains of the Kimmeridge and Portland strata that once covered the tract; and these, during the course of centuries of exposure to the heavy seas that break upon the coast, must have undergone some considerable amount of destruction. Formerly, therefore, this shoal must have formed a natural breakwater, and have rendered the channel within it a convenient harbour. The gradual destruction of this barrier has probably been accompanied by a gradual silting up of the depression within. The accompanying map is taken from the Admiralty chart "copied from the Pilote Francais of 1836, and in a later chart (1848) the depth of water at points here marked $3\frac{1}{2}$ and $3\frac{1}{4}$ fathoms is marked as only being 3 fathoms, so that if any reliance is to be placed on these data, the process of silting up is progressing very rapidly. It occurs to me, as by no means improbable, that a change of level of the land, by a slight sinking, may have at the same time lowered the barrier, and by increasing the general depth of water in the bay have, to some extent, counteracted the effect of this very rapid silting up of the old harbour. But this is mere conjecture, and I only throw out these remarks in the hope that some archæologist may, perhaps, be induced to search out any evidence of the cause why Wissant has ceased to be a port; geologists may thereby be enabled, perhaps, to form some idea of the nature and amount of the changes that have taken place in and around this interesting bay during the period of history.

But to revert to the more ancient history, the raised beaches (or that of Sangatte, at least) prove a period when the land was depressed below its present level, and the peat bed shows one of re-elevation. The sand above and the second layer of mould indicate a second alternation of movement; and I am inclined to think that the growth of the present dunes took place during yet another upheaval; and their partial destruction, as already suggested, during a final and very modern period of depression, which has left the submerged forest where we now find it. Such a succession of oscillatory movements is, at the present day, well understood, and is in perfect accordance with facts observed elsewhere.[1] De la Beche tells us also that the dunes of the Cornish coast are composed of two parts of different ages.[2] This gives us an example parallel to that above described, where the two portions appear to have been separated by a period during which, what must have been at the time, an abundant vegetation covered the older. Where this stratum of mould has not been preserved we lose all clue to the fact that these dunes are not throughout of one date, but belong to epochs, probably separated by a long interval of time. By such perishable evidences are the remarkable events of the world's history preserved to us in the Geological Record! If the pages that we have before us are so fragmentary we may well judge how many must have been altogether destroyed!

[1] *Vide*, for one instance, De la Beche's Report, etc., pp. 401, *et seq.*; also the Abstract of Mr. Godwin Austen's paper "On Submerged Forest" (Geol. Mag., vol. ii. p. 556.

[2] Supra, p. 426, *et seq.*

Fig 1.

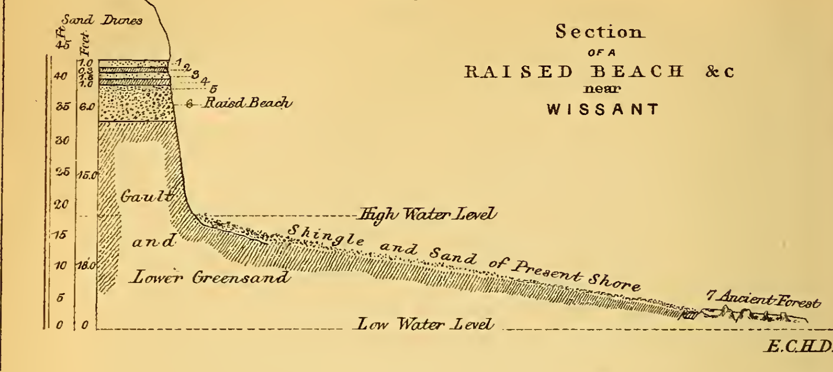


Fig. 2.

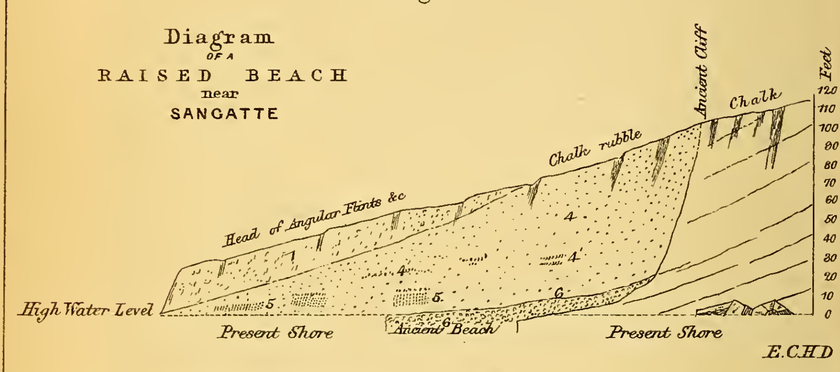
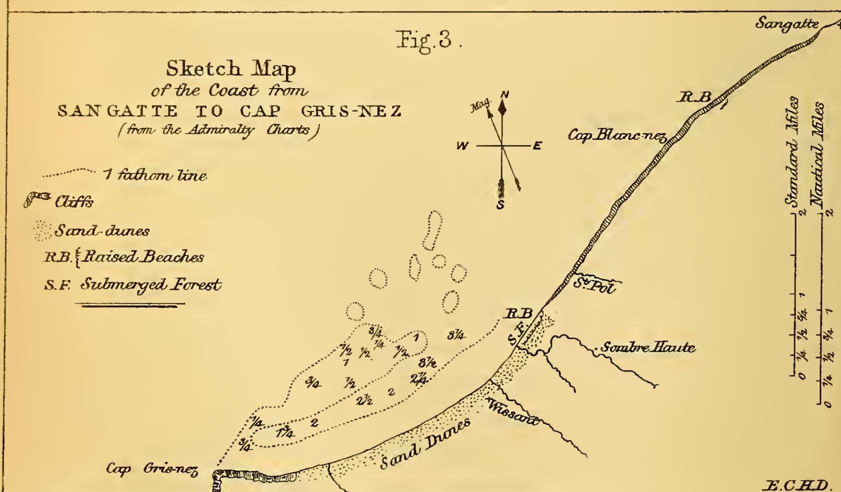


Fig. 3.



F. Dangerfield lith:

ANCIENT BEACH & SUBMERGED FOREST, NEAR CALAIS.

In conclusion, I can only reiterate the hope that now that I have drawn attention to the subject, some more competent Geologist will devote more time than I was able to afford to the thorough examination of this interesting field of enquiry. If my hastily-made observations be found accurate, I shall be glad of the confirmation; if they are otherwise, then the sooner they are corrected the better I shall be pleased.

Note.—Since the above was printed, I have accidentally met with a notice "On a Recent Marine Accumulation at Boulogne," published in the Proceedings of the Geologists' Association. The author, my friend Mr. Rose, F.G.S., of Yarmouth, therein states upon the authority of the late M. Bouchard, that "there appears to have been a subsidence of this part of the French coast since the Roman period;" the supposition being founded upon the present position of works constructed during the Roman occupation of Gaul. This observation, therefore, affords me most unexpected corroboration of my conjecture regarding a possible subsidence of the Wissant district within even very recent times.

EXPLANATION OF PLATE VII.

Fig. I.—Section of Recent Formations on the coast, near Wissant.
1. Sand; the base of the dunes.
2. Layer of vegetable mould (3 inches thick), absent in places.
3. Sand (12 inches), apparently similar to that of the dunes.
4. Peaty-stratum (12 inches).
5. Patches of greenish sand; capping
6. Shingle of rolled flints and chalk-pebbles; resting on Gault and Lower Greensand.
7. Ancient Forest; probably a continuation of No. 4.

Fig. II.—Diagrammatic Section of the Raised Beach, etc., near Sangatte.
1. "Head" of angular flints, etc.
4. Chalky débris; with
4′. Slight beds of coarse gravel here and there in the mass.
5. Greenish and brown sands, stratified and associated with layers of fine gravel.
6. Ancient Beach; resting upon Lower Chalk.

N.B. The same Nos. are applied in these two Figs. to the beds of the one series, possibly of contemporaneous origin, with those of the other.

Fig. III.—Sketch-map of the coast between Sangatte and Cap Gris-nez, to show the position of the Raised Beaches, etc. (Copied from the Admiralty Chart, Sheet XIV., 1836.)

V.—On a Raised Beach and other Recent Formations, near Weston-super-Mare.

By E. C. H. Day, F.G.S.

I CANNOT refrain from adding, as a supplement to my remarks upon the Raised Beaches in the Pas de Calais, a few rough notes upon a similar formation, examined by me some years since, in Birnbeck Cove, near Weston-super-Mare. The distance apart of the two localities may seem to render this association of the descriptions uncalled-for, but a similar feature in each case makes a comparison between them interesting.

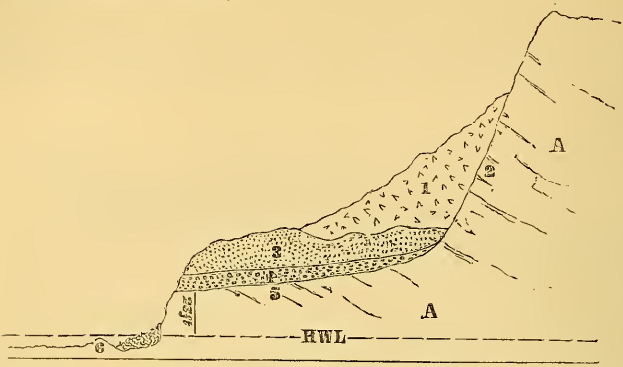


Fig. 1.—Diagram of a Raised Beach, etc., near Weston-super-Mare.

1. "Head." 2. Ancient Cliff. 3. Ancient Dunes. 4. Ancient Beach. 5. Ancient Shore. 6. Present Beach. A.A. Carboniferous Limestone. H.W.L. High-water Level.

Birnbeck Cove, immediately to the north of Weston-super-Mare, is bounded by a cliff of Mountain Limestone and Trap-rock (fig. 1). At about 25 feet above the level of the highest tides a bed (from 3 to 4 feet thick) of old water-worn shingle rests upon this cliff. About the time that I examined it, a large mass of the underlying rock fell, and masses of the conglomerate were brought down upon the present beach. The materials of these were so firmly cemented together, that it required violent labour with heavy tools to break them up; a process that was very destructive of the numerous bones imbedded in them. These bones included, I remember, limb-bones of ruminants and their teeth, also a few teeth of carnivora; but the most abundant remains were the teeth of a small species of horse.[1] It was suggested at the time that this accumulation might be an infilling of a fissure, but the shingle which composed it is as much rounded as that upon the present beach, which occupies a situation very similar to that of the ancient one. Moreover, there occurred in the conglomerate numerous shells of *Litorina* (*L. litorea* and *L. litoralis*) and a few of *Tellina tennis*, all forms at present abundant on the coast. My own impression at the time was not only that it was a genuine Raised Beach, but that it was probably coeval with that of Brighton,—in which likewise were obtained the bones of a small species of horse.[2]

[1] The bones then obtained from this deposit were in the possession of the late Dr. Tomkins and of Charles Pooley, Esq., both of Weston, and some in my own. I have still a few of the teeth. Amongst my specimens is one tooth of *Hyæna-spelæa*, the Cave Hyæna. Mr. Pooley, if I remember rightly, also obtained some flints from the conglomerate—a remarkable fact, as no such flints are to be found anywhere in the neighbourhood, at the present day, unless artificially imported.

[2] On examining the fossil remains of horses in the British Museum, I find two very

Over this Raised Beach is a mass of blown sand, precisely similar in character to that now accumulating, within the distance of a mile or two, at the bottom of the neighbouring bay. The road from Weston to Kewstoke passes partly through this sand, and partly through an extensive mass of angular "head" that rests upon it, and forms a talus at the foot of an ancient and now inland cliff. In this instance we see that after the Raised Beach was formed, in a similar position and under similar conditions to the present one, a slight elevation must have occurred, during which the Sand-dunes were heaped upon it; and that, subsequently, quantities of angular fragments were dislodged from the upper cliff and piled upon the dunes. The fact that these angular fragments do not occur scattered throughout the sand is important, because it tends to show that the head is not an accumulation of all times, but one belonging to a distinct period, when some agency was in action which was not so in the Saud epoch. Whether that agency be still in force may be doubted; the head probably is slightly increased by the occasional dislodgement by frost of blocks from the cliff, even at the present day; but I am inclined to think that the bulk of the mass is decidedly the result of the same power, in much greater activity during a former period, intervening between our own times and that of the Sands. If this be the fact, then the formation of the present Sand-dunes in Kewstoke Bay is, at least partly, subsequent to the accumulation of the head, and we have thus here two sets of dunes, just as we have in Cornwall and in the Bas Boulonnais, the ages of which are separated by a marked interval of time. The uniformity of these successions at spots so far removed from each other deserves at least a passing notice.

Another point of interest in the Weston Raised Beach is its level relatively to the lowest of the ossiferous caverns of Somersetshire. Of all the bone-caves yet explored in the neighbourhood, the one situate nearest to the level of the sea is that of Uphill, two miles from Weston. It is placed, I should say (speaking from recollection) at about 40 feet above the present high-water level (fig. 2). Assuming that this den was occupied by the Cave-fauna contemporaneously with the formation of the Raised Beach, it must at that

distinctly-marked forms of teeth from the Kent's Hole Cave, the smaller of these are identical with those from the Weston Raised Beach. They may be the teeth of Professor Owen's *Asinus fossilis*, the fossil Ass or Zebra (*v.* Brit. Foss. Mammals, p. 397, fig. 158). The only carnivorous teeth from this beach in my possession is one of *Hyæna spelæa*, the Cave Hyæna, and one of *Canis vulpes*, the Fox. The occurrence of so many remains of the horse in this deposit reminded me of an anecdote told me by the late Mr. Atkinson, the celebrated Oriental traveller, of the cunning with which wolves will avail themselves of the physical difficulties of a country the more speedily to run down the horse. The pursued and pursuers being well matched in speed, the latter so arrange themselves that they gradually turn the frightened animal towards the nearest morass. Once therein, his speed is slackened, and his enemies have time to gather themselves up for the fatal spring. May not the instinct of the wolf of bygone days have prompted him to use the ancient cliff, as his Siberian successor does the marshy ground, as a means of more surely and swiftly reaching his prey? The terrified horse was driven to the edge of and over the precipice, which his foes then descended at their convenience to feast upon the mangled carcase.

time have been within 15 feet of the sea-level; and we have, in this instance, corroborative evidence of the truth of such an inference.

FIG. 2.—DIAGRAM OF CAVES AT UPHILL, NEAR WESTON-SUPER-MARE.
A.A. Carboniferous Limestone. B. Hyæna den. *a*. Accumulation of Cave-bones. *b*. Blocks of Limestone wedged into *c*. Chimney passing down to C. Lower Cave. *d*. Clay containing human remains. *e*. Bed of sand. *f*. Recent "Head" concealing *g*. Entrance.

Beneath the old den there is at present, at very little above spring-tides, a second, larger and much more commodious cave (fig. 2, C). The latter, though containing human remains and the bones of animals of the human period, embedded in clay (*d*), and here and there covered with Stalagmite, contains no fossil remains either in this clay, or in or beneath the bed of sand (*e*) that underlies it. The mouth of the cave (*g*) was closed, when first discovered, by a mass of head (*f*); but it was not this that prevented its occupation during the Cave-epoch; since this accumulation (which, it is worthy of remark, is in appearance more recent than that on the Kewstoke Road) must have been formed subsequently to the introduction into the chamber of Roman coins. The reason why this lower cavern was not occupied at the time of the formation of the Raised Beach and of the occupation of the den above, was of course that it was at that time under water; but when the elevation took place which accompanied the accumulation of the older Sand-dunes, then this cave was likewise brought up dry and partially filled with similar drifted sand. This correlation, I think, proves that the land, at the time that the cave-animals occupied this country, was at a slightly lower level than at present. Such an alteration of level, although not amounting to more than 20 or 30 feet, would however have greatly modified the character of the district; as it would have been quite sufficient to depress beneath the sea all the extensive flats that now so widely border this coast.

It will be evident to the reader that the Raised Beach at Weston deserves more attention than has as yet been bestowed upon it, especially in the identification of the remains found in it. I may add that if the student wishes for a fuller description of the Uphill Caves as they were when first explored, he will find such in Rutter's

"History of Somersetshire," the work from which many of the facts above stated were derived.

NOTE.—A curious circumstance in connexion with these caves, though not exactly relevant to the subject of the present paper, is the existence of a pipe or chimney, passing from the lower to the higher one. The opening of this passage above was filled up by blocks of Limestone wedged together in such a manner as to form the floor of the den above, so that it was upon them that the remains of the extinct animals were found. These loose blocks were removed by the first explorers of these caves, and it was by way of this "chimney" that the lower chamber was first entered, the outer entry beneath the head being discovered subsequently.

Had an earthquake shock in modern times dislodged the floor of the hyæna den, its contents would have been scattered over the human and recent remains and the Roman coins below. Such a simple case of "false" super-position might not have misled an acute observer; but had the convulsion been accompanied by a temporary irruption of the sea, or by a permanent depression of the coast line, (either combination of events being by no means improbable) then the entire contents of the cave, ancient and modern, would have been disturbed, washed about and intermingled in such a manner as altogether to conceal the true history of the confused mass. Such a case may not be expected to occur in the British Isles, but cave-explorers in less favoured countries, where earthquakes and changes of level are of frequent occurrence, would do well to bear the suggestions of this instance in mind. Neither, it must be remembered, will the state of preservation of the bones, under such circumstances, always give certain evidence as to their age; for in this same cave I met with recent bones, some in the sand and some in the clay, of which the former had lost the greater part of their animal matter, whilst the latter were almost as fresh as if yesterday thrown out of the kitchen.

NOTICES OF MEMOIRS.

QUARTERLY JOURNAL OF THE GEOLOGICAL SOCIETY OF LONDON. VOL. XXII. PART I. FEBRUARY, 1866.

THIS Number of the Journal does not contain such a long list of original articles as did the last, which contained more than twenty original papers on various interesting topics, while this number contains but five, one on Foreign Geology, the rest on the Tertiary and Post-tertiary Geology of Great Britain. Mr. Godwin-Austen gives a description of the submerged forest-beds of Porlock Bay, showing what light they throw upon the minor oscillations to which our island has been subject in the more recent periods. The Rev. R. Boog Watson discusses the origin of the "parallel roads" of Glen Roy, advocating the Marine Theory, in opposition to the

Ice-dam Theory supported by Professor Agassiz and Mr. T. F. Jamieson. Dr. Duncan describes some spaces formerly occupied by selenite in the Lower Eocene Clays of the London Basin, giving some valuable remarks on the origin and disappearance of the mineral; he comes to the conclusion that the occurrence of selenite in a deposit proves the former existence of organisms in it. The Rev. O. Fisher endeavours to prove the superposition of the Norwich Crag to the Chillesford Clay, as exhibited in the section at Thorpe, near Aldborough. Captain Godwin-Austen's paper on the Carboniferous Rocks of Kashmere, with notes on the Brachiopoda, by Mr. Davidson, of which an abstract appeared in the former number of the Journal, is here printed in full, with two plates of the fossils executed by Mr. Davidson.

An abstract of Part iii. of M. Barrande's "Défense des Colonies," a notice of the second volume of Dr. Bischof's "Elements of Chemical and Physical Geology," and a communication on Dr. Laube's "Brachiopods, etc., of the St. Cassian Beds," conclude the number.

REVIEWS.

I.—Petroleum and Oilfields and Oil-Discoveries in their Geological Aspect.

1. Derrick and Drill; or an Insight into the Discovery, Development, and Present Condition and Future Prospects of Petroleum, in New York. etc., etc.[1]
2. Geology, Oil Fields, and Minerals of Canada West, etc. By Henry White, P. L. Surveyor, Toronto.[2]

MINERAL pitch and pitchy fluids issuing from the earth, have been known from the earliest times of history. From the date of the bituminous bricks of Babel to our own oily era, bitumen and its derivatives, or its allies, have been used, here and there, and now and then, for one purpose or another: a building material in the ancient East, an embalming agent amongst the Egyptians, a medicine amongst the civilized and the uncivilized; its more general utility has shone forth at all epochs as an illuminator. In almost every quarter of the globe this mineral has been found to occur; it still flashes over the surface of the ground from

> ———"those fountains of blue flame
> That burn into the Caspian,"—

where it was formerly deemed sacred by the fire-worshippers of Western Asia; whilst for ages it has been largely obtained in the Birman Empire. The horrors of the Dead Sea included Asphalt in their list, and France and Italy, Germany and England, Russia and the Island of Trinidad, all swell the roll of localities in which free bitumen, under one form or other, has been found. But it remained

[1] Second Edition. New York: James Miller, 1865; London; Trübner & Co.
[2] Toronto: W. C. Chewett & Co., 1865; London: Trübner & Co.

for America—where, as has often been observed, Nature does everything upon the largest scale, and Man aims at accomplishing all things possible in the most extreme style—to exceed in its production of the raw material, and for Americans to excel in their application, and to rush in the maddest spirit of speculation into a commercial mania almost unparalleled in modern times. The most extraordinary feature of the story is that Nature has hitherto so far replied to the extravagant demands of the gamblers as to turn up for their benefit a series of prizes such as would never have been dreamt of by the most sanguine enthusiast. On the borders of the Pacific, the remote Californian has a rich supply of bitumen, welling up in his region;[1] and, to look across a hemisphere, we hear from Australia of "Petroleum" Coal Seams, which, though probably not coming within the strict limits of our subject, yet show that our Antipodean relatives are fully alive to this world-wide subject, and are not unlikely to discover the free mineral.[2] The value of these natural materials brought home to us have caused their more full recognition upon our own soil; and in addition to the long-known, and not long since much-discussed,[3] manufacture of artificial oils from bituminous shales and coals, we now learn, from recently published accounts, of "Petroleum in North Wales."[4]

To convey anything like an adequate idea of the extent of the natural supply of the crude material, and of the commercial importance of their derivatives, would carry us beyond the scope of the present article, which has for its object to consider the production of free bituminous substances in its purely geological aspect. We must therefore refer our readers to "Derrick and Drill," and to Prof. Draper's most interesting paper in the Quarterly Journal of Science[5] for statistics, and the perusal, we can assure them, will well repay the research.

In spite of the touches of exaggeration that are sure, especially amongst Americans, to accompany the history of such a really wonderful commercial discovery, and of its unanticipated results, the general reader will find that the actual facts of the case are full of information and interest, and in "Derrick and Drill" these are conveyed to him in an amusing and readable form.

But with all the abundance of bitumen and bituminous fluids, and the ubiquity of their occurrence, we may search volumes in vain for anything like satisfactory information as to its geological history. The *scientific* geologist who would warn his *practical* brother from fruitless efforts in search of coal, or wishes to point out to the explorer where he may hope to find a supply of subterranean fuel,—be it lignite, ordinary coal, or anthracite,—has something more to depend upon for his statements than the mere empirical

[1] The Resources of California; Hittell, p. 63.

[2] *Sydney Morning Herald*, Sept. 7th, 1865.

[3] In the celebrated trial of Young *v.* Fernie.

[4] *The Railway News*, Nov. 25th, 1865, quoting from *Ryland's Iron Trade Circular*, Nov. 11th, 1865.

[5] No. V., January, 1865.

knowledge that these have or have not been found in such or such a locality. Stratification aids him; Carboniferous Rocks indicate a great probability, the presence of Oolites a possibility, of Coal; whilst Tertiary beds may contain a more or less valuable substitute. But Bitumen and Naphtha and Petroleum set all calculations hitherto made at defiance. They may be bored into in a Palæozoic region, far below any coal-bearing rocks, or they well up through Tertiary strata; Shales may be impregnated with them in the Silurian, the Devonian, or the Oolite Formations; the mineral oil may exude slowly and cold from the cells of a most ancient coral, or boil up, and cooling form a recent rock. So multitudinous are the modes of its occurrence—so baffling, at first sight, are its associations with rocks of all ages and all kinds; so concealed are its hidden sources, if apparently of recent origin, or so utterly lost, if of ancient date,—that it is scarcely a wonder that geologists have allowed it to remain a known but an unexplained existence; that, at the best, but hazy ideas of the truth have been thrown out, amongst a host of most unnatural theories. For sundry examples of the latter we must refer the reader to Mr. White's little work;[1] though, we regret to add, that the theory which that author suggests to replace them is by no means more scientific or even comprehensible. *Chemical Agency* is a very safe expression; but the assumed existence of "*hippuric* acid," of "almonds, or other Benzoic acidulous food," and of the constituents of mammilliary (*sic*), and other remains of sedimentary organism in Palæozoic Strata, would be simply laughable, if it did not appear to be scientific (!) *quackery.* The only object of the whole farrago of nonsense appears to be to make people believe that oil-wells in general, and Canadian ones in particular, are inexhaustible—a view that is contrary to the opinion of those who have disinterestedly studied the statistics of the American oil-fields.[2]

Two theories have met with more favour than others, and of these two, it appears to us that the least tenable has obtained the most and best supporters. A theory, which, to account for the presence of Petroleum in Silurian or Devonian strata of undoubtedly marine origin, assumes that the remains, not merely of sea-weeds but even of molluscous animals, may be converted into bitumen similar to that derived from the mineralization of the higher plants, "must give us pause," though it be supported by the names of Dana and Logan. The best evidence adduced in favour of the view that fluid bitumen is the result of a "special mineralization," of even vegetable remains, that of Mr. Wall, in his remarks on the Geology of the Island of Trinidad, appears to us to be defective; for though that writer implies that the beds of vegetable matter undergoing conversion by chemical reactions, at the ordinary temperature, and under the normal conditions of climate, become a solid bitumen identical with the fluid of the "pitch-lake," yet, we fail, on referring to the original paper, to see the connection between the one and the

[1] Oilfields of Canada, etc., p. 62.

[2] *Vide* Logan, Geological Survey of Canada.

other. They *may* be different portions of one and the same phenomenon, but are there no differences between the chemical reactions which at first, by a special mineralization, convert vegetable matter into solid bitumen, *in sitû*, and which are also assumed to convert this same bitumen into a fluid again at the normal temperature, to cool once more to the solid form? It appears to us that, as far as any proof is contained in Mr. Wall's paper, the source of the fluid pitch may not lie at all in the stratified vegetable seams seen near the surface, but in some far more deeply seated deposits, and that the writer may have been misled by a similarity of appearance and a contiguity in position to assume identity of origin. We advance the doubt cautiously, and in the hope of obtaining more certain knowledge on the point. Mr. Wall's evidence, when made clear, must be regarded as of more than ordinary importance, as it seems to be the best stone in a structure that otherwise appears to stand upon a ricketty basis. The theory, as applied to the sources of Petroleum in North America, appears to have resulted from difficulties in making all the circumstances of the case agree with another and far more simple hypothesis. A "special mineralization," or "fermentation" theory, to include both animal and vegetable substances, according to need, in its operations, was therefore built up to replace a "distillation" theory, which, though well based, seemed at first sight incapable of explaining enough. It has long ago been suggested that free bituminous products, more especially those which rise to the surface as oils, are the results of a natural distillation of bitumen-containing substances, such as lignites and coals, by the action of the heat of the interior of the earth. Now, considering that bituminous products can be obtained artificially from such substances by heat, and that Coal-beds, after their formation, must, in very many instances, have been buried beneath enormous accumulations of later date, and consequently have been exposed to a great increase of temperature, there is a *primâ facie* case in favour of this view. In anthracites we have further witnesses in support of it, for these are coals which, having been exposed to the supposed conditions, have parted with their contained hydro-carbons. Such being our case, let us cross-examine the witnesses against it. It has been said that the products of a natural and of an artificial distillation of coal should be identical, which they are not; but this objection is of no value, since man and nature work under such dissimilar conditions, that the utmost we can expect is a similarity, far from an identity, of results. Geological proof is given that Petroleum occurs in localities far distant from any yielding coal,—in rocks far older than any known to contain it,—and that the strata in which it has been found have, to all appearance, never been heated. The last is evidence actually in favour of the distillation theory; for the Hydro-Carbons having been driven off from beds at a high temperature, must have been condensed in strata which remained cool, and if such strata were subsequently heated, they would have to give off again the bituminous products which they had temporarily retained. But, say the objectors, the Petroleum reservoirs are frequently in rocks older, and therefore inferior, in position to the lowest known Coal-measures, and if the latter had been heated, the former must have been more so. This objection assumes that the condensed substances are found now on the very spot where they were originally distilled. But, suppose distillation to have taken place in the heated and upthrown Coal-measures now forming the Appalachian Chain, the distilled products would have found their way down the subterranean slopes of the colder rocks, flanking the actual site of disturbance, until penetrating cracks and fissures, they found a permanent resting-place upon an impervious series of unheated rocks, far distant from, and quite possibly below, in geological position, the Carboniferous strata from which they had their origin. We may even imagine a case, where the vapours and oil, retained for a time in higher rocks, may, when a cooling of the beds below occurred, have drained downwards through the very strata from which they had been expelled, into reservoirs below; or, again, products driven off from a disturbed region, may have drained away to a position below an unaffected series of Coal-measures. We must remember, too, in connection with this subject, the probability, nay the certainty, that immense masses of carbonized vegetation may have been denuded from localities where we now find oil, but neither coal nor lignite. Many corroborative items of evidence in favour of, or at least not inconsistent with, the distillation theory, will occur to the investigator of the subject; as, for instance, the nature of the ground in which the oil is found, the very rifts and fissures into which the boring rods fall being the ancient drains by which the Hydro-Carbons found their way from the great natural stills to the permanent receivers.

To sum up the evidence in favour of either of the two theories; the case to our mind stands thus,—That *vegetable* matter, in becoming bituminized, or converted into lignite and coal, undergoes processes of mineralization varying according to the diverse conditions in which such vegetable deposits may be placed, we admit; but further proof is required to show that any such special mineralization will produce free bitumen. Still less are we inclined to admit, without anything save conjectural hypothesis to support the view, that the remains of animals may be so converted. On the other side, it is a fact that Hydro-Carbons may be derived from pre-existing bituminized substances; and, so far from seeing physical and Geological objections to this view, it appears to us that the circumstances under which free bituminous substances are described as occurring in Nature, are not merely not inconsistent with such an origin, but actually, in some cases, such as we should *à priori* expect. Let us be clearly understood. The chemical action which reduces vegetable substances to a carbonized state may, *possibly*, under favourable circumstances, be carried on to a second stage, and liberate Hydro-Carbons from the results of the first. *Possibly* the conditions may be such that the chemical action of the first stage is so energetic as to develop in itself an amount of heat sufficient for the accomplishment of the second. Mr. Wall's remarks, above quoted, at the utmost, imply no more, and we are, by them, left in the position that we have taken up,—that bituminous substances are derived from accumulations of previously carbonized *vegetable* substances. If any such deposits are known, or if there is a probability of such beds having existed, and having been destroyed, in the neighbourhood of bitumen- or petroleum-yielding districts, it surely is more in accordance with the rules of inductive philosophy, and more safe in practical investigations, to construct our hypotheses upon such known facts than upon the possibility of these substances having been derived from the decomposition of animal remains. Acknowledging fully the difficulties of the subject, we would yet

———" rather bear the ills we have,
Than fly to others that we know not of."

With respect to bituminous shales, or pyro-schists, in which the Hydro-Carbons exist in such intimate connection with the earthy constituents of the rock, as to require distillation to set them free, it is easy to conceive that, when they first became impregnated with bituminous vapours, or oils resulting from a natural distillation, they were placed under such circumstances as favoured a chemical action in the substances introduced into the matrix, resulting in their solidification within its pores. Where no such chemical action was set up, the association between a rock and the distilled products it contained, was, as before assumed, of a purely hydrostatical nature.

It may be said, at first sight, that both the given theories are equally inadequate to assist the practical man: that, according to either, bituminous substances may be found impregnating the earth anywhere, or in any formation. But a little reflection will show the thinking Geologist that if he makes himself thoroughly acquainted with the structure of a district, and with its internal history, he will, supposing the distillation theory be a correct one, have some means of ascertaining the possibility, and even the probability, of free Hydro-Carbons existing therein. Their presence, in the first place, would depend upon the existence, at some time or another, of coal or lignite, either in that region or in one adjoining; and, secondly, the hope of determining the actual position of reservoirs will depend upon our power of comprehending the conditions of the subterranean drainage at the time of the supposed distillation. The presence of anthracite should, under this view, induce an examination of the subterranean structure of the surrounding districts, as such an examination might tell us whether there was a probability of the lost Hydro-Carbons of the anthracite being stored up within accessible reservoirs, or the contrary.

Any practical results of the acceptance of the distillation hypothesis, under the very difficult circumstances in which the enquiry is placed, may seem remote; but cases may arise where it would be advisable for the practical man to remember that the hypothesis of Bitumen, or Petroleum, having arisen in some instances from a "special mineralization" of animal remains, is a doctrine by no means generally accepted, and most certainly containing nothing in it upon which to base either a scientific or commercial investigation. —E.C.H.D.

II.—A Description of some Fossil Plants, showing Structure, found in the Lower Coal-seams of Lancashire and Yorkshire. By E. W. Binney, F.R.S. Phil. Trans., 1865, pp. 26, vi. tab.

ADDED to his ardent devotion to the study of the vegetation of the Coal Measures, Mr. Binney has the most abundant opportunities of obtaining the best specimens, and examining these in the localities where they occur. His delight is to collect with his own hands the fossils from the beds that contain them. Wherever a miner can crawl to his work Mr. Binney will follow, if it is to add anything to his extensive acquaintance with the Carboniferous Flora. To have such enthusiasm, and such opportunities, is a rare combination, and one which should be productive of valuable results to Science. That it has been so every geologist is aware; and we have now before us a further contribution to our knowledge in this paper, extracted from the last part of the Philosophical Transactions.

In a paper recently published in our pages,[1] Mr. Carruthers described some of the peculiar fruits belonging to the Carboniferous vegetation, and Mr. Binney here figures and describes some stems which exhibit a remarkable, and, indeed, anomalous, structure. He confirms and adds to the observations of Witham, Brongniart, and Corda. The specimens were found in calcareous nodules dispersed throughout the seams of coal. They are referred to two species, *Diploxylon cycadoideum*, Corda; and *Sigillaria vascularis*, Binney. The *Diploxylon* is Witham's *Anabathra pulcherrima*, a name though not very elegant, yet very characteristic of the tissue of which it is chiefly composed, and which, according to the universally accepted law of priority, should supersede the newer designation of Corda. Mr. Binney's specimen, which is carefully figured by Fitch, exhibits no true cellular structure. The centre or "pith" is composed of what, in the cross section, looks like large cells, but the longitudinal section (Plate xxx. fig. 5*a*, and Plate xxxiii. fig. 1*a*) shows them to be true vessels with scalariform structure, as Mr. Binney describes them. Scattered through this core are some vessels having a smaller diameter, and well marked transverse bars, which the author considers to be septa. The core is surrounded by a compact cylinder of woody scalariform tissue. Bundles of vessels traverse this cylinder, very gradually ascending in their progress outwards, and evidently connected with the leaves borne on the surface of the stem. We can see no evidence of the existence of any cellular structure that can be called a medullary ray. Surrounding the woody cylinder is a space represented on the plate as without structure, and described by Mr. Binney as "composed of large cellular tissue, and traversed by vascular bundles, frequently disarrranged or destroyed, and replaced by mineral matter." Outside of this there is another cylinder of woody tissue, perforated by the vascular bundles which have been traced through the inner woody cylinder and the amorphous mass surrounding it, and which are now seen to

[1] Geological Magazine, Vol. II. p. 433, Plate XII.

terminate in the leaf scars on the outer surface. The figures and descriptions of *Sigillaria vascularis* exhibit a structure precisely similar.

The affinities of these stems to any living organism are not very obvious. The large mass of cellular tissue—supposing that the amorphous cylinder represents original cellular structure—with the cylinders of wood, remind one of such fleshy trunks as those of *Cactus* and *Cycas*. Indeed, the arrangement of the tissues in *Cycas* is nearer to that of *Sigillaria vascularis* than anything else with which we are acquainted. In the stem of *Cycas revoluta*, Thunb., there is a large central pith composed of true cells, surrounded by a woody cylinder; then a layer of true cells, followed by a second series of woody tissue, and this is surrounded by a thick external parenchyma, traversed by fibrous bundles, which extend to the bases of the leaves. There are, however, large and numerous rays of cells, or medullary rays, passing through both the woody cylinders, and uniting the three series of cellular tissue. These are obvious in every section which one makes of the woody portion of *Cycas revoluta;* but, as we have already said, we cannot detect anything like medullary rays in the admirable and evidently faithful drawings which accompany Mr. Binney's paper. The want of the medullary rays, the passage of fibrous bundles through the woody cylinders, and the striking scalariform tissues, would incline us to look for the affinities of *Anabathra* and *Sigillaria* among the Lycopodiaceæ, or the allied orders to which the *Lepidostrobi* and *Flemingites* undoubtedly belong.

III.—The Fauna of the Lower Oligocene Tertiary Beds of Helmstadt, near Brunswick. By Dr. A. v. Koenen.

[Die Fauna der unter-oligocänen Tertiärschichten von Helmstädt bei Braunschweig. Von Dr. A. v. Koenen. Zeitschrift der deutschen geologischen Gesellschaft. Jahrg, 1865, pp. 459-533. 2 plates.]

Dr. Von Koenen is one of the hardest known workers at Tertiary fossils, whether in the field, the museum, or the library. The results of his labours are arrived at slowly, but no doubt possess the compensating quality of stability. At any rate, all who know our learned and enthusiastic author retain and record his statements and opinions, apparently with a wonderful amount of faith in his judgment. But Dr. Von Koenen is a German, and a strong upholder of Professor Beyrich's Oligocene system. In England, we are accustomed to Eocene, Miocene, and Pliocene; and without some very strong and easily grasped reason, we should be loth to interpose the Oligocene division between the two first-named groups. The philosophy of Tertiary classification is at present beyond our ken; and as we are so wedded to tradition and precedent, it probably will continue to be so for the next ten years. Nevertheless, we have the satisfaction of having heard a Wollaston medalist call the Scaldisien of Dumont Lower Kainozoic, showing, that in his mind at least, a most radical revolution is in progress.

In this pamphlet, Dr. Von Koenen endeavours to show that the division of the Tertiary system into Eocene, Oligocene, Miocene, and Pliocene, is the most philosophical, and the most convenient. He also discusses a number of incidental questions, including the age of the Tertiary sands on the North Downs, which he believes to be of Pliocene age, as they contain no typical Miocene fossils, but several species peculiar to the Upper Crag.

Besides the immediate object of his paper, Dr. Von Koenen's great point is to show that Dr. Giebel's description of the fossils from the Brown-Coal of Latdorf is both defective and inaccurate. He says that Dr. Giebel knew of only 180 species from that formation, while he possesses three times the number; and of the 65 species figured by Dr. Giebel, more than 30 are considered to have been incorrectly determined.

The author then describes 122 species of Mollusks from the Helmstadt beds, of which 98 are known to occur in Lower Oligocene deposits, 31 in Upper Eocene, and 30 in Middle Eocene. Six corals have been determined in these beds by Dr. A. Roemer, and of the shells, 17 are peculiar to this locality. Dr. Von Koenen's researches have led him to the conclusion that we must expect to find species considered characteristic of the Lower Oligocene fauna in beds of widely different ages occurring in distant districts.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. January 24, 1866.—W. J. Hamilton, Esq., President, in the chair. The following communication was read:—"Notes on Belgian Geology." By R. A. C. Godwin-Austen, Esq., F.R,S., For. Sec. G.S.

This communication related to the Upper and Lower Kainozoic formations of Belgium, in the following order:—1. The Polders, or sea-mud beds, and their equivalents. 2. The Campine sands, and Lös, or Limon de Herbaye. 3. The Boulder-formation. 4. Cailloux Ardennais. 5. The Lower Kainozoic, or Crag.

The Polders, which form a belt along the sea-board of Belgium and Holland, occasionally running inland up the courses of rivers, as up the Scheldt to Antwerp, indicate an elevation of very small amount, corresponding to the raised estuarine and other beds around our own coasts. They are covered by dunes and drifted sands. A great deal of the fen-land at higher levels, with peat and bog-iron, belongs to the age of the Polders, and of still earlier times, inasmuch as the Polders very generally overlie a terrestrial surface. The Campine sands, which run parallel with the coast from North Holland towards Antwerp, but within the Polder-belt, were conjectured, from their composition, and on other considerations, to have been derived from sands carried inland away from dunes of the Boulder-formation period. The Lös, which is of freshwater origin, resulted from the annual depositions of melted snow-waters. The dispersion of the Cailloux Ardennais was referable to another and earlier stage of a period of cold, and when the axis of the country had a greater relative elevation than at present. These views were supported by reference to the Coast Section at Sangatte.

The Boulder-formation proper is only slightly represented in some of the sections about Antwerp.

With respect to the Lower Kainozoic series, the author preferred the divisions proposed by M. Dumont (Scaldésien and Diestien) to the minute subdivisions of Sir C. Lyell and M. Nyst. The exceedingly narrow vertical dimensions of the Crag, and the manner in which, along the continuous sections now exposed, one bed of the Scaldésien Crag replaces another, are new facts, and preclude any systematic order of sequence, founded on percentage comparisons, from local assemblages of fossils.

The Antwerp Crag series presents two conditions of sea-bed, a deepish-water and life-zone formation, corresponding to the ooze-depths of existing seas; this is the Diestien of Dumont, or Lower Crag. On an eroded surface of this, there occurs, at Antwerp, an upper series of coarser sands, shingle, and gravel, together with much which has been derived from the lower; this is the Scaldésien. The change from one to the other indicates a change as to depth over the Crag sea, and the result has been an admixture of the characteristic materials of distinct sea-zones.

The original boundary line of the Crag sea is traced, as also the great breadth of the drift-sand zone, over the Belgian area; this,—coupled with the consideration that the Crag sea-waters on the continental coast-line nowhere came in contact with any beds older than Nummulitic, such as Tongrien and Bruxellien, even as high as Denmark, whilst on the English side, from Suffolk north, its coast-line was of chalk with flints,—indicates a closed sea on the south, as alone by such an arrangement could the flint-gravel be carried along.

The differences between the Crag-fauna of England and of Belgium were explained in acccordance with bathymetrical distribution. The Scaldésien beds of Antwerp contain an assemblage which is composed in part of a littoral fauna, and in part of that of ooze-depths. The Red Crag of Suffolk differs from the Scaldésien in its forms, as also from containing the materials of a Bryozoan zone.

The Bolderberg beds, which afforded M. Dumont his evidence in favour of his "Système Bolderien," were shown to have been wrongly interpreted, and to belong to the Crag-sea accumulations.

The following specimens were exhibited:—Miocene Corals from Malta; presented by Dr. P. Martin Duncan, Sec. G.S. Metamorphic rocks containing remains of plants, from the Alps; presented by M. Crescenzo Montagna. Specimen of *Sagenaria dichotoma* from the Clay Cross Coal Company's Mine, Derbyshire; presented by Mr. Soulby.

II. February 7, 1866.—W. J. Hamilton, Esq., President, in the chair. The following communications were read:—1. "On the mode of formation of certain Lake-basins in New Zealand." By W. T. Locke Travers, Esq. Communicated by Sir C. Lyell, Bart., F.R.S., F.G.S.

The author's observations had been chiefly directed to the neighbourhood of the Spencer mountains, which occupy the centre of the area constituting the Provinces of Nelson and Marlborough, in the Middle Island, and in this paper he more particularly described Lake Arthur, Lake Howick, and Lake Tennyson, with the rivers flowing out of them. After describing the nature and mode of occurrence of certain Post-pliocene boulder-beds overlying older Tertiary deposits in the vicinity of Lake Arthur, Mr. Travers showed that that lake owes its existence to the presence of a moraine nearly a mile and a half in width, and extending for several miles down the valley. Similar facts were then described as having been observed at Lakes Howick and Tennyson; and attention was specially drawn to their great depth, Lake Howick being 1000 feet deep rather less than half way up, and the others also attaining a depth of several hundred feet. The valleys of the Rivers Dillon and the Clarence present abundant evidence of the former existence of enormous glaciers in them, and these the author described in detail.

In conclusion Mr. Travers stated that, although he had confined his remarks to the lake-basins found amongst the spurs of the Spencer mountains, he firmly believed that all the lakes which lie in the valleys of rivers debouching on the Canterbury Plains owe their existence to moraine-dams which have the same foundations as the Post-pliocene shingle of which the plains themselves are formed; and that, therefore, the sites of those lakes were occupied by ice at the commencement of the period of depression, and so continued for some time after the re-emergence of the upper part of the plains above the level of the sea.

2. "On the occurrence of dead littoral shells in the bed of the German Ocean, forty miles from the coast of Aberdeen." By Robert Dawson, Esq. Communicated by T. F. Jamieson, Esq., F.G.S.

The occurrence of shells of *Purpura lapillus, Litorina rudis, Solen siliqua,* and *Mytilus edulis,* in a worn and semi-fossil condition, at depths of 36, 40, and 42 fathoms, on the bank known as "the Long Forties," seemed to the author, in conjunction with other and well-known facts, to point to a time, towards the close of the Glacial period, when the British islands stood higher above the sea than they do at present. The fact of four species having been found in the course of one day's dredging was, Mr. Dawson considered, sufficient to render it probable that they had lived and died where they were found, and did not owe their presence at that depth and distance from land to any mere accident.

3. "On the glacial phenomena of Caithness." By T. F. Jamieson, Esq., F.G.S.

The glacial drift of Caithness occurs in sheets filling up the low troughs and winding hollows which form the beds of the streams, the rocks on the higher ground being either bare or hidden by a growth of peat and heather. It thins out at altitudes of from 100 to 150 feet, and its thickness is therefore very variable, though it seldom much exceeds 100 feet. Mr. Jamieson first described the distribution of the drift beds over the area in question, their texture and colour at the different localities where they occur, and the nature and appearance of the stones and boulders found in them; he then noticed the broken state of the shells, the most common species being *Cyprina Islandica, Astarte borealis, A. elliptica, Tellina calcarea, T. Balthica,* and *Turritella ungulina.* The direction of the glacial markings on the rocks was shown to be pretty uniformly from N.W. to S.E. (true), so that it must have been produced by a movement of ice proceeding from an external region to the N.W., and not by glacier-action proceeding from the interior of the country, as is the case in the midland region of Scotland. The glacial drift of Caithness and the old boulder-clay of the middle of Scotland, resemble one another in their physical arrangement, but differ in the prevalence of marine organisms in the former; the absence of tranquilly deposited glacial-marine beds, of moraines, and of gravel-hillocks, and the deficiency of valley-gravel in Caithness, are also points in which the glacial series of that area differs from that of Central Scotland; and Mr. Jamieson inferred that, of the two series, the Caithness drift was the more recent. In conclusion, the author described the deposits of the Post-glacial period in Caithness, and showed that they did not differ materially from those occurring in the rest of Scotland.

III.—Annual General Meeting.—February 16, 1866.—W. J. Hamilton, Esq., President, in the Chair.

The Secretary read the Reports of the Council, of the Library and Museum Committee, and of the Auditors. The increase in the numbers of the Society, and the flourishing condition of the Society's finances were stated to be very satisfactory.

The President announced the Award of the Wollaston Gold Medal to Sir Charles Lyell, Bart., D.C.L., &c., in recognition of the highly important services he has rendered to the study of Geology by his various original works, and for the masterly and philosophic manner in which he has treated the subject, both in developing the principles and in expounding the elements on which the science is founded: and, in handing the Medal to that distinguished geologist, he more particularly dwelt upon the great influence the establishment of Sir Charles's percentage system of classification, and his division of the Tertiary strata into Eocene, Miocene, Pliocene, and Post-pliocene, had had in facilitating and aiding the study of Tertiary Geology; but he also showed how great had been the immediate influence of the "Principles of Geology" when first published, more than thirty-five years ago. Sir Charles Lyell, on receiving the Medal, expressed his gratification at the honour which had been done him by the Society, and remarked upon the increasing difficulty with which any single geologist could now keep pace with the progress of geology and its allied sciences. The President then stated that the balance of the proceeds of the Wollaston Donation Fund had been awarded to Mr. Henry Woodward to assist him in carrying on his researches on the Fossil Crustacea, and placed it, together with a diploma to that effect, in the hands of that gentleman. Mr. Henry Woodward briefly thanked the Society for this testimony of the interest they took in his researches, and referred to the greater advantages enjoyed by the younger palæontologists than had been within the grasp of their predecessors.

The President then proceeded to read his Anniversary Address, in which he discussed the progress of Geology during the past year, prefacing it with biographical notices of lately deceased Fellows, Foreign Members, and Foreign Correspondents of the Society, namely, Henry Christy, Esq.; Sir J. W. Lubbock, Bart.; Dr. S. P. Woodward; Lovell Reeve, Esq.; Nicholas Wood, Esq.; G. E. Roberts, Esq.; Dr. C. H. Pander; Prof. G. Forchhammer, and Dr. A. Oppel.

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.; Prof. T. H. Huxley, F.R.S.; Sir Charles Lyell, Bart., D.C.L., F.R.S.; Prof. A. C. Ramsay, 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:* 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.; R. A. C. Godwin-Austen, Esq., F.R.S.; William J. Hamilton, Esq., F.R.S.; Prof. T. H. Huxley, F.R.S.; J. Gwyn Jeffreys, Esq., F.R.S.; Prof. T. Rupert Jones; M. Auguste Laugel; Sir Charles Lyell, Bart., D.C.L., F.R.S.; J. Carrick Moore, Esq., M.A., F.R.S.; Prof. John Morris; 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, F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; Capt. T. A. B. Spratt, R.N., C.B., F.R.S.; Lieut.-Col. R. Strachey, R.E., F.R.S.; Rev. Thomas Wiltshire, M.A., F.L.S.

Edinburgh Geological Society. — I. 25th January, 1866; R. A. F. A. Coyne, Esq., C.E., in the chair.

1. Mr. John Young, of the Hunterian Museum, Glasgow, exhibited a beautiful of Carboniferous Entomostraca from the limestone and shales of the west of Scotland, and explained his mode of collecting and mounting those minute organisms. In a paper which he read on the subject, he stated that the Entomostraca, which belong to a family of small bivalve crustaceans, are common in certain beds from the bottom to the top of our Coal-measures. But some of the finer ornamented species are only to be found in the marine limestone shales. Certain oil shales in the Coal-measures seem to be made up almost exclusively of the bivalved coverings of these minute animals, and he (Mr. Young) often wondered

whether the oil, which many of the shales contained, might not have been partly due to the enormous quantity of these minute crustaceans that died in these beds. This idea, he said, was not new, for several Geologists had stated that the bituminous and carbonaceous matter found in many rocks, had been due to the great number of organic remains that had been entombed therein. Of course, many rocks, full of fossils, contain no oil; but this may be entirely owing to the peculiar nature of the sediment in which the fossils are embedded, and to other causes acting upon the strata, allowing the organic elements of their bodies to pass away by percolation through the strata or otherwise, leaving us nothing but their hard skeletons. The question, therefore, of the oil in these Entomostracan shales being due to those animals, is one of considerable interest. Mr. Young then said that he had seen in summer, in certain states of the weather, large shoals of the recent species of this crustacean swimming about in the Glasgow and Monkland canal, their numbers actually making the water appear of a reddish-brown or mahogany colour; and by dipping in a wide-mouthed net among them they could be lifted out in thousands; but thickly as he had here represented them, in recent times, they must even have swarmed to a greater extent in many of the waters of the Coal-period, as their abundant remains in certain strata now clearly show. Many of the smaller fishes of the Carboniferous strata, seemed to have preyed to a large extent upon those minute crustaceans, as many of the fish-coprolites testify. In a fish-coprolite sent to him by Dr. Rankin, of Carluke, he found upwards of 300 specimens of a very rare species, *Cypridina Rankiniana*, of which only a single specimen had previously been found. If the fishes lived upon the Entomostraca, they, in their turn, seem to have preyed on the dead bodies of many of the fish as they lay on the sea-bottom. Mr. Young, in conclusion, gave a minute description of the twelve genera of Entomostraca, or Phyllopod crustaceans, that have been found in our Scotch Coal-measures.

2. Mr. E. A. Wünsch, of the Geological Society of Glasgow, then read a paper on "The Discovery of Fossil Trees buried in Volcanic Ash in the Island of Arran."

II.—1st February, 1866; R. A. F. A. Coyne, Esq., C.E., in the chair. The Society unanimously resolved to transmit a memorial to Government, praying for the establishment of a chair of Geology in the University of Edinburgh. Mr. D. J. Brown read a paper on "The Denudation of Upper Annandale, and the Erosion of 'The Devil's Beef-Tub.'"

Geological Society of Glasgow.—Monthly Meeting, January 11th, Dr. John Scouler, F.L.S., V.P., in the chair. Mr. William Cameron read a paper on "The Gold Drifts and Rocks of Victoria."

Granite is to be found in the vicinity of all gold-fields, cropping out in high ranges and upheaving the Silurian rocks; and it is generally near the junction of the granites with these that gold is most plentifully distributed. Ballarat has hitherto been the richest alluvial gold field; the phenomenon of gold in the matrix, however, he said, was much more interesting, and far more worthy the consideration of the Geologist than its presence in alluvial deposits. Quartz was the true matrix of gold. He had heard of its being found in sandstone, slate, and granite; but had never seen an instance of this, except when these rocks were somehow associated with quartz. The question as to how far gold may be profitably sought for in the matrix is of great importance. Sir Roderick Murchison, in his "Siluria," inclines to the belief that gold only exists in payable quantities on or near the surface; that the search for it in deep lodes will be unprofitable, and that it is only in the detritus of denuded hills, containing auriferous rocks, that it can be profitably worked. In reference to the preponderating richness of alluvial drifts, however, Mr. Cameron said that it must be borne in mind that when the denudations, which supplied these drifts, took place, a large proportion of the detritus was probably carried away for miles, whilst the gold, from its superior gravity, remained in the nearest depressions, where these drifts were also deposited, so that the present proportions of gold and drift afforded no correct index of the proportion which that gold orginally bore to the rocks in which it was held prior to the formation of these drifts. Any conjecture, therefore, as to the amount of gold still remaining in its native rocks, based upon the nature of its alluvial deposits, must be manifestly unreliable. In reference to the non-success of deep quartz mining in other countries he could offer no opinion; but in Victoria the reverse (where a fair trial had taken place), was generally the case, and the instance of non-success due more to the imperfect nature of the search than to the non-existence of the gold. Of the thousands of shafts that have been sunk in Victorian quartz reefs, perhaps not a dozen had been sunk to the 400 feet level, and at least three or four notable instances of success in sinking to that depth could be selected from the Bendigo district alone. He believed that the auriferous reefs of Victoria would, if properly prospected at these depths, prove, in many instances, quite as remunerative as on the surface; and experience seemed to show that in .all quartz reefs there were rich and poor levels alternately, and that where the surface veins had become exhausted it would be found that, by sinking still farther, the unproductive region would be passed, and that another, and perhaps another, series of rich veins be struck. He detailed the appliances now in use in Victoria for extracting gold from quartz, which were both extensive and very perfect; and, alluding to the various histories of discoveries of gold in this country, he thought it not improbable that, with these improved appliances, the gold mines of Britain might yet be worked to advantage.

II.—The second monthly meeting of this Society was held on Thursday, February 1st. Edward A. Wünsch, Esq., one of the Vice-Presidents, in the chair.

Mr. R. Whyte Skipsey read a paper on "The Fossil Shells of the Upper Coal Measures," which he illustrated by numerous specimens collected by himself from the Clyde Pits and other localities; from Parkhead and Shettleston eastward for about five miles to Bargeddie, and bounded respectively on the north and south by the Monkland Canal and the Clyde. Of these shells there are three genera—*Anthracosia, Anthracoptera,* and *Anthracomya*; of the first of which he had collected in the above district six species, of the second three, and of the third one, and their range, he said, is from the ell, down to the roof of the splint-coal, under which horizon they had not been met with as yet. Mr. Skipsey, after contrasting the shells from the Upper Coal Measures with *Myalina Verneuilli* from the Lower Carboniferous beds, referred to his own recent discovery of Lower Carboniferous forms at Drumpark, above all the seams of the Upper Coals, and said that he could not believe these belonged to a mere isolated fossiliferous bed, cut off by a gap of several hundred fathoms from any others containing homogeneous forms; but, on the contrary, when the excavations permitted further research, there would be found proofs of a succession of fossiliferous strata containing ocean types, and in searching the immediate neighbourhood he had already found both *Anthracosia* and *Anthracoptera*, and fully calculated in yet finding them at Drumpark, in close proximity with acknowledged Lower Carboniferous forms.

Rev. H. W. Crosskey read a paper on "The Relationship between the Fossils of the Glacial Beds of Canada and those of the Clyde," which he illustrated by a fine set of fossils from the former beds, presented to him by Principal Dawson, of Montreal, who, among his other great services to geological science, had very carefully investigated these beds. From his researches, and a comparison of the respective fossils, Mr. Crosskey stated that he found the difference between the fossil glacial shells of Canada and those now existing in the Gulf of St. Lawrence to be far less marked than the difference between the glacial shells of the Clyde and those now existing in the Forth. In the glacial beds of Canada only two species are found, which do not occur living in the neighbouring sea,—viz., *Leda Portlandica* and *Astarte Laurentiana*. The fauna in its general aspect, and in the proportions and characteristics of species, is slightly more Arctic than that of the Gulf, but does not present that broad contrast with which we are familiar in our local clays. The fossil species extinct in our present seas are far more numerous. In conclusion, Mr. Crosskey observed, that every discovery made by Mr. David Robertson and himself intensified the Arctic character of the Clyde beds, and it was very evident that the change of climate in Canada had been less complete than in Scotland.

Mr. John Young read a paper on "The Genus *Lingula*, and its occurrence in the Carboniferous Beds of Scotland."

Liverpool Geological Society—February 13th, 1866.—R. A. Eskrigge, Esq., F.G.S., in the Chair. The following papers were read:—1. "On the Geology of Sussex," by Mr. C. Potter. The author who formerly resided at Lewes) gave a description of the Wealden, Cretaceous, and more recent strata of the Forest-ridge and the surrounding country, including the coast. He alluded to the extensive iron-works which once existed in the district, and illustrated his communication by many beautiful specimens from his collection.

2. "On a New Locality for *Paradoxides Davidis* and associated fossils in North Wales," by Mr. R. A. Eskrigge, F.G.S.

In introducing the subject the author referred to the discovery by Mr. Selwyn, more than twenty years back, of a fragment of a large trilobite, apparently identical with the Swedish species *Paradoxides Forchhammeri.* But as it could never be satisfactorily determined where this specimen was found, its scientific interest was much lessened if not entirely lost, so that it long remained merely as a challenge to the zeal and activity of geologists, and it was not until 1863 that a true British locality was discovered for the genus. The merit of this discovery is due to the distinguished palæontologist, Mr. Salter, who, perhaps, more than any other deserved such an honour; and though partly the result of accident, it was also in great measure owing to that scientific acumen and insight which have so often led their possessor into the path of success. The place where it was found, is the now celebrated Porth-y-rhaw, near St. David's, in Pembrokeshire, whence the species has been named *Paradoxides Davidis;* and where, owing to the assiduous and able researches of Mr. Hicks and Mr. Salter, so rich a fauna has since been brought to light (see GEOLOGICAL MAGAZINE, Vol. III. p. 27).

Within two years another locality for *Paradoxides* was accidentally found by Mr. Readwin, of Manchester, at the gold-mines on the river Mawddach, near Dolgelly, a district subsequently well worked by Mr. Williamson; but neither of these is the place from which Mr. Selwyn's original specimen can have come, for the species are quite distinct.

This latter locality is on the eastern flank of the great Merioneth anticlinal, and the relation of the beds in which the fossils are found to the underlying Cambrian is identical in North and South Wales; so that from his general knowledge of the country Mr. Salter felt convinced that by a patient search on the other or North-Western side of the Cambrian axis, near the point where the grits dip under the overlying more slaty beds the same fossils would be found. He accordingly wrote to Mr. Homfray, of Portadoc, pointing out a spot, marked Tufarn-helig on the map, as the most likely, and requesting him to institute a careful examination. After two days' work Mr. Homfray vindicated most satisfactorily the correctness of Mr. Salter's induction, by finding at the exact spot he had indicated, seven or eight of the characteristic St. David's fossils, *but not Paradoxides.*

During a recent run through North Wales, the author of this paper paid a hasty visit to the spot, and notwithstanding that he had to work standing in the bed of a stream, and in the midst of pouring rain, he had the good fortune to detect two distinct and unmistakeable fragments of the *Par. Davidis;* one a pleural spine, and the other a portion of the glabella of a large individual. This discovery completes the parallel both with the South Wales beds and also with those near Dolgelly, though the number of species found in North Wales still falls far short of those known at Porth-y-rhaw. The fossils found by the author at Tufarn-helig comprised *Agnostus princeps; Microdiscus punctatus; Conocoryphe variolaris; Conocor. sp. Holocephalina; Erinnys; Theca; Paradoxides Davidis,* and some fragments at present undetermined. Most, if not all of these had also previously been found by Mr. Homfray, but as yet the beds have only been very partially worked, and it may be confidently expected that many other forms will be found there.

In order to illustrate the position of the beds more clearly, and at the same time to attach a more general interest to the paper, the author gave a sketch of the main features of the geology of the central portion of North Wales, extending in a north-westerly direction to Snowdon and Llanberris, and east and south to the Arenigs and Cader Idris; *i.e.* to the country on both sides the Barmouth and Harlech grits, which form the anticlinal axis before referred to. He also exhibited and explained three of the admirable horizontal sections of the Ordnance Survey, on the scale of 6in. to the mile, which relate to this district.

Palæontographical Society.—A meeting of this Society was held on February 16th, at the apartments of the Geological Society of London, Somerset House, for the purpose of presenting a clock to Dr. J. S. Bowerbank, F.R.S., F.G.S., as a testimony of the high esteem in which he was held by the members of the Society, and of their appreciation of the services which he had rendered to Palæontological Science as the originator of the Palæontographical Society, and in having so well filled the arduous office of secretary for seventeen years. A marble bust of Dr. Bowerbank had been executed by means of subscriptions, and was, by the Doctor's request, presented to the Geological Society.

CORRESPONDENCE.

THE TRANSACTIONS OF THE ROYAL GEOLOGICAL SOCIETY OF CORNWALL.

To the Editor of the Geological Magazine.

Sir,—Having lately, for the first time in my life, had an opportunity of consulting the Transactions of the Royal Geological Society of Cornwall, I have been surprised at the amount of information contained in them. Among other matters connected with rocks and veins, there are some which, at the present day, may be more generally interesting. As others may find as much difficulty in procuring access to these volumes as I have hitherto done, I may venture, perhaps, to solicit space for an account of some curious circumstances given in two papers in the fourth volume.

The first paper is by J. W. Colenso, Esq.[1] (read October, 1829), entitled "A description of Happy-Union Tin Stream Work at Pentuan."[2] The valley of Pentuan is near St. Austell, and is described as about six hundred feet in breadth, but narrowing in places to three hundred, or even one hundred, the surface having a fall of one hundred and twenty feet in four miles. The rock is blue slate, covered in the bottom of the valley by an alluvial deposit, which, commencing at St. Austell bridge, becomes about sixty feet deep at Pentuan. The section of this alluvium at Pentuan is said to be the following (descending order):—

g. River and sand, silt, etc. .... 20ft.
Under this, at one place, just on a level with present low water at spring tides, piles were found as if for the construction of a foot-bridge.

f. A stratum of sea sand, with timber trees, chiefly oaks, lying in all directions, and also the remains of red-deer, heads of oxen, with the horns turning down, different from any now in Britain, said to be like those at the Cape of Good Hope; the bones of a large whale, and *human skulls, supposed to be either African or Asiatic* ... 20ft.

e. Silt, in the middle of which is a layer of stones, conglomerations of sand and silt, with sometimes wood and bone.. 2ft.

d. Sea sand with shells, the water proceeding from which is salt, while that above and below is fresh.............. 4in.

c. Silt or "sludge," brown or lead-coloured, with shells, wood, hazle-nuts, bones of deer, oxen, etc.; the bivalve shells in layers, valves often united, spoken of as sea-shells. There was one piece of oak that had been "brought into form by the hand of man," but had floated in the sea, as a small barnacle was fixed at one end .... 10ft.

b. Dark silt mixed with decomposed vegetable matter, having at top a layer of moss scarcely altered "almost retaining its natural colour," with leaves of trees, hazle-nuts, and sticks, 30 feet below level of sea at low water, 48 below high tides; extends with some interruption all over valley .... 2ft.

a. The tin ground, sand and clay, with fragments of granite, elvan, greenstone, "killas" or clay slate, and *irestone,* a hard black rock, and vein stones, with sand and pebbles of tin-ore, the tin mostly at bottom, varying from...3 to 6 and 10ft.

This paper is followed by papers on the stream tin-works, by Mr.

[1] Was this gentleman the father of my old college friend and companion, the Bishop of Natal?

[2] See De la Beche's Report on the Geology of Cornwall and Devon, 1839, p. 406.

Carne and Mr. W. J. Henwood, the latter of which gives details of several other stream tin-works in Cornwall, very similar to those given by Mr. Colenso regarding those at Pentuan, particularly mentioning the occurrence of human skulls with bones of other animals. Mr. Colenso expressly states that he sends one skull to the Society for their Museum. If this Museum be still in existence and the skull retained there, it appears to me it would be well worthy of examination by some competent authority.

There is something about the description of the "tin-ground" in these papers that reminds one very much of the "boulder-clay." Whether formed by ice or water, it was afterwards covered by a "moss," and therefore was above the level of the sea then, but was subsequently depressed at different times till covered by more than 40 feet of marine deposits. It seems like the "sub-marine forests," or submerged mosses, with roots and erect stumps of trees found all round our coasts. The most interesting point, however, seems to me to be the finding of human skulls in these beds.

DUBLIN, *February* 10*th*, 1866. J. BEETE JUKES.

THE RAISED BEACH OF CANTYRE.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—I have only just seen Mr. Hull's interesting communication relative to "the Raised Beach of Cantyre," or I would otherwise have made some earlier remarks upon it.

In October last, I spent a week in the neighbourhood of Campbeltown, and I was struck with the apparent proofs, on every hand, of a *comparatively* sudden rise of the land at no distant date, speaking of time in a geological sense. The cliffs of the Island of Davar, and of other parts of the coast, have, in most places, a footing of many yards in width, composed of broken rock fragments; and the rock faces, which contain the sea-worn caves, are now far removed from the direct influence of the waves. The height of the floors of those caves which I examined was from 15 to 30 feet above the present high water mark.

It occurred to me, at the time of my visit, that the cave of St. Kiaran might be used as a cogent argument in favour of the theory that the relative heights of sea and land have not been altered since the Saint inhabited the cave. Were the land to be twenty feet lower, the cave would not be habitable, and it would then be quite unapproachable excepting by means of a boat; whereas, tradition asserts that St. Kiaran occupied the cave as a residence for some years, and that he communicated with his neighbours by means of a horse, that he had trained to go forth and to bring to him the supplies which were sent by his charitable admirers.

St. Kiaran is *believed* to have been the tutor of St. Columba. Of the latter-mentioned Saint, Bede says,—"In the year of our Lord 565, when Justin the younger, the successor of Justinian, had the government of the Roman Empire, there came into Britain a famous priest and abbot, a monk by habit and life, whose name was Columba, to preach the word of God to the provinces of the northern Picts, who are separated from the southern parts by steep and rugged mountains." Now, the history of St. Columba, who made Iona famous, and who preached, among other places, in Cantyre, is tolerably authentic. But St. Kiaran, who is *said* to have been baptised by St. Patrick, and to have commenced his preaching in Cantyre in the year 536, is comparatively a mythical personage. I cannot meet with any information respecting St. Kiaran that will bear the sceptical examination of geologists ; otherwise the cave of the Saint would conclusively prove that the high-water mark was not at a greater elevation 1300 years ago than it is at the present time.

This will be a most important fact if the premisses can be proved by our historical friends ; and should it turn out that the thirty feet elevation of the land has taken place since the building of the Roman wall of Antoninus, the space of time during which it could only have occurred, would thus become narrowed to the interval between A.D. 140 and 536.

It is evident, as Hugh Miller remarks, looking at the greater number, and far greater dimensions of the caves, that are situated on the so-called "thirty feet shore line," as compared with those existing between the present high and low-water marks, that the time during which the waves washed the higher line was immensely greater than that in which they have been operating upon the present coast line.

The Cave of St. Kiaran has evidently originated, as Mr. Hull says, in a line of fault in the Old Red Conglomerate; and there is in course of formation, in front of the cave, a very large mound of fragments that have fallen from the face of the cliff, owing to the action of frost and sun upon the lofty face of rock in which the cavern is situated. This growing heap is in itself a proof of the great antiquity of the elevation of the coast line, for, so long as the waves reached the place upon which the fragments had fallen, they must periodically have washed away all the talus deposits.

In proof that the beach is in course of being eaten away by the wearing action of the waves, I may mention that the shingle bar, of about three-quarters of a mile in length, which connects the Isle of Davar with the mainland, and which is covered by the sea at half tide, partially occupies ground which, in the memory of the last generation, regularly bore crops of corn. Should this bar be ultimately entirely carried away, the noble harbour of Campbelton will have seen its most prosperous days.

In reference to the porphyries of Davar, M'Culloch says,—"The rock produces some beautiful varieties of green as well as of brown porphyry, easily wrought, to be obtained of any size, and extremely ornamental when polished, but as yet neglected. Sweden, with far less capital and far less industry (or of reputation for that at least) than ourselves, contrives to fill all Europe with the elegant produce of an article similar, yet far inferior in beauty, and utterly without variety; whereas this rock produces not less than ten or twelve distinct kinds." This beautiful stone is still as much neglected as it was in the time of M'Culloch. If a market were found for it, it might be quarried close to deep water, where vessels might ride and load in safety; and the works would be carried on with the advantage of every facility that the owner, Sir Lewis Campbell, would willingly afford.

During the few short hours that I could devote to a ramble over Davar, I found the attractions of the porphyritic rocks to be so seductive, that the hammer was much more frequently in use than the gun.—I am, Sir, yours obediently,

EDWIN BROWN, F.G.S.

BURTON-ON-TRENT, *February* 13, 1866.

GEOLOGY OF THE MOON.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—I have no doubt many of your readers will thank you for introducing the subject of the Moon into the GEOLOGICAL MAGAZINE. The letter of Mr. Birch on Lunar Glaciers ought to lead to observations and speculations calculated to enlarge our knowledge of the present and past condition of the moon's surface. That glaciers to a limited extent may now exist, and that traces of former glacial action may be discovered on the surface of the moon, does not appear to be a very extravagant assumption. But few astronomers would probably be disposed to concede that all the white parts of the moon are Snow and Ice. The absence of an atmosphere (beyond a possible shallow gaseous envelope) would at first sight appear to be incompatible with a belief in a general glacial condition of the lunar surface. It is however for the photo-selenologists to inquire whether the modern theory of the moon advocated by Professor Hansen and others will afford him any support. This theory implies that the farther or unseen hemisphere of the moon is a comparative depression in which an ocean surmounted by an atmosphere may exist, and in which volcanic fires have not yet become exhausted—that the side of the moon turned towards us is a vast hemispherical mountain-system, rising above the lunar sea-level to a height corresponding to the distance between the Centre of figure and Centre of gravity, or according to some about 30 miles. Is it possible that Vapour from the "ultra-montane" sea may find its way over the border, so as to be converted into snow and ice on the higher lands of the visible hemisphere of the moon? The mere asking of such a question may subject a writer to a charge of presumption, if not of ignorance, in the present state of astronomical discovery.

But there is one subject connected with the Geology, or rather Selenology of the moon, on which one may now venture to make suggestions with less hesitation. The theory above noticed implies that the lunar depressions anciently called *seas* are really *deserted ocean-beds.* Professor Phillips expressed himself in favour of this doctrine at the late meeting of the British Association. It is, I think, very desirable that the army of observers (including those officially instructed by the "Lunar Committee") now besieging the surface of our satellite, should direct particular attention to sea-coast phenomena. Excepting where lines of craters have been converted into an irregular succession of cliffs, the effects of marine denudation can scarcely be mistaken. In the moon as well as in the earth, they may be expected to consist of nearly straight lines of escarpment apparently due to undermining and lateral encroachment—winding lines of cliff apparently scooped out into bays with headlands and semi-circular hollows—level areas under escarpments, either terrace-shaped or graduating into the general level of the neighbouring plain—ridges resembling sand-banks, running across the plains or old sea-beds—isolated rocks, or groups of rocks in the neighbourhood of escarpments and especially of promontories, etc. Among the apparent sea-coast phenomena which ought to be minutely observed, I would venture to mention the following:—

First, the more abrupt coasts of the Mare Imbrium. The great Appenine escarpment is very instructive. It is exceedingly steep and lofty, and has apparently been formed along the *strike* of the metamorphic (?) rocks of which the mountain-range consists. It has here and there been hollowed out into semicircular coves, which have not reached the dimensions of bays. Along a considerable part of its course, it overhangs a level beach terminated by a striking line of rocks resembling a natural break-water. Palus Nebularum and Palus Putredinis are so wonderfully level as to point at once to deposition parallel to a horizontal fluid surface. The Wedge-shaped Valley of the Alps is a cleft (voe ?) nearly 12,000 feet deep. Sinus Iridum is a semicircular bay "level almost as water," with "abrupt and colossal cliffs" and promontories 140 miles apart.

Second, the headlands, bays, and coves of Mare Serenitatis and Mare Tranquilitatis, and the apparent beaches and sand-banks by which their surfaces are varied.

Third, the Mare Crisium, with its smoothly-rounded bays and coves. The Promontorium Agarum resembles many terrestrial headlands. Near the east edge there is a pass with island-like mountains. In this deserted sea-bed I have frequently traced level beaches extending from the bases of the cliffs a considerable distance sea-ward, and then terminating suddenly. Similar beaches or level plateaus may be traced in other lunar sea-beds.

The so-called canals or rills, especially Hyginus and Ariadæus, with their tributaries, tunnels, raised banks, etc., deserve to be particularly examined with the view of discovering traces of their being dried-up river channels.[1]—Yours truly,

D. Mackintosh.

[1] For information on the Selenography of the above and other regions of the moon, see the Rev. T. W. Webb's *Celestial Objects ;* also articles by the same astronomer in the *Intellectual Observer.*

MISCELLANEOUS.

Head of Pliosaurus.

There have recently been added to the Palæontological Collection of the British Museum the most interesting remains yet discovered of *Pliosaurus*. These consist of a nearly perfect skull, with the lower jaw of the same individual, which are but slightly altered by compression or distortion from their normal form. The skull measures nearly five feet in length, from the end of the muzzle to the occipital condyles. The basi-occipital, palatal, and maxillary bones being very perfect, and their divisions well marked. The rami of the lower jaw are each upwards of five feet in length from the anterior end of the symphysis to the articulating condyles, one ramus being more perfect than the other; in each ramus and on one side of the upper jaw, the entire series of the alveoli is preserved. Some of these contain incipient teeth, but the whole of the perfect teeth have been lost.

These fine fossils will be figured and described by Professor Owen in an early volume of the Palæontographical Society's Monographs.

The public is indebted to the liberality of J. C. Mansel, Esq., F.G.S., of Longthorns, Blandford, Dorset, for these very desirable acquisitions to the National Collection. Mr. Mansel had on a former occasion presented to the Museum the fine typical tooth (12 inches long) of *Pliosaurus grandis, Owen*, to which species, probably, this head may belong. They are both from the same deposit and locality, the Kimmeridge Clay of Dorsetshire. In addition to the above-mentioned specimen Mr. Mansel has since presented another equally fine lower jaw, with part of the cranium of the same individual, which Professor Owen has determined to be a new species, having very distinct characters from the preceding.—W.D.

Minerals of Lake Superior.—Professor Chapman, Ph.D., notices in the "Canadian Journal" for November, 1865, the discovery of native lead near Dog Lake. It occurs in the form of a small string in white semi-opaque quartz. The quartz contains no other substances with the exception of a small quantity of specular iron ore; the absence of gold is noteworthy, as in the European localities where native lead has been found it is generally accompanied with gold. He also records the occurrence of Galena, Marcasite, Molybdenite, Barytine or Heavy Spar, Fluor Spar, and Anthracite, in the vicinity of Lake Superior.

New Cornish Minerals.—Prof. Maskelyne announces the occurrence of an opal allophane in Cornwall. The specimen was forwarded to him by Mr. Talling, of Lostwithiel. It is a hydrated aluminic silicate, of a greenish-blue colour, and closely resembles the allophane from Saltzburg. Mr. Talling has also obtained a curious variety of pitchy copper ore, probably Turgite, from Cornwall.—*Chemical News, Feb.* 16, 1866.

Fossils from the Diluvium of the Tiber.—M. de Verneuil has lately obtained a small series of fossil bones from the diluvium of the Tiber. They consist of teeth of a large hippopotamus (probably *H. major*), teeth of rhinoceros, wild boar, ox, horse, and deer. At Ponte Molle the bones are most abundant, but they are better preserved at Mont Sacré, in the diluvium of the Aniene.—*Bull. Soc. Géol. Fr.* vol. xxii. 1865, p. 521.

The Ossiferous Caverns of Belgium.—A report was recently presented to the Belgian Government by Monsieur Dupont, of Dinant, on the scientific explorations lately made in the caverns on the banks of the Lesse, to November 1865.[1]

The cavern of Chaleux has, in particular, yielded a most abundant harvest of remains of pre-historic man. Besides great numbers of worked bones, there were found more than 30,000 cut flints, several cubic metres of bones of animals, including more than 900 teeth of horses; implements of reindeer horn of various forms, as arrow-heads, spatular and pointed instruments, and polishing tools. Pieces of fluor-spar, and numbers of fossil shells, from the "Calcaire grossier," pierced with holes; some jet, and the teeth and a vertebra of a shark, have also been discovered, together with Ologiste (Hematite), iron-pyrites, and pieces of Fumay slate rudely carved.

The animals eaten included, besides the horse, the brown bear, chamois, wild goat, reindeer, fox, badger, hare, wild boar, and probably the water-rat, as remains of several hundreds of these animals were likewise found among the ashes and *débris* of the ancient hearth.

In the middle of the fire-place was also discovered the "fore-arm" (*sic*) of a mammoth (*Elephas primigenius*), which M. Dupont considers was placed there as a "fetish charm."

After the discovery made by Messrs. Lartet and Christy of a drawing of a mammoth upon a flake of ivory, in the ossiferous cavern of La Madeleine,[2] we need no longer doubt that the Cave-men of France and Belgium were contemporaries of the mammoth, and sometimes, though rarely, destroyed one by stratagem, or in the chase.

OBITUARY.

Prof. W. T. Brande.—We regret to notice the death of the veteran chemist, Prof. W. T. Brande, D.C.L., F.R.S. Besides numerous works on Chemistry, he published, in 1816, a descriptive catalogue of the British specimens deposited in the Geological Collection of the Royal Institution, and in 1817 the "Outlines of Geology," being the substance of a course of lectures delivered at the Royal Institution in 1816; a second edition of this work was issued in 1829. He died on February 11th, aged 81. A new edition of his dictionary is now being re-edited.

[1] Extracted, in part, from the *Gloucester Journal*, December 30, 1865.

[2] See the Geological Magazine, vol. ii., p. 480.

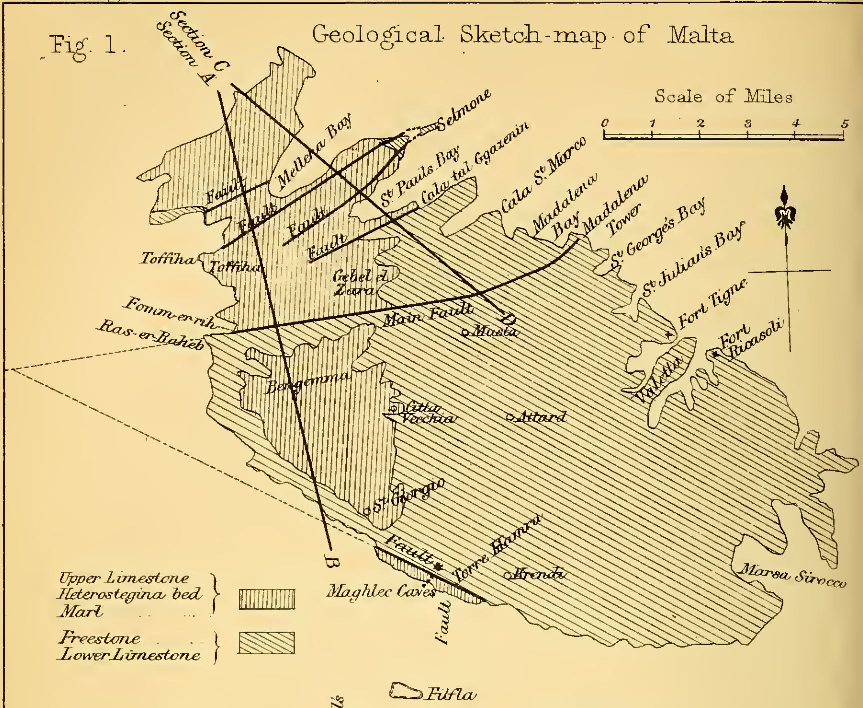


Fig. 2. Section along the line A.B. on the Map.

Fig. 3. Section along the line C.D. on the Map

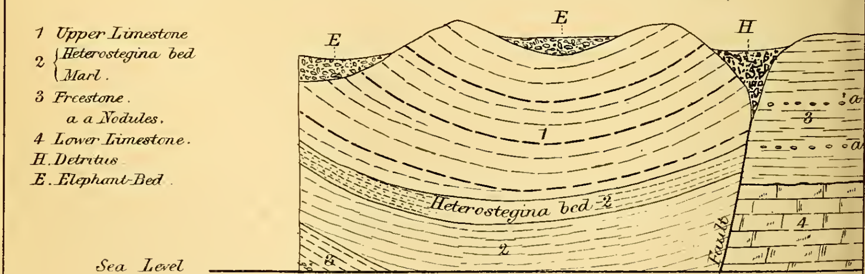


Fig 4. Section of the Main Fault at Fomm-er-rih

F. Dangerfield, lith.

GEOLOGY OF MALTA.

Fig. 5. Rocks near Gain Toffiha.

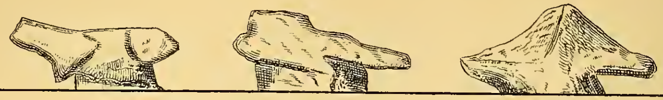
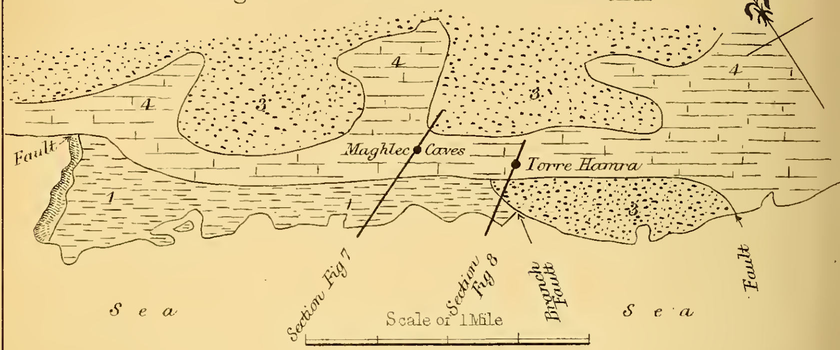
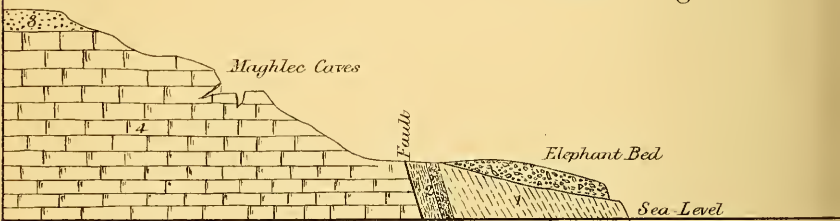


Fig. 6. Plan of the Fault near Krendi.



Section Fig 7.



(Note. *The figures refer to the same formations as those in Plate VIII.*)

Section Fig. 8.

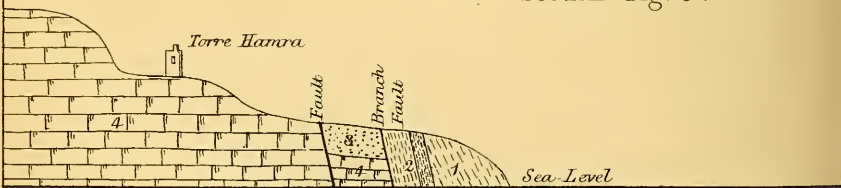
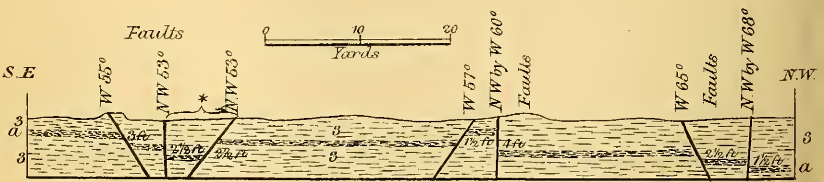


Fig. 9. Sketch of Cliff near Fort Tigne.



3.3 Freestone, a.a. Band of Fossil Sea weed (?)
**Same fault, it crosses a Promontary.*

F. Dangerfield, lith.

GEOLOGY OF MALTA.

THE

GEOLOGICAL MAGAZINE.

No. XXII.—APRIL, 1866.

ORIGINAL ARTICLES.

I.—Sketch of the Physical Geology of the Island of Malta.

By Captain F. W. Hutton, F.G.S.,
Late Deputy-Assistant-Quarter-Master-General at Dublin.

(PLATES VIII. and IX.)

GEOLOGICAL Structure of Malta.—The Island of Malta is entirely composed of Tertiary aqueous rocks, which lie in a nearly horizontal position, but which, being traversed by several faults, are found at very different levels. This horizontal position of the strata is interesting, as it is seldom seen in small islands situated so far from the main land; and it is probably to be accounted for by supposing that any unequal pressures which might have occurred during the upheavals of the Island, expended themselves in the production of faults, instead of inclinations and contortions of the strata.

The length of the Island is 17 miles, and its greatest breadth not quite 9 miles; it is 56 miles distant from Cape Passaro in Sicily, and nearly 200 miles from the coast of Africa. On the north-east, between the Island and Sicily, the water is not deep, never, perhaps, exceeding 80 fathoms; but on the south-west coast the hundred fathom line runs within three miles of the coast.

The rocks, or strata, are divided as follows:—

Pleistocene.—*Elephant-bed.* (Marked E in section.) Either a hard red Conglomerate, or roughly stratified beds of sand and gravel, in which are found remains of *Elephas*, *Sus*, *Arvicola*, and Land Shells. The Conglomerate contains fragments of a compact and almost black Limestone, unlike anything now found on the Island. This interesting bed has been ably described in detail by my friend, Dr. Leith Adams (who had the honour of first pointing it out), in the Geological Magazine, vol. ii. p. 488.

Miocene.—*Upper Limestone.* A white, or reddish, very fossiliferous Limestone, originally more than 230 feet thick, but now much reduced by denudation. The upper part is hard, and in places much broken, while the lower parts are softer.

It contains a small quantity of carbonate of magnesia, principally in the lower parts. Its specific gravity is two, and it is capable of absorbing three gallons of water per cubic foot. (Marked 1 in sections.)

Heterostegina-bed. A reddish-yellow sand, or sandstone, containing in places large quantities of dark-green grains of glauconite (silicate of iron and alumina), which then give their colour to the rock. It varies in thickness from 50 feet to 1 foot, and in some places seems entirely absent.

Marl. A dark-blue or light-brown laminated Marl, containing nearly 25 per cent. of carbonate of lime. Its thickness varies from 50 to more than 100 feet.

(The Heterostegina-bed and Marl, are together marked as 2 in all the sections.)

Freestone. A pale-yellow, or grey, granular, siliceous Lime-stone, traversed by several thin beds of dark-coloured nodules. This Limestone contains carbonate of magnesia and clay in very perceptible quantities; the former being most abundant in the pale-yellow varieties, the latter in the grey. It is much jointed, owing, probably, to the quantity of clay that enters into its composition; and it contains numerous fossils, including some *Diatomaceæ* (*Synedra, Navicula, Pleurosigma,* and *Surirella?*). Its specific gravity is 2.5, and it can absorb 1½ gallons of water per cubic foot. Its thickness is about 200 or 250 feet. (Marked 3 in sections.)

Lower Limestone. A hard Limestone, usually white, but sometimes light-brown; very variable, but generally composed of rolled calcareous débris, the pieces of which vary in size from a few lines to two or three inches. The light-brown parts are often crystalline. It contains, besides other fossils, large quantities of *Foraminifera,* and a few Diatoms (*Navicula*). I can find no trace of magnesia in it. Its thickness is more than 400 feet, but how much more it is impossible to say, as no rock is found below it. Its specific gravity is 2.7. (Marked 4 in sections.)

Of these strata the Elephant-bed, as at the Krendi fault, and at Fomm-er-rih, rests sometimes unconformably on the Upper Limestone (see Section, Plate IX. Fig. 7, and Plate VIII. Fig. 4). The others are always conformable, and generally pass gradually into each other; the most distinct division being between the Freestone (3) and the Marl (2); and this is perhaps entirely owing to to the very different colour and composition of the beds. We must not, however, jump to the conclusion that, because these beds appear to pass one into the other, no great period of time elapsed between the formation of one and the other; for, in one instance, at any rate, we have proofs to the contrary. The Lower Limestone (4) often passes quite insensibly into the Freestone, so that it is impossible to say where one ends and the other begins; yet the surface of the Lower Limestone is very uneven, and had evidently undergone considerable denudation before the Freestone was deposited. Large bosses rise up in places to higher levels than the surrounding Freestone, as at Musta, at the Lunatic Asylum near Attard, and near Krendi. I have satisfied myself that these are not owing to faults. Sometimes also the upper surface of the Lower Limestone is much waterworn, in a way that could only have been done after the rock had become hard. This is well seen at Fomm-er-rih, where the Limestone appears to pass gradually into the overlying Freestone; but on close examination it will be seen that the surface of the Limestone is honey-combed, and the hollows filled up with Freestone.

The Island, with the exception of some valleys in the Marl district, is quite destitute of surface-soil, but the fissures in the Limestone rocks are filled with a red clay, which the inhabitants dig out and spread over the surface. This clay has evidently been derived from a deposit superior to the Upper Limestone (1). A fault running in a W. by S. direction, from Madalena Tower to Fomm-er-rih (see Map, Plate VIII. Fig. I., and Sections, Figs. II. and III.) divides the Island into two unequal portions. Its throw at the former place is 270 feet, and at the latter 350 feet (Fig. IV). South of this fault the strata incline to E.S.E., so that the Lower Limestone, which is 210 feet high at Bengemma is "submerged," or "awash," on the south-eastern coast.

The land on this side of the Island forms an undulating plain of Freestone and Lower Limestone, crossed by many valleys, and rising gently from the sea until it reaches the base of the flat-topped hills, about 800 feet high, which extend from St. Giorgio to Bengemma, and which are composed of the upper series of rocks, namely, Nos. 1, 2, and 3. These flat-topped hills, with perpendicular escarpments, are the most noticeable features in Maltese scenery, and are due to the soft Marl-bed being rapidly washed away from under the hard Limestone, which then breaks off in a perpendicular direction, and falls by its own weight.

On the south coast, near Krendi, there is another fault, which was first pointed out to me by Dr. Adams, in the summer of 1863. As this fault is not shewn on the Ordnance Geological Map, I have added a plan of it, extending three miles (Plate IX. Fig. V.). This fault, commencing at the cliffs under Krendi, runs in a general N.W. by W. direction, until it comes out at the end of the bay, under the hills of St. Giorgio. Its throw is 350 feet, the same as the main fault as Fomm-er-rih. Near the centre of it, just below Torre Hamra, a branch-fault occurs, and the land west of this branch-fault has been again thrown down another 200 feet, making a total throw of 550 feet. The top of this fault forms a terrace, varying from 60 feet above the sea below Torre Hamra, to 230 feet below St. Giorgio, where a sea-cliff of that height is seen formed entirely of the Upper Limestone. On this terrace, west of the branch-fault, the Elephant-bed is found, lying unconformably on the edge of the other strata, which have been turned up during the formation of the fault (Fig. VII.), but it is not found on the Freestone east of the branch-fault (Fig. VIII.). Inland the cliffs again rise, until, at a height of about 300 feet, another terrace is formed, on which Torre Hamra is situated. It is on this terrace, about a mile west of Torre Hamra, that the Maghlec Caves were found (Plate IX. Fig. VII.). Behind the Tower the ground again rises, until it attains a height of 400 feet.

No other great faults are known in this part of the Island, but round Valetta, and perhaps in other places, numerous small faults, with throws of a few feet only, occur in the Freestone; a few of the largest of these extend down into the Lower Limestone, but most do not. In a low sea-cliff near Fort Tigne, six faults, with throws of from 1½ to 4 feet, occur within a distance of 90 yards (Plate IX. Fig. IX.). A thin dark band, composed apparently of the remains of marine Algæ, runs through the cliff about half-way up, and enables these throws to be accurately measured. None of these faults penetrate the Lower Limestone, the top of which is exposed at the sea-level; it is therefore evident that they were not produced by movements from below, it is also certain that they could not have been caused by lateral pressure, for in that case the throws of the faults would all have been reversed; nothing therefore remains to account for them but pressure from above, and this I believe to have been the cause. I suppose that the rock, being already jointed, was pressed down before it was quite hard, by the weight of the superincumbent strata, and the pressure on each fragment being proportional to the area of its upper surface, those fragments which had the largest upper surface in proportion to their bulk were more compressed than the others, thus forming the faults. The broken state of many of the fossils, particularly the *Echini*, in this bed, is a proof that it has undergone considerable compression.

I may, perhaps, here mention that I consider that all cases of "reversed faults" will be found to have been caused by lateral pressure.

North of the main fault the land is much lower than on the south side. This is due partly to the throw of the fault, and partly to the fact that the Upper Limestone on this side has undergone a greater amount of denudation. Along the line of fault, and at various other places on the Upper Limestone, such as Fomm-er-rih and Toffiha, patches of the Elephant-bed are found, generally filling up hollows. This part of the Island is again crossed by two faults on each side of Melleha Bay, which, running parellel to the main fault, have let down the land between them, so as to form the valley and Bay of Melleha (see Plate VIII., Figs. I. II. and III.). The fault south of the bay has a throw of 100 feet; that on the north, 150 feet.

North of Melleha Bay, the beds dip due north in a more marked degree than in any other part of the Island.

The general dip of the strata, between Melleha Bay and the main fault, is very slightly to the west; but on the south-west coast the beds have been compressed into one or two undulations, which are not found on the north-east coast. These undulations appear to have been caused by the lateral pressure exerted when the faults where in process of formation. The upper part of the Limestone being here hard, and not able to bend with the other strata, has been very much crushed and broken up. The Valley of St. Paul, of which St. Paul's Bay forms a part, runs quite across the Island, and, on the south-west coast, is clearly seen to be caused by a synclinal folding of the strata; but at St. Paul's Bay the bottom of the syncline seems to have fallen through, forming two faults (Fig. III.), which run half-way across the Island, and can be seen on either side of the bay, at the Rock of Selmone, and near Calatal-Ggazenin, respectively. The fault on the north side of the bay has a throw of about 170 feet at Selmone. The country between St. Paul's Bay and the main fault has great similarity with the southern part of the Island; like that, an undulating plain rises from the sea-level on the north-east coast until it reaches a line of flat-topped hills, similar in all respects to those of Bengemma, but not rising to more than 450 feet.

Most of the Maltese faults show, in places, remarkably well-preserved specimens of slickenside, especially at Fomm-er-rih, at Selmone, and at the Krendi fault, near Torre Hamra.

Macluba.—One of the natural "lions" of Malta is Macluba, which must not be passed over. It is a cylindrical hollow in the upper part of the Lower Limestone, near Krendi, and is about 100 feet deep and 200 feet in diameter; the sides are perpendicular and rough, without any trace of slickensides. It is situated in a small valley, and is crossed by two fissures, the larger of which is perpendicular and runs down the centre of the valley; the smaller one is inclined 60° to the horizon, and 45° to the larger one. Evidently rain-water, charged with carbonic acid, obtained from the decaying vegetable matter on the surface, percolated through the fissures, dissolved the limestone-rock, and formed a cave, the top of which has given way in the same manner as the Brixham Cave, which was discovered by the falling in of the roof.

Gozo.—The Island of Gozo is separated from Malta by a strait, three miles wide. In composition and structure it is very similar to Malta; and the geology of both should be studied together, as in all probability they would throw mutual light on each other's history; but, as my acquaintance with Gozo is not sufficient to enable me to make any original observations on it, I have omitted it in the present sketch.

Geological History of Malta.—I will now make a few speculations on the probable history of Malta, which the reader must take for what they are worth, as a further knowledge of the geology of the Island may perhaps require some of them to be modified.

The Maltese beds were deposited at a time when, probably, the Alps, Apennines, and the mountains of Turkey, Greece, and North Africa, formed groups of islands in a shallow Miocene sea, which extended over the valley of the Danube, the greater part of Switzerland, and the valley of the Rhine, as far as Mayence. Central France we know to have been then land, with large fresh-water lakes, and several active volcanos. A long blank follows, and the next information we possess is that, at the commencement of the Pleistocene period, submarine volcanic disturbances began, which resulted in the land being raised and Etna formed. It was during this upheaval that most of the faults appear to have been made, but not the small branch fault under Torre Hamra. The main and Krendi faults are, no doubt, continued under the sea, and meet, as shown by the dotted lines on the map (Fig. I.). I suppose that during this rise, that portion of land contained between these faults was raised 350 feet above the surrounding country; and this will account both for the decreasing throw of the main fault towards Madalena, and for the dip of the south-east portion of the Island. Malta now was part of a continent which included most of Europe, the Mediterranean area, and the north of Africa; the Desert of Sahara and Egypt being then sea. A large river, or lake, appears to have existed south-west of the Island, one shore of which was partly formed by the cliffs of these two faults; the Bengemma hills being a promontory jutting out into it. It was this lake, or river, that formed the Elephant-bed, and bound together into a firm conglomerate the fragments of rock that fell from the cliffs. I suppose those portions of the bed below the Maghlec caves to have been at this time on the same level as those at Fomm-er-rih.

Then followed the Glacial period, at the close of which the land forming the present basin of the Mediterranean again sank, that part of it which now constitutes Malta to rise once more, barren and denuded of all its surface-soil, with the exception of portions retained in the fissures of the rocks, which have been again dug out by the unceasing industry of the Maltese, and spread thinly over parts of the Island; and which, though still retaining abundant proofs of its former fertility, is but a very small remnant of what once, probably, supported forests, in which herds of elephants browsed. It was during this last rise that the branch fault under Torre Hamra was formed, the piece west of it slipping down 200 feet more, and thus escaping the effects of the denudation, which swept off so much of the upper beds.

When the Bengemma Hills were about 500 feet above the sea-level, a long pause in the upward movement evidently took place, during which the upper strata were washed away from the plain on the eastern side of the Island, which slopes from the sea to the table-land of Citta Vecchia, and the terrace on which Torre Hamra stands, and where the Maghlec caves are situated, was cut by the sea out of the hard Lower Limestone. Another rise, of more than 200 feet, was followed by another period of rest, during which the plateau below Torre Hamra, and the plain from Cala-San-Marco to Gebel-el-Zara, were formed. The Island then once more rose some 60 or 70 feet, and attained its present position. That the land for some time past has remained stationary, we have evidence in the numerous rocks seen on the west coast. Fig. V. represents some of these near Gain Toffiha, which are composed of the hard parts of the Upper Limestone. The straight low undercutting of these rocks could only have been done by the constant lapping of the all but tideless sea, and not by the force of large waves. The clear blue water of the Mediterranean, the colour of which proves that it contains but little sediment, must have beaten long in the same place before it could have eaten so far into so hard a rock. This undercutting at the sea-level may also be seen in the cliffs of Lower Limestone at Ras-er-Raheb.

An interesting corroboration of this is supplied by the zoology of the Island. The rock of Filfla, about $2\frac{3}{4}$ miles distant from Malta, is inhabited by a Lizard found nowhere else. This Lizard, although only considered as a variety of *Podarcis muralis* (the Green Lizard so common in Italy), is larger than the typical form of that species, and is perfectly black on its upper parts, and spotted with green and blue on its belly. It must have taken a long time to produce so distinct a variety, during which time Filfla was evidently separate from Malta; and, as the channel between them is only 37 fathoms deep, and Filfla itself is only 150 feet high, no great elevation or depression can have taken place.

It was during this last period that all the minor physical features of the Island were formed, either by rain or atmospheric decomposition. To this class belong all the small rocky valleys, or "fiumares," and most of the inland cliffs, some of the latter being also partly due to the hand of man.

In this sketch it must not be supposed that I pretend to have stated all the oscillations to which the Island has been subjected. I have only enumerated those which appear to me to have more or less proof: for instance, during the last upheaval of the Island, the periods of rest may have been very numerous, but proofs of two alone remain, which two were probably of longer duration than the others.

APPENDIX.

NOTE ON SOME SPECIMENS FROM MALTA.

By Professor T. Rupert Jones, F.G.S.
Royal Military College, Sandhurst.

Captain Hutton permits me to append the following observations on some Maltese specimens which I have received from our friend Dr. A. L. Adams, since I noticed a former set of specimens in the "Geologist," of April 1864 (vol. vii. p. 133) :—

1.—From the *Upper Limestone*. A friable yellow shell-grit, composed of rolled fragments of *Polyzoa*, *Pecten*, *Heterostegina*, etc. Probably from the lower part of this group of beds.

2.—From the *Sand Bed*. ("Heterostegina-bed" of Captain Hutton's memoir). A friable, yellow, fine-grained, sandy shell-grit, with abundance of well-preserved *Heterostegina depressa*. The grains of sand are round and chiefly brown and green (silicate of iron, etc.), with some quartz. The green grains are mostly rough segmented or lobulated, as glauconite often appears in sand, and some have apparently been derived from casts of *Foraminifera Polyzoa*, etc.

2.—From the *Marl.* *a.* Grey marl, probably Foraminiferal, but not examined yet. *b.* Ferruginous nodules; that is, pyrites decomposed into concentric nodules of iron-oxide and ochre, with traces of sulphur.

3.—From the *Calcareous Sandstone.* ("Freestone" of Captain Hutton's memoir). *a.* Shell-grit, or friable limestone, with *Nodosaria, Dentalina, Cristellaria, Amphistegina, Lituola Soldanii* (large, coarse-shelled, greenish-grey, abundant), *Polyzoa*, Shells (*Pecten*, etc,), Echinoderms. *b.* Two small greenish-grey lobulated pebbles (water-worn) of hard limestone; one compact (polished outside), the other shelly. One of these pebbles has been drilled by boring animals, and the hollows have been filled compactly with greenish calcareous grit. *c.* Nodular masses, or rather, water-worn honeycombed patches of hard ferruginous shell-limestone, full of Polyzoan fragments. In some specimens this is adherent to a water-worn surface of softer and whiter limestone, composed of similar materials. *Polyzoa*, Shells, Echinoderms, *Orbitoides*, etc. I do not know whether *b* or *c* (or both) belong to the bands of "nodules" mentioned in Captain Hutton's memoir.[1] *d.* Ferruginous nodules, like those from No. 3.

4.—From the *Lower Limestone.* *a.* Some specimens of Shell-grit, some of compact Limestone; with *Polyzoa, Orbitoides Mantelli*,[2] *Heterostegina depressa, Amphistegina vulgaris*, &c. *b.* A white Orbitoidal Limestone, with pisolitic structure (looking somewhat like an Alveolina-limestone at first sight), and with crystalline carbonate of lime irregularly distributed in the interstices throughout the mass. A hard limestone from St. George's Bay, given me by Captain Hutton, also has this quasi-stalagmitic arrangement of calcite among the constituent particles. *c.* Pieces of the tube of a large *Teredo*, abundant in portions of the lowermost rock, especially such as are broken up for lime-burning. Near Marsa Sirocco one part of the Limestone is almost entirely composed of these tubes (*Adams*).

Lastly, found only in the breccias and gravels of Malta, a hard, dark-grey, siliceous limestone, formed almost entirely of *Amphisteginæ*, and ossicles of Starfishes; the latter are strikingly conspicuous as white subangular spots on a blackish ground.[3] Treated with acid, this rock exhibits a delicate siliceous skeleton.

I have to add, that, after careful comparison of specimens, I find no true *Operculina* in the Maltese Limestones and Shell-grits. The Foraminifers that I alluded to as *O. complanata* ("Geologist," vol. vii. p. 134) are really *Heterostegina* of old and strong growth (see also *foot-note*, Geological Magazine, vol. i. p. 104). The "*Lenticulites complanatus*, Def.," alluded to by Dr. Adams in his remarks on the so-called "Sand-bed" in the Quart. Journ. Geol. Soc., vol. xx. p. 472, is also the same *Heterostegina depressa.*

[1] See Plate VIII. Fig. 4, bed No. 3, *a*, *a*.

[2] See Geological Magazine, vol. i. p. 104.

[3] This black limestone is without doubt the same as that alluded to above by Captain Hutton, when describing the "Elephant-bed."

II.—On a Deposit of Phosphatic Nodules in the Lower Green-Sand, at Sandy, Bedfordshire.

By the Rev. P. B. Brodie, M.A., F.G.S.

THE summit of the hill, about two miles from the station, on the property of Arthur Peel, Esq., M.P., consists of yellow and brown sand, with much iron; and the harder beds of the latter, where they form a stone, are composed largely of small pebbles of quartz, sandstone, and mica. In these the phosphatic nodules are found. Generally they lie at a variable depth from the surface—in some cases cropping out; but, in others, they prevail at a greater depth, with a capping of soft sand from three to four feet, but none have been met with below six feet from the top. The average thickness of the strata exposed is two feet, now and then reaching to six feet. Below is a loose sand, in which a deep well has been lately sunk to a depth of fifty feet. This is on the eastern side of the hill. These nodules are not uniformly spread over the surface, but appear to run in patches, being occasionally altogether absent. The area which they occupy, as at present worked, is limited to one mile and a half in length, by a quarter of a mile in width, in a straight line. The nodules are mixed with pebbles and other extraneous matter, which are carefully picked out, including masses of iron. The whole sometimes forms a kind of conglomerate of pebbles, iron, sand, and phosphatic nodules. West of the above, at a considerably lower level, there is a large quarry of hard, dark-coloured ferruginous sand-rock, which appears to dip under the sand below the phosphate-bed. This stone, which is very hard, is used for walls and buildings, and, though of a sombre colour, is a good useful material for this purpose, as it hardens by exposure to the atmosphere. The only fossils I observed in it were small pieces of vegetable matter, and an imperfect cast of a species of *Rhynchonella*. A large mass of silicified wood was obtained either from this bed or the overlying sand. With these exceptions, all the other fossils are evidently derivative, unless a rolled specimen of *Endogenites erosa*, from the top of the hill, may be considered to belong to the age of the Lower Green-sand.

As remains of *Clathraria Lyellii* have been discovered in the sands near Woburn, it is probable that both these plants, so characteristic of the Wealden, continued to live on to a somewhat later period, as indeed we know the latter did, from the discovery of a most interesting portion of that singular plant in the Chalk Marl of the Isle of Wight. The most numerous fossils occur in the phosphate-bed above referred to, the general character of which, from the white appearance of the nodules, presents a striking contrast to the beds above and below. The interior of the nodules is of a black or brown colour, and often, though not always, envelop an organic body, generally an Ammonite (*A. Lamberti*) of the Oxford Clay, which is very abundant—more so, indeed, than any other species. The nodules are of all shapes, rounded and elongated, and frequently pitted on the surface, but comparatively of small size. Associated with them there are lumps of hardened clay, which are more or less phosphatic. Some of the fossils, which all, in a greater or less degree, seem to have been either enveloped in, or permeated by, the phosphatic matter, have been so much water-worn, that it is almost impossible to distinguish them. There are numerous small shells, viz., casts of *Terebratulæ, Cardium,* broken *Pholadomyæ,* other species of *Ammonites* too imperfect and eroded to be determined; large Bufonitic palate (*Cyclodus gigas*), similar to a species which occurs in the Lower Green-sand at Farringdon;[1] Ichthyodorulites; bones and teeth of Saurians, much broken and worn, consisting of vertebræ, paddle-bones, dermal scutes, a small femur, and large reptilian teeth, many of which may have belonged to the *Pliosaurus.* I also picked up part of an oyster, probably *O. deltoidea.*

Every organism in this phosphatic bed is evidently extraneous, and probably was derived from the destruction of the Oxford and Kimmeridge clays, and intervening Coral Rag, from which the phosphatic matter must have been obtained, while the Lower Green-sand was in process of formation. It is well known that similar masses of phosphate of lime occur both in the Gault and Upper Green-sand, though, in both these cases, it does not appear to have been derivative, but to have been deposited on the spot. Although phosphate of lime is known as a simple element in rocks, it is, I believe, generally only present in very small quantities, and in most cases, it must have been derived notably from animals, especially Saurians and fish in all such marine deposits. I am aware that Mr. Seeley is of opinion that the phosphatic masses in the Upper Green-sand, at Cambridge and elsewhere, were derived from *Zostera* and other marine plants; but, as in the Lower Green-sand at Sandy, there is such a large preponderance of animal remains, it seems most probable that in that case, and others like it, the phosphates were purely of animal origin. It need hardly be observed that the discovery of these phosphates has greatly increased the value of the land, and it now lets at a much higher price, and though, of course, not inexhaustible, are possibly spread over a much larger area than the one at present opened up. The same process is employed in extracting the phosphate and preparing it for agricultural purposes as that used in the Upper Green-sand.

Mr. Peel has kindly favoured me with the following analysis of some of the best average samples of phosphatic or coprolitic nodules made by Dr. Voelcker:—

	Average Samples of Siftings from layers at 1 & 2ft.	Washed Coprolites from another spot.
Water of Combination	5.17	5.67
Phosphoric Acid *	22.39	15.12
Lime	32.73	26.69
Magnesia, Alumina, and Flourine (by difference)	6.64	4.51
Carbonic Acid †	3.06	2.18
Oxide of Iron	8.08	20.61
Siliceous Matter	21.93	25.22
	100.00	100.00
* Equal to Tribasic Phosphate of Lime (Bone Earth)	48.51	32.76
† Equal to Carbonate of Lime	6.95	4.95

[1] The Farringdon Lower Green-sand contains many fossils, derived from the Kimmeridge clay.

Dr. Voelcker states that these phosphatic nodules vary much in composition, and that the average examples which he analysed are not so valuable as those in the Upper Green-sand at Cambridge, which generally contain 58 to 61 per cent. of phosphate of lime; but it is possible that some bands at Sandy may turn out to be much richer than others, and, hence, by careful separation, the percentage may be increased in the bulk to 54 or 56 per cent. The top beds are richer than those worked at the depth of six feet. The phosphatic matter contains a great deal of iron, derived, no doubt, from the formation in which they are embedded, and which does not necessarily belong to them, and many of them have a red tinge from this cause. It may be observed, in conclusion, that this new locality at Sandy has only been known for about two years, and has not long been worked.

III.—The Sea against Rivers: or the Origin of Valleys.

By D. Mackintosh, F.G.S.

In a former article[1] I endeavoured to show that the more abrupt inequalities of the earth's surface, so far as they consist of escarpments with their associated phenomena, are chiefly due to the former action of the sea. Before proceeding to consider the origin of Valleys, I find it necessary to refer to a statement I made in the last article about Raised Beaches (page 69). My object was merely to show that the preservation of numerous terraces in the Cretaceous districts of Wilts and Dorset furnished an evidence of limited subaërial denudation since these terraces were formed. The terraces to which I alluded, principally occur at comparatively low levels; and that they are raised beaches can, I think, be clearly proved. But this is not necessary, so far as the *present controversy* is concerned; for the preservation of terraces in *gravel* (more easily worn away than chalk, according to the subaërialists), which all admit are either raised sea-beaches, or glacial-lake-beaches (such as those of Glenroy), afford an equally convincing proof of the impotence of rain as a denuding agent.[2]

Additional Remarks on the Denudation of the Weald.—Dr. Foster and Mr. Topley, in their very learned paper already referred to,[3] admit that the gravel terraces of the basin of the Medway, some of which are "*well marked*," consist of "loose and incoherent deposits," which the sea, had it been there, would surely have swept away.

[1] Geol. Mag., vol. iii., No. 2, Feb., 1866.

[2] Mr. Codrington, F.G.S., informs me that he has found *made ground* on the brows of several terraces of the class locally called Linchets, near Warminster. That the Belgæ or other races may have increased the transverse horizontality of some of these terraces, or may even have formed whole terraces, is easily conceivable; but that the thousands of terraces in the chalk districts of England were all fundamentally of human workmanship, is, I think, a theory involving such a series of improbabilities as to render it credible only to those who assign a most unwarrantable degree of stability to the relative levels of land and sea.

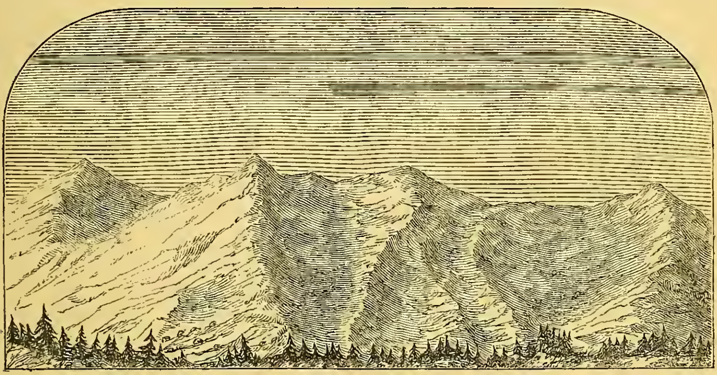
[3] Quar. Jour. Geol. Soc., vol. xxi., No. 84, Nov., 1865.

But if these terraces have resisted the action of rain to so great an extent during the immense period required by the river to deepen its bed 300 feet, is it consistent to attribute to rains the power of eating out "the Gault valley," in the neighbourhood, to a depth of 120 feet, and breadth of $1\frac{1}{4}$ mile? Dr. Foster and Mr. Topley dispose of the marine theory in a very summary manner. But I cannot see the force of their objections. (1) The want of corresponding level, all round the Weald, of the foot of the Chalk escarpment, *can* be explained by unequal elevation, especially if several upheavals are admitted; and the fact of rivers flowing in the lowest parts is quite reconcileable with the idea of these parts having been scooped out by the sea, and does not necessarily imply that they were mainly excavated by rivers. (2) With regard to the assertion that the escarpments follow the *strike of the beds*, changing their direction as the strike changes, this remark cannot apply to the smaller bays and combes of the South Downs, the side-cliffs of which often run at right angles to the strike. That the British Isles do not furnish an example of long lines of cliff following the general direction of the strike is no more remarkable than it is that they do not supply an instance of the sea denuding the fractured summit of a series of formations *anticlinally* arranged like those of the Weald district of Sussex and Kent. (3) The absence of shingle or ordinary marine deposits at the foot of the escarpments can be satisfactorily explained, by supposing that they were removed soon after they were formed, as the land rose above the sea; or washed away during a second submergence, if not by the ordinary action of the sea, at least by a debacle, or series of debacles, occasioned by violent upheavals or depressions. The Woolhope valley of elevation in Herefordshire has been denuded without leaving any trace of the denuding agent, and very few would venture to assert that its concentric system of valleys, with only one effective outlet, could ever have been worn down and swept out by rains and brooks[1]. (4) As it is quite certain that many changes of level have occurred in the Wealden area since the process of denudation commenced at the *summit* of the Chalk ranges, if not at a greater altitude, any objections to the marine theory founded on the present relative levels of different parts, cannot be regarded as possessed of much force, more especially when they come from subaërialists, whose theory of river-action involves a succession of local elevations.

Denudation of the Malvern Hills.—The Malvern Hills form perhaps the driest mountain ridge in England; and yet this ridge is much indented on its eastern side by valleys and hollows of denudation. Some account of these may perhaps prepare us for forming

[1] Have any geologists yet particularly noticed what the sea is now doing under the chalk cliffs of the Isle of Wight? From some statements in Mr. Whitaker's paper (Quar. Jour. Geol. Soc., vol. xxi, Nov., 1865) I should infer that in many places no deposit is allowed to accumulate under the cliffs, and that the "hard Chalk-marl and harder Upper Green-sand stretch out as a foreshore for some way westward of their outcrop in the cliff," so free from detritus, as to allow their even bedding to be clearly perceived.

a more correct estimate of the limited extent of fluviatile action in valleys traversed by rivers. The smaller valleys of the Malvern Hills were referred to during a discussion at the last British Association Meeting; and a hint was then thrown out that they may have been formed by streams arising from melting snows towards the close of the Glacial period. But that they could only have been formed by the sea will, I think, appear from the following considerations:—Their lower entrance is in general narrow, and they widen out very smoothly upwards, uutil they either graduate into the slope of the nearest summit, or into a shallow pass or col. They sometimes open at the very summit of the ridge, where no stream from the melting snow could possibly have originated; and between the highest ground and the lowest of these valleys there is not sufficient space for a stream to have formed. They are of the same shape with the deeper valleys or passes which at intervals divide the hills



Coves on the Western Coast of the Malvern Straits.

(such as the valley terminating in a combe behind North Malvern, and the pass leading from Great to West Malvern), only differing from them in extent; and no one would assert that the latter could have been excavated by any torrent of water derived from the very narrow saddle-shaped ridge of the Malverns. Both passes and shallow valleys present clear indications of their having been scooped out by an agency assailing the hills from without, and operating in an inward and upward direction. That the sea was the denuding agent becomes more apparent when we trace the connection between these hollows and the very decided combes which may be seen farther to the south behind Malvern Wells. These smooth hollows have been scooped out in hard Gneissic rocks, composed of Hornblende, Mica, Felspar, and Quartz, and cannot be explained by the waste of softer materials, for here the Trappean protrusions, which, farther to the north, have guided the excavating agent, are nearly if not entirely absent. Of the three combes represented in the accompanying woodcut, one, I believe, is quite dry. All the water coming from another finds its way through a small spout on the roadside; and although the stream from the third may not make so great a display of its denudating power, in the shape of an artificial cascade, it may be quite as large, and, in the eyes of subaërialists, perhaps as able to scoop out a combe as the last-mentioned. But these "dismal hollows"[1] cannot by any straining of the subaërial hypothesis be satisfactorily explained. All the facts are against rain, frost, and streams. The slopes are protected by a thick and varied covering of vegetation. Their dryness is quite remarkable; and to appeal to the very few small springs, scattered at long intervals along the base of the hills, as denudating agents, would be out of the question. I do not see how the conclusion can be evaded, that these deep hollows point out some of those parts of the western shore of the Malvern Straits which were most exposed to the fury of storms, or the sweeping action of currents. As the geologist surveys these hollows, he may at the same time look across the old bed of the Severn Sea; and recognize in the distant Cotswold escarpment the counterpart of the coast-line on which he stands, with headlands on the one side corresponding in form to headlands on the other, and combe answering to combe, where once "deep called unto deep."

Denudation of the Longmynd Valleys.—From the dry valleys of the Malvern Hills we may find an easy transition to the deep "gulleys" of the Longmynd, in Shropshire. I am not aware of any spot in South Britain to which the subaërialist might more readily lay claim; but even here I think it can be shown that the streams were originally usurpers of the valleys, or that the valleys made the streams, and not the streams the valleys. From the high and comparatively level plateau of the Portway, the main valleys in their general course cut across the strike of the nearly perpendicular strata, towards the pass of Church Stretton, which bounds the mountain on the east. Their directions could not, therefore, have been determined by comparatively yielding strata. The valleys in many parts are very winding, and they could not, therefore, have been excavated by a stream running down so steep an inclination as would have been necessary to give sufficient excavating power; for in proportion to the slope in the bed of a stream, must be its tendency to flow in a straight line.[2] In the Longmynd, the smaller streams run in nearly all directions, irrespective of hard and soft rocks, and the hollows they traverse are often continuations of intervening cols. Many hollows are dry, or are moistened by a rill so choked with vegetation as to render it scarcely visible. Several streams flow down into the deep valleys along a general inclined plane, without any depression, beyond a few inches, to mark their course; and these are as large as streams which in other places traverse comparatively deep and wide gulleys. The upper ends of some valleys (Oakham Dingle for instance) are large and combe-

[1] Camden long ago called a hollow in this neighbourhood the Dismal Hollow.

[2] See Mr. Fergusson's Paper on the Ganges, in Quart. Journ. Geol. Soc., vol. xix., Aug. 1863.

shaped, with an abrupt termination. The sides of the valleys graduate into the slopes of the hills, and are uninterruptedly continued around detached hills (Round Hill, for instance), in such a manner as to show that the denudation which spared the hills also excavated the valleys down nearly to their bottom. The level at which the action of the streams commenced may, in some of the larger valleys (Ash's valley for instance) be distinctly recognized, being indicated by a sudden and abrupt increase in the steepness of the declivity on both sides. In the lower parts of some of the valleys, the stream cuts through drift similar to that of the open country. In all instances where the streams debouche into the pass of Church Stretton, which is a continuation of the plain of Shropshire, they fail to cut a channel in comparatively incoherent gravel, though their waters (the Oakham brook for example) flow as swiftly as in some of the upper parts of their courses. While it is difficult, if not impossible, to reconcile all these facts with the hypothesis of subaërial aqueous agency, I think they can be at once accounted for by the undermining and indenting action of the ocean. The gulleys of the Longmynd are mainly winding and ramifying *voes* or creeks, excavated while the mountain, as an island, was gradually, or at intervals, suddenly rising above the sea.

Absence of Correspondence between River-courses and Valleys.—In tracing the courses of the larger streams and rivers of England and Wales, we find, in many instances, a much more striking proof of the pre-excavation of valleys than among the gulleys of the Longmynd. Generally speaking, there is a remarkable absence of correspondence between the size, form, and direction of valleys, and the size, velocity, and the course of the rivers by which they are traversed. A river debouches on a plain through a valley which is an arm or ramification of the plain—the line of escarpment that bounds the plain running up each side of the valley. This valley frequently extends far into the bosom of the hills, and is covered by a continuation of the marine drift that is scattered over the plain. After leaving the valley the river retains as much excavating power as before; but it fails, under equally favourable circumstances, to cut a channel in the plain beyond a few feet or yards in depth. Why, then, give the river credit for having worn down the valley? A river, after flowing through a plain without making much impression in the shape of a channel, suddenly enters a narrow gorge, through which it flows to the sea; or the gorge is merely a breach in a barrier, on the other side of which the river re-enters a plain, where, with unimpaired velocity, it flows only a few feet below the general level. On the supposition of its having formed the gorge, it must have commenced the work of excavation when the level of the plain was at least as high as that of the barrier, and the plain itself must have been worn down by the river. Many considerations prove that the plain could never have been worn down by the river, or its subaërial assistants but supposing this to have been the case, why should the river have made such a wide display of its denudating power on the area of the plain, and done so little in the gorge? Many river-courses which do not embrace plains, consist of a succession of wide basins and narrow connecting gorges, where the rivers ought to have formed continuous valleys, supposing them to have been the excavating agents.[1] All these phenomena can be easily explained by supposing the plains to have been arms of the sea, the wide valleys or basins inland seas and bays, and the connecting narrow valleys or gorges, straits.

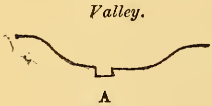


Fig. 1.

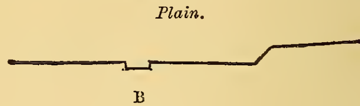


Fig. 2.

That rivers have not excavated large valleys of the form represented by Fig. 1 is, I think, evident, not only from the fact that they have done so little on plains, but likewise from the similar form of their *actual* channels in the valleys and on the plains. I cannot see why the channel A, Fig. 1, should not be regarded as the measure of fluviatile denudation as much as the channel B, Fig. 2.

Reserving for a future occasion some additional remarks on the river-courses of Wales, the Lake District, and other parts of England, I would conclude this article by again directing attention to the simplicity of the marine contrasted with the pluvial and fluvial theory of denudation. The latter, regarded as embracing only one period of emergence, requires such a combination of disintegrating and carrying agents, and such a correspondence between local elevatory movememts and inclinations in river-channels, to keep its complicated machinery going, and prevent a glut of detritus, as to render it untenable without very strong evidence in its favour, consisting of an extensive collection of instances, and a wide indication of facts; and when we come to connect former with recent periods of emergence, the theory becomes still more entangled. The reiterated and locally-unequal movements, necessary to submerge and re-elevate a given area, accompanied by the increase or obliteration of pre-existing inequalities through the action of the sea, must be sufficient to derange the effects of any former system of subaërial denudation, so as to render a resumption of its operations impossible, and a fresh beginning necessary.

IV.—On a Species of Lichas, and other new forms from the Llandilo Flags.

By H. Wyatt-Edgell, 59th Regiment.

It was publicly stated not long since[2] that of all the Silurian strata there were no two so closely connected as the Llandilo

[1] Examples of all the above phenomena may be found in the courses of the Ogwen, Dee, Severn, Teme, Lug, Derwent (Derbyshire), Wye, Usk, Avon (Somersetshire), Exe, Dart, etc.

[2] See Professor Ramsay's Address, 1863, Quart. Journ. Geol. Soc., vol. xix. p. 38.

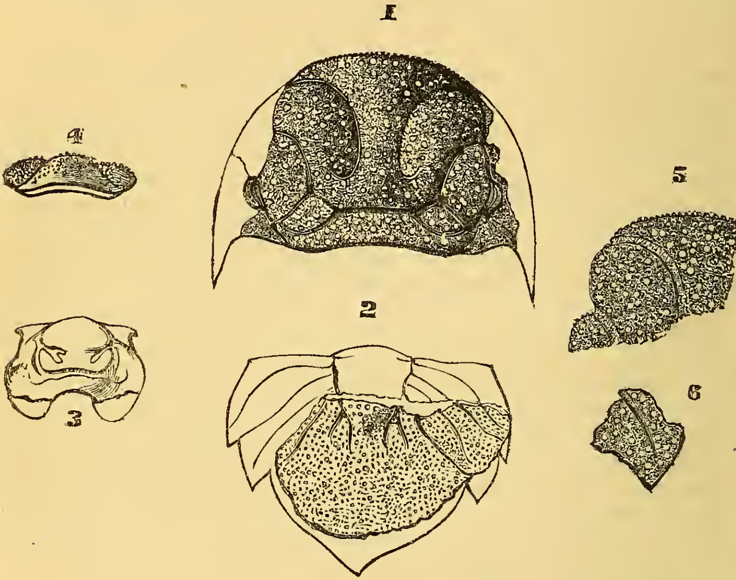
and Caradoc groups. At the time this seemed a bold assertion, considering the great number of genera which were then thought to originate in the latter, not being known in the former. Some new forms, however, that have lately come to light from the Llandilo flags, show the connection between the two strata to be closer than it formerly appeared.

When on a tour last autumn through South Wales, I was so fortunate as to find the following trilobites in the Llandilo strata:—A new species of *Phacops* (which I believe Mr. Salter intends to describe under the name *P. cōnatus*), new species of *Proetus*, new species of *Trinucleus*, and *Lichas patriarchus* new species. The last fossil is described below. Besides these trilobites, there are in my collection some mollusca and minor things from the same formation, which make an important addition to the known British fauna of that period. I here give a list of them :—*Endoceras*, new species, *Helicotoma*, or *Ophileta*, new species (these two I hope to describe before long, naming them respectively *E. Eoum* and *H. Anglica*), *Orthoceras subundulatum* (?), *Trematis* (?) new species, *Rhynconella* species, *Strophomena* (common but unnamed species), *Orthis crispa*, *O. testudinaria*, *O. insularis*, *O.*, species something like *insularis*, *Palœarca* species (like *P. bulla*), *Modiolopsis*, two new species, *Ctenodonta* species, *C. varicosa*, *Beyrichia complicata*, a Crinoid (the *Rhodocrinus? quinquangularis* of the list in appendix to "Siluria"), *Phyllopora* species, and I may add *Heterocrinus* (?), of which I have seen a fine specimen in the collection of Mr. Eskrigge, of Liverpool. It is through the kindness of this gentleman in lending me his specimens, that I am enabled to figure the anterior margin of the head and the restored tail of *Lichas patriarchus*, of which fossil he was the first discoverer. The portions of it in his possession, as well as those in my own, were obtained from Pont Ladies quarry, Llandilo; where they were associated with *Asaphus tyrannus*, *Calymene Cambrensis*, and most of the common Llandilo forms. I subjoin a description of this new form.

Anterior margin of the head a semicircle; central lobe of glabella gibbous, and of a truncate outline; first or anterior pair of lobes slightly convex, curved so as to partly encircle the second lobes. The eyes placed on the outer edge of the latter, which reach the neck-furrow and enclose between them the triangular third, or neck lobes, four-thirds their own breadth apart.

The length of the glabella is five-sixths its breadth, measured from eye to eye. The central part is suddenly widened at the posterior end, owing to the incompleteness of the first pair of furrows, which do not reach the second lobes, but terminate in half loops at about one-eighth the length of the glabella from the neck-furrow. The first lobes almost reach the anterior margin of the head and terminate in obtuse spherical angles, of which one side is enclosed by the central part, this being very wide anteriorly, though narrow between the base of the lobes (two-thirds of their breadth).

The second furrows are nearly parallel from the sharp anterior angles of the centre of the glabella to the lanceolate extremities of the second lobes; thence they converge and are parallel with the first pair. When they reach the third lobes (at which point the third furrows branch off from them), they are abruptly bent, and directed almost on each other, are soon lost in the neck-furrow. The third pair of furrows are short and not deep, making, with the second pair, angles of 130°, which are the anterior angles of the small neck-lobes; these are in the form of sectors of a circle, for their posterior edge is curved. The second lobes are convex and elongate, indented in the centre by the eyes; they are continued as far as the neck-furrow, outside the third pair. This furrow is straight



Lichas patriarchus, nov. sp. Llandilo Flags.
Pont Ladies Quarry, Llandilo.

Fig. 1. Head of *Lichas patriarchus*, with sides restored.
Fig. 2. Tail of same, restored from a specimen belonging to Mr. Eskrigge.
Fig. 3. Labrum of same.
Fig. 4. Anterior margin of head, as seen in Mr. Eskrigge's specimen.
Fig. 5. Portion of head magnified. Fig. 6. Portion of tail magnified.

in the centre, and curved round the third lobes; outside them it sweeps forward, parallel to the posterior margin of the head. The space between the two is in the centre one-sixth, and at the neck-lobes one-twelfth of the whole length of the glabella. This in my specimen is about six lines; in a larger one of Mr. Eskrigge's it is about ten lines.

I have only one specimen of a pleura, which shows the pleural furrow to be very deep, and continued, apparently, to the outer extremity.

The axis of the tail (which, at the anterior margin, is about three-fourths the breadth of the sides,) is remarkably flat for the greater part of its length: posteriorily it rises to a boss, which must have been nearly equidistant from the extremity and the anterior edge of the tail.

The axal furrows converge (so as to form, if produced, an angle of 25°) as far as this boss; they are slightly curved round it, and then disappear. From each of these, at one-fourth and one-half its length, respectively, branch two deep sinuous furrows, which are curved backwards, the second more so than the first, to the outer margin. There are also less deep secondary furrows, of which the first pair have a wavy course from the anterior corners of the axis to the outer extremities of the nearest primary furrow; the second pair are similar to them; the broad ribs contained between the first primary furrows and the anterior margin are produced into short flattened spines, similar to *L. Barrandii;* probably it was the same with the posterior pair of these ribs, there is a short and shallow furrow diverging from each side of the axis, near its extremity; the rest of the tail, from this point to the posterior margin is flat, merely covered with the mixed granulation observable also on the head. No specimen that I have seen shows the extremity of the tail.

The labrum is a slightly granular and deeply furrowed plate, having two broad and flat auricles posteriorly; the anterior corners being rectangular, and the margin between them gently curved. There is a broad central lobe to the labrum, encircled by a furrow which terminates both ways at the anterior margin, this lobe having on either side a deep indentation.

Of British species *Lichas patriarchus* most resembles the *L. subpropinqua* of McCoy, but the elongate outline and short axis of the latter show it at once to be different.

From most of the Swedish *Lichades* it is distinguished by the incompleteness of the first pair of glabella furrows; from *L. convexus*, Angelin, which resembles it in that particular, by its truncate outline, and by the eyes being placed lower down. The elongate form of all the parts of *L. cicatricosus*, Löven, and the triangular outline of the tail of *L. laciniatus* distinguish directly these two species from ours.

I have made these comparisons with Swedish species at the desire of Mr. Salter, who considers them necessary on account of the great similarity of forms in the group to which *L. patriarchus* belongs. *Lichas pachyrhinus*, Dalm., or *L. convexus* may be taken as its type.[1]

There is no Bohemian *Lichas* which bears much resemblance to ours.

[1] See Angelin's Palæontologia Suecica.

V.—Notes on Chinese Figure Stones.

By Prof. A. H. Church, M.A., F.C.S.,
Of the Royal Agricultural College, Cirencester.

THREE minerals, Nephrite, Agalmatolite, and Steatite, are much used by the Chinese for small articles of ornamental sculpture. The examination of several oriental specimens of these substances in my collection has led to some interesting results, which I have embodied in the following brief notes :—

1. *Nephrite*, or jade, is now generally considered a variety of tremolite, its low density, among its physical characters, being sufficient to distinguish it from augite. Nephrite varies in colour from a dull greyish-white to a dark leek-green ; rarely it is of a much more brilliant green tint. On one or two specimens I have observed small brownish and yellowish patches, and quite lately I met with a large specimen of the mineral of a good and well-defined honey-yellow colour throughout. The hardness was nearly 6, the fracture was splintery, and the lustre glimmering. A careful determination of density gave the figure 2.64. The mineral was further identified by an analytical examination. I believe yellow jade to be, however, rare.

2. *Agalmatolite*, there is little doubt, is a good species ; yet I have seen in a public collection of minerals several oriental figures of steatite labelled "agalmatolite." This error is alluded to in mineralogical works, and is of frequent occurrence. A determination of the density of a Chinese agalmatolite seal gave the figure 2.805, a result closely agreeing with other observations. The red mottlings on some of the larger masses of agalmatolite contain a large quantity of ferric oxide, and are of greater density than the paler portions. In the black mottlings I looked in vain for manganese. The powder of the black parts is grey, and if it be thrown into a fused mixture of caustic soda and chlorate of potassium no green manganate is formed, but a series of slight deflagrations occurs, indicative of the carbonaceous character of the black colouring matter.

3. *Steatite* is clearly distinguished from agalmatolite by its inferior hardness, scarcely more than 1, while agalmatolite is nearly 3. The density of steatite is variously given. For a specimen containing interstitial air, and preserved from the action of water during immersion in that liquid by a film of collodion, I found a density equal to 2.28 ; the same specimen freed from interstitial air gave the number 2.58. I have observed that the surfaces of Chinese steatitic carvings have generally been subjected to an artificial treatment, which materially alters their physical characters. A considerable degree of translucency and an increased hardness have been obtained by a saturation of the surface with wax, probably of vegetable origin. In my experiments I have taken care to remove this altered surface-layer.

NOTICES OF MEMOIRS.

I.—On a Collection of Fossils from the Jarrow Colliery, Kilkenny, Ireland.[1]

By E. Perceval Wright, M.D., F.L.S., Professor of Zoology, Dublin University.

With a Description of the Vertebrate Remains, by T. H. Huxley, F.R.S., Professor of Natural History at the Royal School of Mines, Jermyn Street.

THE Coal-producing portions of the counties of Kilkenny, Queen's County, and County of Carlow, have been described more than half a century ago by Sir Richard Griffith, Bt., under the name of "The Leinster Coal District." The general appearance of the Coal country, when viewed from a distance, is that of a very steep ridge of high land, running in a direct line for many miles, rising from 800 to 1,000 feet above its base, and apparently flat on the summit. It preserves this character on every side; but when viewed from the eminence itself, it resembles a great barren table-land, rising precipitately above a flat and highly cultivated country.[2]

The portion of this district with which we are more immediately concerned, is the high table-land of Castle Comer, which is about 1,000 feet over the sea-level. The whole of this table-land is formed by a series of dark, sometimes black, shales, interstratified with sandstones and flagstones of various shades of gray, which series, from its occasionally containing beds of Coal, is spoken of collectively as "The Coal Measures."

The Coal Measures of this district have a more or less basin-shaped arrangement, resting on the Upper Limestone, beneath which is the calp or Middle Limestone, and then the Lower Limestone resting on the Granite. The depth of the Limestone in the centre of the district is about 1,850 feet, or more than a thousand feet below the level of the sea, while on the outer slopes of the table-land it rises to an elevation of some 250 feet above the sea-level.

The black shales generally contain fossils belonging to such genera as *Aviculopecten, Euomphalus, Goniatites, Bellerophon,* etc.; but the beds interstratified with the Coal are found to contain plants belonging to *Lepidodendron, Calamites, Sigillaria, Pecopteris, Sphenopteris,* etc., etc. Several new species of these latter genera, as well as two new species of the genus *Bellinurus,* have been lately described by Mr. W. H. Baily,[3] from the coal of this district.

In one of these collieries, that of Jarrow, the Coal is worked at a depth of about 210 feet beneath the surface. The roof of the pit is formed of clay slate, immediately under which is a seam of inferior

[1] Abstract read before the Royal Irish Academy, on Monday, 8th January, 1866. The paper will be published in Vol. xxiv. of their Transactions, with a series of plates, by Mr. Dinkel.

[2] Vide Report on the Leinster Coal District, by Richard Griffith, Dublin, 1814, p. 2.

[3] Vide Explanation of Sheet 137 of the Maps of the Geological Survey of Ireland, p. 14.

Coal, about three inches in thickness. Then we find a seam of excellent Coal, about three feet in thickness, known as Stone Coal, which rests on a bad description of a foliated Coal, some fourteen inches in depth. Next is a layer of slaty Coal, nine inches in thickness, called by the miners the "wire sole;" then a four-inch Coal, under which is a white-coloured slate rock, and a six-inch bed of culm, resting on the "Coal seat."

The date of the first boring in this pit is 1812. It was first worked successfully in 1827, and continued open until 1832, after which it was not worked until 1853, when it came into the possession of its present proprietor, Mr. S. Bradley. There is some difficulty, from want of positive evidence, in deciding exactly what Coal bed is the one worked in this pit; but no fossil forms, save those of ferns, had been detected in it, or in the culm, until Mr. W. B. Brownrigg, visiting the pit late in the season of 1864, was struck by the remarkable appearance presented by some of the tail vertebræ of a Labyrinthodont Amphibian, named in this paper *Urocordylus Wandesfordii*. Believing it to be of the greatest interest, he collected all the specimens of fossils to be found from time to time; and, in the course of the following year, having mentioned the subject to one of the authors of this paper, a grant of money was obtained, in September, 1865, to work the deposit from the British Association. Since then, repeated visits have been paid to the colliery, the proprietor of which, and Mr. K. Dobbs, the agent of the property, not only gave every facility for the prosecution of these researches, but aided and assisted them in every possible way, giving the strictest injunction that every specimen found should be properly preserved.

By such systematic collecting a large series of fossils were very soon brought to light, and perhaps the largest number of specimens were those of many genera of plants, some of which, in all probability, will throw much light on existing genera of coal-plants, and others may eventually prove to be undescribed species. There is also a considerable collection of fish-remains; spines apparently referable to several species of *Gyracanthus*, with several other Elasmobranchs; large specimens, with the singular vertebral column wonderfully preserved, of some species of *Megalichthys*. Another ganoid fish, upwards of four feet in length, and especially provided with strong, long and much curved ribs, a broad head and rounded snout, large opercula, characterised by a raised longitudinal rib,—we refer to a new genus *Campylopleuron*. But although the plants and fish were both numerous and interesting, the most remarkable discovery was that of many novel forms of Labyrinthodont Amphibia; and, leaving the description of the former with that of some few strange forms of invertebrates to be described hereafter, our present object is more particularly to give detailed descriptions, drawn up by Professor Huxley, of the following new genera and species of amphibia.

1. The genus *Urocordylus* is distinguished by the remarkable size and strength of its tail, and by the great development of

the neural spines and chevron bones of the caudal vertebræ, which must have conferred upon the tail great power as a natatorial organ.

The tail is not less than nine times the length of the head, and is composed of, at lowest, seventy-five vertebræ. Throughout the anterior three-fourths of the tail, the centra of the vertebræ are short and bi-concave; but their neural spines and chevron bones are produced into long flattened plates of bone, narrower at their attached than at their free ends, where the bony substance becomes longitudinally grooved, and, as it were, frayed out. The height of one of these vertebræ, from the upper edge of its neural spine to the lower edge of its chevron bone (which is continuously ossified into the middle of its under face), is three times as great as the length of its centrum.

In the body the neural spines shorten greatly, their height not exceeding the vertical diameter of their centre; but they retain their antero-posterior elongation.

The number of vertebræ in the body cannot at present be ascertained with certainty. That they were not fewer than ninety is clear, but they may have been much more numerous.

The skull is broad and short, and is about 1.2 inches long in a specimen, the tail of which exceeds twelve inches in length.

Both the hind and fore limbs are completely developed, though small, and the posterior member is longer than the anterior. The hind limb, from the head of the femur to the extremities of the digits, nearly equals the centra of six anterior caudal vertebræ in length, or 1·5. There are five well-developed long and slender digits; but the carpus does not seem to have been ossified. The fore limb is not fully preserved, but it would appear to have resembled the hind limb.

The ventral surface of the body is provided with an armour of dermal ossifications, of an oat-like or spindle-shape, and each about 0·2 in. long by 0·05 in. broad.

We propose to confer upon the species, upon which the above description is based, the title of *Urocordylus Wandesfordii*, after Mr. Wandesford, the lord of the soil of the colliery from which it was obtained.

2. *Ophiderpeton.*—When the peculiar caudal vertebræ of *Urocordylus* were first discovered they were, for the most part, unconnected, not only with body vertebræ, or skulls, but with any other remains. Only in one instance did a series of such vertebræ present, at its anterior end (where it was obviously about to pass into the body, which was unfortunately broken away), a number of scattered oat-shaped dermal ossicles.

At the same time, however, certain slabs exhibited skulls, followed by long series of dorso-lumbar vertebræ and ribs, with a very complete ventral dermal armour, composed of elongated and oat-shaped ossicles. Thus one was naturally led to combine these disjoined anterior and posterior fragments, which seemed to be identified by their common armour. But it turned out, on strict comparison, that the ossicles of the anterior fragments, which are termed

Ophiderpeton, are more slender and rod-like than those of the posterior; and with the most complete specimens of *Urocordylus* and those of *Ophiderpeton* side by side, it is obvious that while the dorsal vertebræ are equal in length, the head is smaller in *Ophiderpeton* than in *Urocordylus*.

Again, although the series of dorso-lumbar vertebræ in the most complete *Urocordylus* is unfortunately interrupted, it seems difficult to imagine that the total number of these vertebræ (of which about twenty are now discernible) could have exceeded thirty or thirty-five, while in the original specimen of *Ophiderpeton* there are between forty and fifty such vertebræ following the head; and, in another, nearly a hundred vertebræ, apparently belonging to the same genus, succeed one another without being commenced or terminated by head or tail.

Neither of these specimens exhibits any trace of limbs; but a much smaller one, apparently (though not certainly) belonging to the same genus, shows a pair of minute anterior limbs, and what looks like a jointed filamentous appendage posteriorly. The phalanges of the digits in the anterior limbs are thick and short, and only three digits are preserved.

The study of new specimens will, doubtless, speedily clear up all these ambiguities and difficulties. The species at present known thus far, attained a length of three feet. We propose to call it after the indefatigable explorer of the produce of the collieries, to whom we are so much indebted, *Ophiderpeton Brownriggii*.

3. *Ichthyerpeton*.—We have, at present, only the hinder half of the body of a single individual of this genus, which is, however, extremely well marked by its deep and, comparatively, short tail, covered with small truncated and apparently horny scales. The hind limb is remarkably short and broad, and appears to have been sheathed in a rugose or scaly integument as far as the bases of the short digits, of which five can be counted. The vertebræ are short and deep, and either biconcave disks or rings; they seem to have been only incompletely ossified in the caudal region. The ventral region in front of the posterior limb, presents transversly directed rows of curved spiculiform ossicles.

What remains of the body of this remarkable animal is ten inches long, and its total length could hardly have been less than fourteen inches.

We have named the species *Ichthyerpeton Bradleyæ*, after the wife of the proprietor of the colliery, to whom we are indebted for leave to collect these fossil remains.

4. *Keraterpeton*.—This is the genus which is best represented in the collection; very complete specimens having been obtained, showing all needful details of the structure of its skeleton.

It is a salamander-like animal, which attained a length of between eight and nine inches. The tail is rather longer than the body and the head taken together. The broad and short head, with large and forward orbits, is remarkably characterized by the prolongation of the epiotic bones into the long and somewhat curved horn-like processes, which have determined the name of the genus. There appear to have been not more than twenty vertebræ, all provided with strong curved ribs, between the head and the commencement of the caudal region; and, probably, there were about as many in the tail.

All the vertebræ have long, but not high, lamellar neural spines, the length of which is hardly increased in the caudal region, where the chevron bones take a form corresponding with that of the neural spines, and like them are fimbriated or grooved at their free edges.

The tail is thus, in principle, similar to that of *Urocordylus*, but differs widely in its details.

The hinder limbs, somewhat larger than the anterior, have five long and slender digits, and an unossified carpus, as in the recent *Proteidea*. The fore limb had certainly four and probably, five, similar digits.

The ventral surface of the thorax was provided with the sculptured bony plates, characteristic of the Labyrinthodonts, and between these and the pelvis is a dermal armour, composed of minute granular ossicles, and apparently in some parts of broader plates.

This genus was first brought to Prof. Huxley's notice by his friend and colleague, Prof. Jukes, who forwarded to him a drawing of a specimen obtained by Mr. Galvan, of the Irish Survey.

Prof. Jukes' letter is dated Nov. 8th, 1865, and contains the information that Mr. Baily says "it is not unlike the things figured in Pl. 7 and 10 of Dunker and Meÿer, vol. vii. These however are called *Andrias Tschudii*, and come from the Brown Coal." It does not appear that Mr. Baily ever gave a more definite opinion than this as to the nature of these remains.

Prof. Huxley returned the sketch, with the information that the animal represented was certainly a new Labyrinthodont Amphibian, and named it *Keraterpeton Galvani*.

5. *Lepterpeton*. This new form is readily distinguished from all the others by its slender body, its elongated head, and especially by the prolongation of the symphysial part of the mandible, somewhat approaching what occurs in the *Ichthyosauria*, and certain *Crocodilia*.

The body and head are shorter than the tail, and the hind limbs, which have remarkably long digits, are twice as long as the fore limbs. There seem to be about eighteen vertebræ, with hour-glass shaped centra, in the dorso-lumbar region. The largest complete specimen of this genus is six inches long; but some fragments indicate that it attained greater dimensions.

We name the species *Lepterpeton Dobbsii*, after Mr. K. Dobbs, the agent of the property.

6. *Anthracosaurus*. The sixth genus is represented by a specimen containing the posterior half of the skeleton of an animal, probably not less than seven feet long, and displaying caudal and dorsal vertebræ, many ribs, the relatively small hind limbs, and part of the pelvis. From the character of the vertebræ and ribs we are greatly

disposed to refer these remains to the genus *Anthracosaurus* (Huxley) of the Glasgow Coal-field. If it be different from *Anthracosaurus* it is a new genus.

Besides the genera thus diagnosed there are indications of the existence of several others; but the evidence is not sufficient to justify us in saying more, at present, than that such indications exist.

The importance of the discoveries which have been made in the Kilkenny Coal-field may be estimated by calling to mind the fact that two months ago the total number of genera of vertebrate animals of higher organization than fishes, known to exist in the Carboniferous rocks of Europe, amounted only to eight, viz., *Archegosaurus, Sclerocephalus*, and *Apateon*, in Germany; *Parabatrachus, Anthracosaurus, Loxomma, Pholidogaster*, and *Anthrakerpeton*, in Great Britain. In addition to these, America had yielded the five genera, *Baphetes, Raniceps, Dendrerpeton, Hylerpeton*, and *Hylonomus*, making a total of thirteen genera for the Carboniferous formation in general.

One Irish Coal pit has thus yielded, in the course of a few months, by careful exploration, more genera than are known from all the American Coal-fields, and nearly as many as have been obtained from Europe generally.

Five-and-twenty years ago only one genus of *Vertebrata* higher than fishes (*Archegosaurus*) was known to occur in the Coal; and, curiously enough, this genus, by the imperfect ossification of its vertebral column, and the persistence of its branchiæ, lent strong support to the opinions of those who believe that Palæozoic vertebrates must necessarily be of low organisation.

Dr. Dawson's discoveries in the Nova Scotia Coal-fields first shook this view, which finally ceased to be tenable when the great *Anthracosaurus* of the Scotch Coal-field was found to have well ossified biconcave vertebræ.

The Jarrow discoveries afford a most important aid in the same direction, shewing as they do that the Labyrinthodont type was abundantly represented in the Carboniferous epoch, by animals with well ossified vertebræ; with no trace of persistent branchiæ; and, to all appearances, just as highly organised as their congeners in the Trias.

Furthermore these discoveries have a value of their own in the circumstance that they make us acquainted with forms of Labyrinthodonts of a new character. All previously known Labyrinthodonts have the form of salamanders,[1] with long tails and moderate limbs.

But *Ophiderpeton*, with its snake-like body, seems to represent among the Labyrinthodonts the type of *Amphiuma*, or perhaps of *Cæcilia*, among existing *Batrachia*. Should further investigation bear out this suggestion, three groups will be recognisable among the Labyrinthodonts: a perennibranchiate division represented by *Archegosaurus;* a salamandroid group, comprising most of Laby-

[1] The current restorations of the genus *Labyrinthodon* under the form of a great toad have no justification, but are contradicted by well-known facts.

rinthodonts at present known; and an ophiomorphous division, typified by *Ophiderpeton.* The anurous frog-like form will be alone wanting to complete the representation of the existing Amphibia in ancient times.

In concluding, it is but right that we should return our best thanks to Mr. Brownrigg, Mr. S. Bradley, and Mr. K. Dobbs, not only for what they have done in collecting these remains, but for the generous manner in which they have placed all their collections at our disposal. Our thanks are also due to the Rev. Prof. Haughton, M.D., the Rev. J. Emerson, and Dr. Swan, for the loan of specimens; and to the Directors of the Irish Great Southern Railway for liberty to bring from Carlow any quantity of Coal-fossils, carriage free.

II.—On a Possible Cause of Climatal Changes.[1]

By John Evans, F.R.S., F.S.A., Sec. Geol. Soc.

THE Author called attention to the great climatal changes which have taken place in the northern hemisphere, and suggested that corresponding changes have in all probability taken place in the southern hemisphere; but on account of our more limited geological observations we are unacquainted with them.

The extreme refrigeration of this portion of the globe at the glacial period is constantly receiving fresh corroboration, and various theories have been proposed to account for this accession of cold in a satisfactory manner.

Variations in the distribution of land and water, changes in the direction of the Gulf stream, the greater or less eccentricity of the earth's orbit, the passage of the solar system through a cold region in space, fluctuations in the amount of heat radiated by the sun, alternations of heat and cold in the northern and southern hemispheres consequent upon the precession of the equinoxes, and even changes in the position of the centre of gravity of the earth, and consequent displacement of the polar axis, have all been adduced as causes calculated to produce the effects observed.

Mr. Evans referred to the observations of Laplace and other astronomers as rendering untenable any theory involving a material change in the earth's axis of rotation.

Sir Henry James (*Athenæum,* Aug. 25, 1860) appears nevertheless to have concluded that it was impossible to explain certain geological phenomena without recourse to the supposition of constant changes in the position of the axis of the earth's rotation. The late Sir John Lubbock's observations (Quart. Jour. Geol. Soc., Vol. v., p. 5), were also quoted by the author.

Sir John Lubbock, in common with other astronomers, appears to have regarded the earth as consisting of a solid nucleus with a body of water distributed over a portion of its surface, and upon this

[1] Abstract of a paper read before the Royal Society, March 15th, 1866.

assumption the doctrine of the persistence of the direction of the poles seems almost unassailable.

Assuming, however, that the solid portion of the globe consists of a comparatively thin but rigid crust, with a fluid nucleus of incandescent mineral matter within, and that this crust from various causes is liable to changes disturbing its equilibrium, such disturbances may lead, if not to a change in the position of the general axis of the globe, yet at all events to a change in the relative positions of the solid crust and fluid nucleus, and in consequence to a change in the axis of rotation so far as the former is concerned.

The author admitted that the existence of a central mass of matter fluid by heat, although accepted by most geologists, had been called in question by some, and among them a few of great eminence.

The gradual increase of temperature observed all over the world in descending beneath the surface of the earth in mines, and deep borings, the existence of hot springs, and the traces of volcanic action, either extinct or still in operation, strongly support the hypothesis of central heat.

The fact of the increment of heat at different depths from the surface seems so well established, it would appear that at a certain point such a degree of heat must be attained as would reduce all mineral matter with which we are acquainted to a state of fusion. Beyond this point probably no great variation in temperature takes place. Those who regard the globe as a solid, or nearly solid mass, consider that many volcanic phenomena may be accounted for upon the chemical theory. But the existence of local subterranean seas of fluid matter would hardly account for the increase of heat at great depths in places remote from volcanic centres, nor for the rapid transmission of earthquake-shocks; whilst the enormous amount of upheaval and subsidence of the sedimentary strata seem inconsistent with the general solidity of the globe, or any very great thickness of its crust.

The author illustrated his theory by a diagram of a sphere as the simplest form in which to consider the relations to each other of a solid crust and a fluid nucleus in rotation together. Let the crust of the sphere be composed of solid material of uniform thickness and density, and the interior filled with fluid matter, over which the solid shell can freely move, and the whole be in uniform rotation upon an axis, the hollow sphere being in perfect equilibrium, its axis, and that of its fluid contents, would perpetually coincide. If, however, the equilibrium of the shell or crust be destroyed by the addition of a mass of extraneous matter, midway between the Pole and the Equator, the centrifugal force of the mass of matter so added would gradually draw over the shell towards the Equator; thus, though the whole sphere continued to revolve around its original axis, yet the position of the Pole of the hollow shell would be changed by 45° and the whole surface would have shifted from its original position to the same extent. The axis of the hollow sphere and of its fluid contents would again coincide, and would continue to do so until a fresh disturbance took place. If, instead of the addition of fresh matter, a portion of the shell be removed, a movement the reverse of that caused by the addition of matter would result, and that portion of the shell so excavated would eventually find its way to the Pole. In order more clearly to exhibit these effects the author had prepared a very ingenious model, suggested by Mr. Francis Galton, F.R.S., consisting of a wheel, having its axis in a frame, which is itself made to revolve with rapidity, in such a manner that the axis of its rotation passes through one of the diameters of the wheel, or what would be the axis of the sphere of which it a section. A series of screws, with heavy heads, are inserted around its rim; by screwing any of these in or out, the addition or abstraction of matter at any part of the sphere can be represented. With the screws on the wheel evenly balanced, a slight alteration in the adjustment of any of them, except at the Poles or the Equator, immediately tells upon the position of what may be called the Polar axis. [A number of experiments which were made with this model fully testified the constancy of this rule].

Assuming that the earth, instead of being a spheroid, was a perfect sphere, consisting of a hardened crust of moderate thickness, supported on a fluid nucleus, over which the crust could travel freely in any direction, but both impressed with the same original motion and revolving upon the same axis; assuming, moreover, that the surface had certain projecting portions, represented in nature by continents and islands, rising above the level of the sea, it is evident that so long as these remained unchanged, the position of the crust to the fluid nucleus would remain unaltered also. But the further upheaval or the wearing away or depression of any land-surface would result in a corresponding change in the axis of rotation, as seen in the experiments with the model.

The author contended that if all this be true of a sphere, it will also be true in a modified degree of a spheroid so slightly oblate as our globe. In the case of a spheroid every portion of its internal structure would, however, be more or less disturbed in proportion to the thickness and rigidity of the crust. The author next alluded to the ingenious speculations upon this subject by Mr. Hopkins, and suggested that if once the possibility of a change in the axis of the earth's crust be admitted, the value of the data upon which his calcu lations are based will be materially affected.

Taking the increase of heat as 1° Fahr. for every 55 or 60 feet in descent, a temperature of 2,400° Fahr. would be reached at a depth of about 25 miles, sufficient to keep in fusion such rocks as Basalt, Greenstone, and Porphyry; and such a thickness appears much more consistent with the fluctuations in level and the internal contortions and fracture of the crust everywhere to be observed. With a crust 50 miles in thickness instead of 25 miles, and the present elevations of land, it seems probable that all the foregoing experiments would hold good. Without undervaluing other causes of climatal changes, Mr. Evans thought that possibly his hypothesis might, if accepted, satisfactorily explain the extreme variations from a tropical to an arctic temperature, evidenced by the fossil remains of former geological periods discovered in such extreme northern latitudes as Greenland and Melville Island (lat. 75° north), representing forms of vegetable and animal life suited to tropical or sub-tropical regions.

Lastly, he read an extract from the Report of the Astronomer Royal (for 1861), "That the Transit Circle and Collinators still present those appearances of agreement between themselves and of change with respect to the stars, which seem explicable only on one of two suppositions—that the ground itself shifts with respect to the general earth, or that the axis of rotation changes its position."

A prolonged and interesting discussion ensued, in which Professors Ramsay and Tyndall, Mr. Grove, Mr. Spottiswoode, Mr. Mallett, Mr. Hopkins, and the Secretary took part.

III.—On the Discovery, in Hainaut, of a Limestone with a Tertiary Fauna, beneath the Sands referred by Professor Dumont to the Landenien System.

By MM. F. L. Cornet and A. Briart.

THE Lower part of the Tertiary strata of Belgium has been divided by M. Dumont into five systems, distinguished by their nature, relative position, and fossils, to which he has given the names Landenien, Ypresien, Paniselien, Bruxellien, and Lackenien.

The lower stage of the Landenien system, a marine formation, is placed by M. Dumont on the same horizon as the lower bed of the Paris Basin, and it is below this (Landenien) stage, in the neighbourhood of Mons, that MM. Cornet and Briart have found a Limestone containing a rich Tertiary fauna. But it is most remarkable that this fauna, instead of resembling that of the Landenien system or the corresponding French stages, appears to be equivalent to that of the Bruxellien, from which it is separated by all the strata of the Landenien, Ypresien, and Paniselien systems.

The discovery was made during the boring of a well, which traversed 1 metre 70 of diluvian *débris*, and 5 metres of glauconitic sand, belonging to the lower Landenien system, and then 14 metres of the Limestone, which has yielded a great quantity of fossils, many of which appear new. The authors have determined specifically 12 Gasteropods and 10 Lamellibranchs, namely—

Gasteropods.

Turritella intermedia, Desh.
Turritella imbricataria, Lm.
Voluta spinosa, Lm.
Ancillaria buccinoides, Lm.
Mitra terebellum, Lm.
Cerithium unisulcatum, Lm.
Melanopsis buccinoides, Fér.
Buccinum stromboides, Lm.
Nerita coronis, Brong.
Natica perforata, Lm.
Natica epiglottina, Lm.
Monodonta Cerberi, Lm.

Lamellibranchs.

Cytherea multisulcata, Desh.
Cardita planicosta, Lm.
Crassatella compressa, Lm.
Corbula striata, Lm.
Corbis lamellosa, Lm.
Arca biangula, Lm.
Arca modioliformis, Desh.
Tellina rostralis, Lm.
Tellina donacialis, Lm.
Lucina mitis, Sow.

M. Bosquet also has determined several species of *Entomostraca* and *Foraminifera*, all of which are Tertiary.

The authors have assiduously studied the geology of the region, and made a number of sections, in order to learn whether any disturbance of the strata has produced such a peculiar arrangement, and whether the Limestone is really overlain by the Landenien beds. They have, however, come to the conclusion that the succession is normal; but for the discussion we must refer the reader to their original paper.—*L'Institut*, 28th Feb., 1866.

IV.—Beitrage zur Palæontologie der Jura und Kreideformation im Nordwestlichen, Deutschland.

Von Dr. U. Schloenbach, Cassel, 1865.

THIS Memoir, on the Palæontology of the Jurassic and Cretaceous formations of North-western Germany, of which the first part only has appeared in one of the late numbers of the well-known "Palæontographica" of Dr. W. Dunker, is intended to illustrate the new or little known fossils of these formations. The first part contains six plates, with full descriptions and synonyms, of thirty-three Jurassic Ammonites. The author appears to have carefully consulted the various works bearing upon the subject, so that when his book is completed, it will form a useful addition to our Palæontological literature.—J. M.

REVIEWS.

I.—Geology for General Readers, a Series of Popular Sketches in Geology and Palæontology. By David Page, F.R.S.E., F.G.S. Edinburgh, 1866, pp. 268.

THE great mass of readers, now-a-days, anxious though they are to be intelligently acquainted with science, have not the time nor the patience required to master its technical details, and consequently are unable to use the most elementary manual that one would put into the hands of a young student. Those who have attained some proficiency in a science are apt to overlook this, and when seeking to entice friends into the studies which have given them so much delight, are frequently surprised to find that the attractive and simple manual, after a strong effort, is at length laid aside as dry and learned. When one has "finished his education," he will never learn any new science by beginning with a manual, unless with an amount of determination and perseverance which are seldom met with in these degenerate days. Grown up readers must learn a science first through popular sketches; these may then become the first steps to the technical handbook. So evident is this that bookshops are full of popular guides to Geology, Botany, Zoology, etc.

But these are generally prepared for *sale* by men of universal knowledge, who, with the help of "scissors and paste," are able at a few days' notice to send to press an introduction to Painting, Pugilism, or Palæontology, as required. Such productions are utterly worthless, but in the hands of an enterprising publisher, who can give them an attractive appearance, they sell, and unfortunately in a double sense. It is a gain to science when a popular volume is prepared by one who is really acquainted with his subject; such a volume we have before us. Mr. Page, however, must not continue to imagine that such attempts have not been successfully made by others. We need only remind him of that charming volume of Prof. Phillips, published in 1860, under the title of "Life on the Earth," and another by Prof. Ansted, some two or three years back, entitled "The great Stone Book of Nature."

This is one of the best of Mr. Page's many good books. It is written in a flowing popular style. Without illustration or any extraneous aid the narrative must prove attractive to any intelligent reader. As a specimen of his style we quote his notice of the changes which are continually taking place on the earth's crust.

"To the casual observer the hills and valleys that surround him appear unchanged and unchangeable. The plains and battle-fields mentioned in ancient history, the sites of cities and harbours, the courses of rivers, and the contour of mountains, are much the same as when described one thousand, two thousand, or even four thousand years ago. But to him who looks a little more narrowly the case is altogether different. The stream in the valley has cut for itself a deeper channel, and has repeatedly shifted its course—eating away the banks on one side, and laying down spits of new ground on the other. The cliffs in the hills are more weather-worn and rounded, and a larger mound of rock-débris has accumulated at their bases. The lakes of the old historic plain are partly converted into marshes, and the marshes into meadow-land; the site of the old city on the sea-cliff has been partly wasted away by the encroaching waves; and the ancient harbour, once at the river-mouth, is now a goodly mile inland, and separated from the sea by a flat alluvial delta. The Nilotic plain is not precisely the same as when described by Herodotus; the sunderbunds or mud-islands of the Ganges have been largely augmented during the last two hundred years; and many areas that were laid down on the charts of our earlier traders as mud-flats now form fertile portions of the great Chinese plain. Vesuvius has repeatedly changed its aspects since Herculaneum and Pompeii were buried beneath its ejections; and there is scarcely an active volcano that has not materially added to its bulk since the commencement of the current century. Such changes are incessant, and though individually they may seem insignificant, yet when viewed in the aggregate, and continued from century to century, they assume a magnitude commensurate with the crust of the globe itself, every portion of which has repeatedly suffered degradation and renovation, been repeatedly spread beneath the waters as sediment, and as repeatedly reconstructed into newer strata and upheaved into dry land. Imperceptibly as the rains and frosts may wear away the mountain-cliff, slowly as the river may deepen its channel, gradually as the delta may advance upon the estuary, and little by little as the volcano may pile up its scoriæ and lava, yet after the lapse of ages the mountain will be worn down, the river-channel will be eroded into a valley, the estuary converted into an alluvial plain, and the volcano rear its cold and silent dome into the higher atmosphere. All that is necessary is time, and this is an element to which we can see no limit in the future any more than we can discover a beginning to it in the past."

In a closing sentence we would note for use in a second edition the following slips in the scheme of vegetable classification, which have escaped the author. If the terms employed were more precise, the scheme would not be less popular, and the information would be more accurate. *Cryptogams* have no flowers, perfect or imperfect; *Water-lilies* are generally placed among *Dicotyledons; Cycads* are not pine-apples; *Palms* and *Tree-ferns* have true woody tissue in their structure; Ferns are as true "spore-growths" as club-mosses, and liverworts are more "leaf-growths" than horse-tails.

II.—The Geology and Scenery of the North of Scotland; being Two Lectures given at the Philosophical Institution, Edinburgh, with Notes and Appendix. By Prof. James Nicol, F.R.S.E., etc. Edinburgh, 1866, pp 96.

THE first of these lectures, and the appendix, are devoted to an exposition of Prof. Nicol's views regarding the structure of the highly altered rocks of the north of Scotland, and the second to a description of the newer strata found north of the Grampians. It is scarcely possible to popularise a subject which depends for its elucidation on the minutest details of sections and rock characters. It speaks greatly to the credit of the members of the Edinburgh Philosophical Institution, that for two nights they listened to the learned Professor. It is true the flights of fancy with which the lecturer winds up his account of some interesting section, or remarkable natural phenomenon, must have given a fresh starting point to his audience, as when he asks, "Is not the thought of the nation—its intellectual life—born of the soil, fed and nourished by the land in which we live? Is not the free exuberant poetry of Burns the genuine product of the banks and braes of bonny Doon? Does not the romantic chivalry of Scott ever reflect Tweed's silver streams, and Yarrow's dowie dens?" or, after describing the deposition of the Lewis hills on the "low gneiss platform," he says, "When we try to fathom the innumerable ages involved in these two steps in the history of the earth—and they are only two—the mind feels crushed with the interminable lapse of time, and is glad to seek repose in the view of the quiet ocean, with a few ships peacefully floating on its bosom."

The reader will find in the two lectures a connected *resumé* of what Prof. Nicol has done for the geology of the north of Scotland. As we have never been in Glen Torridon, or seen the beauties of the Gair loch, we are unable to judge of the accuracy of the author's sections, and consequently of the position he takes in opposition to the views of the officers of the Survey. In other matters he is at variance with generally received opinions; as, for instance, in regard to the age of the Red Sandstone beds at Elgin, which contain the remains of the *Stagonolepis,* the origin of the parallel roads of Glenroy, and the nature of the agency which produced the Boulder-clay.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. February 21, 1866.—Warington W. Smyth, Esq., President, in the chair. The following communications were read:—1. "On the Tertiary Mollusca of Jamaica." By R. J. Lechmere Guppy, Esq. Communicated by Henry Woodward, Esq., F.G.S.

In 1862 Mr. Lucas Barrett deposited in the British Museum a collection of Miocene fossils, from Jamaica; and the author having described the nature of the beds whence the fossils were obtained, remarked on the extended development of the Miocene formation of the Caribbean area. From his examination of the fossils, he was able to confirm many of the conclusions arrived at by Mr. Carrick Moore, from his investigation of the San Domingo fossils, and by Dr. Duncan's and Prof. Rupert Jones's investigation of the Corals and Foraminifera of the West Indian Miocene deposits.

The author considered that the Middle Tertiary beds of San Domingo, Cuba, Cumana, and the Caroni series in Trinidad, together with the Miocene deposits of Jamaica, represent the upper or latter part of the West Indian Miocene; while the chert formation of Antigua, the Anguilla beds, and the beds exposed at San Fernando in Trinidad, belong to the lower and older part of the same formation.

Reference was then made to the distinguishing features and characteristic fossils of the beds exposed in the several localities named; and in endeavouring to correlate the beds in the different islands, the terms Upper and Lower Miocene were used merely as marking what seems to be their relative antiquity. Out of sixty-one species enumerated in this communication, thirty-four have been found to be common to Jamaica and San Domingo, and fourteen to Jamaica and Cumana. Thirteen species are ascertained to be still living, some of which have been found in the Miocene of Europe and other localities. Several of the extinct species exhibit strong eastern affinities; but there is also a resemblance between a part of the fauna and that now existing in the West Indies; and a certain number of the species are allied to European early and middle Tertiary forms. The fauna as a whole is more nearly related to that of Bordeaux, Dax, and Malta, than to that of the American Miocene deposits.

2. "On Tertiary Echinoderms from the West Indies." By R. J. Lechmere Guppy, Esq. Communicated by H. M. Jenkins, Esq., F.G.S.

The Corals, Shells, and Foraminifera of the West Indian Miocene having been more or less completely described, the author now brought under notice the Echinoderms belonging to the same fauna, which have been found in Anguilla and Trinidad associated with shells determined to be of Miocene age. The species sufficiently well preserved for determination are nine in number, of which two are found in the Maltese beds; three others, which are new, are closely allied to species found in the same locality. Three out of the nine are still living in the West Indian Seas; but these are rare in the fossil state.

3. "On Tertiary Brachiopoda from Trinidad." By R. J. Lechmere Guppy, Esq. Communicated by H. M. Jenkins, Esq., F.G.S.

The beds whence these Brachiopoda were derived have already been mentioned in the previous papers. Their organic remains have led to the belief that they belong to a lower horizon in the Miocene series than the beds of Jamaica, Cumana, and San Domingo. The Brachiopoda, which consist of three species of *Terebratula*, can hardly be considered to throw much new light upon the question, as they seem to be suggestive of Cretaceous affinities. As it had been suggested that the fossils in question might be derived from older beds, the reasons which have led the author to an opposite opinion were stated; and it was remarked, in conclusion, that they do not resemble those of Malta.

4. "On the affinities of *Platysomus*, and allied genera." By John Young, M.D., F.G.S.

The author described in detail the anatomy of *Platysomus parvulus*, Ag., and two new genera, *Amphicentrum* and *Mesolepis*, all from the North Staffordshire Coal-field; and, after discussing their relations to other ganoids and to the *Teleostei*, proposed their inclusion, with the Pycnodonts and *Eurynotus*, in a distinct sub-order of Ganoids.

Sub-orders I. *Amiadæ*, II. *Lepidosteidæ*, III. *Crossopterygidæ*, IV. *Chondrosteidæ*, V. *Acanthodidæ*, have already been described by Prof. Huxley; and the author now gave diagnoses of Sub-order VI. *Lepidopleuridæ* (not equivalent to *Pleurolepidæ* of Quenstedt), including the following families:—

1. *Platysomidæ*. Teeth uniserial, conical, sharp; palate edentulous. *Platysomus*, Ag., *partim*.
2. *Amphicentridæ*. Dorsal and ventral margins sharply angulated; teeth in the form of tuberculated plates on maxillary, mandibular, and palato-vomerine bones; premaxilla and "premandibula" edentulous. *Amphicentrum*, n. g.
3. *Eurysomidæ*. Teeth in the form of blunted cones on a peduncle, with a constricted neck. *Eurysomus* = *Platysomus*, Ag., *partim*.

4. *Mesolepidæ.* Teeth similar to those of *Eurysomus.* *Mesolepis,* n. g., *Eurynotus,* Ag.
5. *Pycnodontidæ.* Teeth oval or hemispherical, or, if elongate, blunted cones. Pycnodonts of authors (except the Labroid forms of Cocchi).

Platysomus ranges from the Carboniferous to the Permian, one species, *P. striatus,* being common to both, as well as to England and Germany. *Eurysomus* is Permian only; the true Pycnodonts exclusively Mesozoic. The remaining families are Carboniferous, while the first three disprove the generalization as to the non-existence of apodal fish before the Chalk.

5. "Note on the Scales of *Rhizodus,* Owen." By John Young, M.D., F.G.S.

Attention was drawn to the fact that, on a slab in the collection of the Royal Society at Edinburgh, the characteristic *Rhizodus* teeth occur along with thick bony scales, whose exposed area is ornamented with coarse tubercles, usually irregularly disposed, while the overlapped anterior area is concentrically striated. These characters confirm the generic distinctness of *Rhizodus* from *Holoptychius,* whose smooth anterior and rugose free surfaces contrast with those described.

The following donations to the Society's Museum were exhibited:—Tertiary Echinoderms from Trinidad and Anguilla; presented by R. J. L. Guppy, Esq. Specimens of siliceous incrustations from the Hot Springs of New Zealand; presented by Miss Kinder. Protographs of the Hot Springs of New Zealand; presented by the Rev. J. Kinder.

II. March 7, 1866.—Warington W. Smyth, Esq., President, in the chair. The following communications were read:—1. "Documents relating to the formation of a new island in the neighbourhood of the Kameni Islands." By St. Vincent Lloyd, Esq., H.M. Consul at Syra, A. Delenda, Esq., Consular Agent at Santorino, and M. Décigala. Communicated by the Secretary of State for Foreign Affairs.

In these documents it was stated, that on or about February 1st, the sea in the neighbourhood of the Kameni Islands, in the centre of the crater forming the harbour of Santorino, began to show signs of volcanic action, and that the result has been the formation of a new island, which has since become nearly joined to the south of the island Nea Kameni. Details of the volcanic phenomena observed up to February 7th were given in the letters from Messrs. Lloyd and Delenda; and, in the impression of "La Grèce" newspaper of February 15th, M. Décigala gave an account of the further progress of the upheaval and increase of the new island, which he had named "George the First."

2. "On the Carboniferous Slate (Devonian Rocks) of North Devon and South Ireland." By J. Beete Jukes, Esq., M.A., F.R.S., F.G.S.

Mr. Jukes gave a sketch of the geological structure of the south-west of Ireland, tracing the Old Red Sandstone and Carboniferous Limestone from Wexford through Waterford into Cork, and showing that some thin beds of black shale, which intervened between those groups on the east, expanded westward until they acquired a thickness of two or three thousand feet. The group then received Sir R. I. Griffith's appellation of Carboniferous Slate. The Old Red Sandstone similarly expanded to the west, from a thickness of a few hundred feet in Wexford to one of several thousand feet in North Cork. Slaty cleavage, which shows itself in both these groups on the east, becomes more marked on the west, until they might both be spoken of as clay-slate formations.

West of Cork Harbour the Carboniferous Slate is covered in one or two places by patches of black slate, which Mr. Jukes believes to be the lower part of the Irish Coal-measures, resting conformably on the Carboniferous Slate, with no very definite boundary between the two, as in North Devon. He believes, accordingly, that as the Carboniferous Slate expands towards the west, the Limestone dies away from below upwards, and that the beds which are the base of the Limestone at Ballea, a few miles west of Cork Harbour, are on the same horizon as the Upper Limestone beds of Waterford, even these uppermost beds disappearing a little further west. He, therefore, looks on the Carboniferous Slate, especially in its upper part, as being contemporaneous with the Carboniferous Limestone. He believes that there is a regular consecutive series from the Old Red Sandstone into the Coal-measures, through the carboniferous Limestone in one area, and through the Carboniferous Slate in the other.

In North Devon the author considered the dark slates and sandstones, which strike from Baggy Point and Croyde Bay by Marwood and Barnstaple to Dulverton, identical with parts of the Carboniferous Slate of Ireland; and red and variegated sandstones and slates, rising out to the northward from underneath the grey series, identical in character with the Irish Old Red Sandstone. On a recent visit, however, to the north coast at Lynton, Ilfracombe, and Mortehoe, he found that those beds also were identical in character with parts of the Carboniferous Slate, and contained some of the same fossils as are found in Ireland and in the Barnstaple district, each district having fossils not found in the others.

These beds, in the absence of any reason to suspect the contrary, would be judged to pass under the Old Red Sandstone. Relying, however, on the conclusions formed in Ireland, Mr. Jukes believes that the central band of Old Red Sandstone must be cut off towards the north by a great longitudinal fault, with a downthrow to the north of some 4000 feet. Mr. Jukes pointed out that this hypothesis would do away with the necessity of asssigning the enormous thickness to the North Devon rocks which the ordinary hypothesis requires.

After discussing in general terms the objections that may be urged against the hypothesis, especially the palæontological ones, he ventured to propose that geologists should no longer include the Old Red Sandstone among the Devonian beds, but confine the term

Devonian to beds containing undoubted marine fossils, lying between the top of the Old Red Sandstone and the base of the Coal-measures. Taking their wide range over the world into account, he would even regard the Devonian rocks and fossils as the most general type of that portion of our series, and consider the Carboniferous Limestone of the British Islands and Belgium as the local and exceptional peculiarity.

The following specimens were exhibited:—*Pterygotus*, *Stylonurus*, *Eurypterus*, and *Cephalaspis*, from the Old Red Sandstone of Forfarshire; exhibited by James Powrie, Esq., F.G.S. *Encrinus moniliformis*, from the Muschelkalk, Saxony; exhibited by E. Charlesworth, Esq., F.G.S. Mineral oils and rocks associated with them from Pisa; presented by St. John Fairman, Esq. Specimens of 'Woodwardite,' a new mineral from Cornwall; exhibited by Bernard H. Woodward, Esq. A miscellaneous collection of rocks; presented by W. T. Black, Esq.

Liverpool Geological Society.—March 13th, 1866. H. Duckworth, Esq., F.G.S., F.L.S., the President, in the chair. The following papers were read:—"The Mineralogical Characters of Rocks," by Mr. F. P. Marratt. "The Geology of the neighbourhood of St. David's, Pembrokeshire," by Mr. R. A. Eskrigge, F.G.S. "The Coal-fields of Flintshire and Denbighshire," by Mr. Edward Nixon, Mining Engineer.

The latter communication was elucidated by a section of the Coal-measures of the district around Mold. The author expressed his opinion that the Coal-seams of North Wales were continued under the New Red Sandstone of Cheshire, and that the time is not far distant when means would be adopted to prove the fact. So far as the Coal-seams could at present be correlated with those of Lancashire, the beds worked in North Wales appear to represent the central portion of the middle productive measures. The upper and lower part of the series are not clearly developed, though it is probable that the whole Coal-series occur in the neighbourhood of Mold, and along the border of the river Dee. The Main Coal is considered to represent the Wigan, nine-feet; but there is no bed worked so low as the Arley Mine of Lancashire. Reference was also made to the oil-producing cannel and associated shale at Leeswood, Coed Salon, and Coppa Collieries, where over one thousand retorts have been erected, showing the importance and wealth of the district.

Mr. T. J. Moore exhibited a fine series of the bones of the Dodo, from the Mauritius, collected and presented to the Liverpool Museum by Mr. Henry P. Higginson.—G. H. M.

Dudley Geological Society.—On Friday, March 9th, a Conversazione and Exhibition of objects of scientific interest was held at the society's rooms, Dudley, under the presidency of Mr. F. Smith, M.A. There was a large attendance of members, and an extensive collection of microscopes, microscopic objects, including several thousand sections of igneous rocks; Ansell's diffusiometer; models of coke ovens, machinery, etc., revolving stereoscopes; Silurian, Carboniferous, and Drift fossils from the district, in addition to the large collection in the society's museum; mining and scientific diagrams; photographs of leading members at recent meeting of British Association.—Mr. David Forbes, F.R.S., delivered an address "On the Igneous Rocks of South Staffordshire," in which he stated that he believed all the igneous rocks of the district belong to the same class, and that they were erupted at a later period than the Carboniferous age. Altogether a very agreeable evening was spent.

Bath Literary and Philosophical Institution.—A Meeting of the Members of this Association was held on Friday evening, January 12th, the President, the Rev. Prebendary Scarth, in the chair. Mr. W. Boyd Dawkins, M.A. (Oxon), F.G.S., of London, read a paper on "Bone Caverns and River Deposits."

In the course of the making of the Great Western Railway that winds along the banks of the Avon Valley, many gravel beds were intersected, and a large quantity of remains found preserved in them. Those in the cutting at Newton St. Loe prove to belong to the elephant and horse. In the cutting at Freshford Station, besides these two animals, the great musk-sheep had been found by Mr. Moore, F.G.S., the reindeer by the Rev. H. H. Winwood, and the bison by himself. He stated that both the gravel and the included remains at Freshford appeared to have been deposited under conditions, to a certain extent, arctic; that the Avon in those days was heavily burdened with ice, and, perhaps, frost-bound for the greater part of the year; and that the pebbles of unequal size, some angular, some waterworn, and none sorted, as in the rivers of Britain now, were then embedded in ground-ice, and floated down till the miniature bergs melted, and their burden of pebbles, sand, and brick-earth was deposited. The gravel-pit at Locksbrook, near Bath, has added three more animals to the list of those from the ancient deposits of the Avon. The Rev. H. H. Winwood, to whom Natural History owes so much in Bath, has obtained from it, remains that belong to the lion, Irish elk, and the tichorhine rhinoceros. Mr. Dawkins then referred to the exploration of the Wookey Hole Cavern by Mr. Ayshford Sanford and himself, an account of which is printed in the eighteenth Quarterly Journal of the Geological Society of London. The list of the animals obtained from it comprises the cave-hyæna, cave-lion, and cave-bear, the brown bear, the wolf, fox, mammoth, two species of extinct rhinoceros, horse, urus, Irish elk, red deer, reindeer, and, last of all, man. The rude flint implements, and the fragments of calcined bone—the relics of his fires—underneath the old floors of the cave, prove that he co-existed with the other animals found in the cave. The whole number of animals living in Britain during Pleistocene times consist of fifty-three species; of these all but seventeen are proved by their remains to have inhabited Somerset, viz:—man, the cave-lion, the cave-panther, the wild cat, the cave-hyæna, the wolf, the fox, the glutton, the marten cat, the otter, the badger, the cave-bear, two species of bat, the bison, the urus, the reindeer, the red deer, the roedeer, the musk-sheep, the Irish elk, the wild boar, the horse, two species of rhinoceros, two species of elephant, the water-rat, the hare, the rabbit, the marmot, and the extinct hippopotamus.

CORRESPONDENCE.

ON THE DISCOVERY OF A BED OF DEVONIAN CORALS AT WITHYCOMBE, WEST SOMERSET.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—There is a band of Limestone, mentioned by Sir H. de la Beche, in his Geological Report on Cornwall, Devon, and West Somerset, which is traceable at intervals from Ilfracombe to Withycombe, the intervening localities being Combe Martin, Simonsbath, Cutcombe, Duxborough, and Treborough, and to quote his words, "if we be right in referring the Limestone of the Quantocks to the same band, it is carried round by Doddington, Asholt, and Cothelstone Park, the connection being concealed by the Red Sandstone series, the Lias, and the Sea."

The existence of Coral-beds in the portion of this Limestone band exposed in the Quantocks has been ascertained by Mr. J. D. Pring, of Taunton, and the only genera and species that I at present know to have been found in them—though doubtless there are many others—are the following: viz., *Alveolites suborbicularis*, *Favosites polymorpha* (*cervicornis*, M. Edwards), *Favosites reticulata*, *Heliophyllum Halli* (?), *Endophyllum abditum*, and an *Acervularia*. Of these species, specimens, presented by Mr. Pring, are to be seen in the Museum, at Taunton, and in the Collection of the Geological Society, at Somerset House.

In the spring of 1860 I was so fortunate as to discover that a Coral-bed existed in the Withycombe portion of this Limestone band, partially exposed in the fields above Sandhill Farm. I was very much interested in the discovery, as I had never expected to meet with Fossils in the Devonian Rocks of the neighbourhood, and from this time, till I left the district in 1863, I made occasional visits to the spot, and searched every part of the bed, which is exposed over a very small area, repeatedly and thoroughly, and succeeded in collecting a great number of specimens. These I have named chiefly by means of polished sections, and the following is a list of their genera and species.

List of Corals from Withycombe.

vc., very common; c., common; r., rare.

1. *Fenestella antiqua*, c.
2. *Stromatopora concentrica*, c.
3. *Favosites cervicornis*, vc.
4. *Favosites reticulata*, vc.
5. *Alveolites suborbicularis*, c.
6. *Alveolites* (species?), c.
7. *Syringopora* (undescribed), r.
8. *Amplexus* (*tortuosus*?), r.
9. *Cyathophyllum* (*Damnoniense*?), r.
10. *Cyathophyllum Boloniense*, vc.
11. *Cyathophyllum cæspitosum*, vc.
12. *Heliophyllum Halli*, c.
13. *Endophyllum abditum*, r.
14. *Cystiphyllum vesiculosum*, vc.

The Withycombe Corals are of various colours, red, yellow, grey, and black, and are usually more or less impregnated with iron. Red and yellow specimens are the commonest, and the latter generally show the structure best, which is also the case with the Carboniferous Corals of Clifton.

With reference to the shales which occur in the Withycombe Limestone, I may mention that Spirifers are common in the quarry referred to above, and in another, on the left side of the valley which leads from Withycombe to Dumbledear, are to be found examples of *Terebratula*, *Spirifer*, joints of Encrinite-stems, and a large species of *Cucullœa*, but no trace of the Corals of Sandhill Farm. In the Limestone of this quarry there are cavities containing a substance like decomposed manganese.

I also discovered, in a field upon the same farm (Sandhill), a portion of the conglomerate band, which a reference to the Map of the Geological Survey will show to be frequently observable in the New Red Sandstone of the district. It is visible for a few yards as an artificial section of no great depth, below the surface of the ground that has been worked for farm purposes. The conglomerate at this point abounds in Carboniferous Corals, amongst which I have observed *Syringopora* (*ramulosa?*), a *Zaphrentis*, *Lithostrotion Martini*, and a *Cyathophyllum;* also other characteristic Mountain Limestone Fossils. It is singular that Devonian and Carboniferous Corals should be found in such close propinquity. Previous to my ascertaining the occurrence of the conglomerate at this spot, I had found a specimen of a Carboniferous *Syringopora*, in a cart-track, beside some Devonian Corals, and was much puzzled, on learning that it belonged to a distinct formation, how to account for its presence in such a locality; but on the bed being pointed out to me, the mystery was explained.—Yours truly.

Spencer George Perceval.

Severn House, Henbury, Bristol.

THE LOWER NEW RED SANDSTONES OF CENTRAL YORKSHIRE.

To the Editor of the Geological Magazine.

Sir,—Perhaps the following notes on the so-called Lower New Red Sandstones, lying between Fountain Abbey and Ripley, may be of use in illustration of Mr. Binney's interesting paper in the February Number of the GEOLOGICAL MAGAZINE: as they refer to that portion of the district, in which, he says, Professor Sedgwick "appears to have lost sight of" the formation.

In the quarry at South Stainley, to which reference is made, and of which the following is a section, the upper beds consist of flaggy Grits, separated from the more compact Grits below by a bed of Red Sandy Clay, about a foot in thickness. The dip is to the N.W. at an angle varying from 3° to 6°.

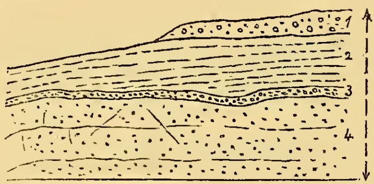


FIG. 1.—QUARRY AT SOUTH STAINLEY.
1. Drift-gravel. 2. Flaggy grits. 3. Clay-bed. 4. Red grit.

About a mile and a quarter due west is a quarry, now disused, in which the beds as they lie, with an inclination 30° S., are broken and split at their edges, and covered with a gravel of disintegrated Sandstone.

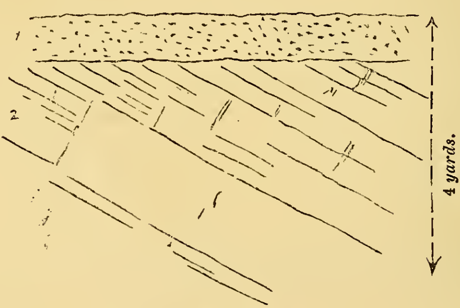


FIG. 2.—RED BANK QUARRY.
1. Gravel. 2. Red grit.

Half a mile to the S.W. of this quarry is another at Kettlespring, of which the upper beds consist of flaggy Grits, to the thickness of about 5 feet, lying upon the Red Grit, the beds of which become gradually harder as they descend. In this quarry, and in the one at South Stainley, and also on the rock to the north of Fountain's Abbey, the face of the rock is occasionally covered with Calcareous Spar, indicating the *former* presence of overlying Manganesian Limestone. A little above the village of Shaw Mills, in the same valley, is another quarry, in which the strata dip to the S.W. at an angle of 45°. There the Grit contains small pieces of Coal, evidently drifted wood, and thin pieces of soft slate. Upon the inclined strata rest two beds—an upper one of broken Sandstone, and a lower one of Yellow and Purple Sands, but these are probably of Glacial age.

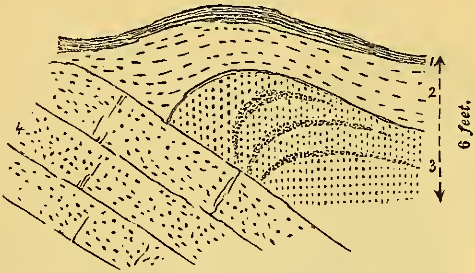


Fig. 3.—Quarry at Shaw Mills.
1. Soil. 2. Broken sandstone. 3. Yellow and purple sands. 4. Red grit.

Near Fountain's Hall a quarry, which was opened a few years ago, exhibits the same flaggy Grits, lying upon the rough Grit, but separated by a thin sheet of Calcareous Spar. Interposed between the beds of this Grit is a coarse Red Sand, some portions of which are gathered into separate masses, and curiously surrounded with sheets of Spar. A few yards to the west of this quarry the Magnesian Limestone rests unconformably upon the Grit.

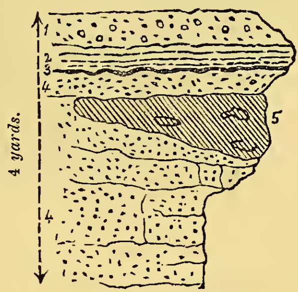


Fig. 4.—Fountain's Hall Quarry.
1. Drift gravel. 2. Flaggy grits. 3. Sheet of calcareous spar. 4. Red grit.
5. Red sands.

A considerable acquaintance with these and other quarries of the same Sandstone in this district, leaves very little doubt in my mind that the Red Grit lies perfectly conformable to the lighter-coloured and harder Grits below, and passes insensibly into them.

Between the Grit and the arenaceous flags mentioned by Mr. Binney, there occurs a highly fossiliferous bed, of three members, which seems to extend to a considerable distance both south and west. The upper bed consists of thin flags, abounding in the remains of encrinites; the second contains casts of various brachiopoda, often exceedingly beautiful, and the lowest is a hard impure

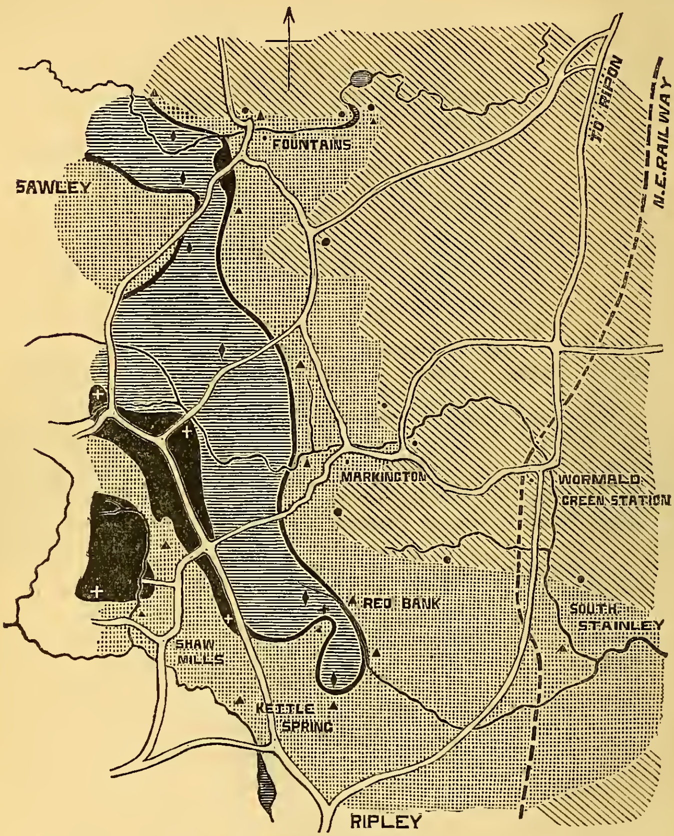


Fig. 5.—Geological Sketch Map, from Fountains to Ripley.

Explanation of Sketch Map.

	Mark of Out-crop or Quarry.	
Magnesian Limestone.	●	1. Thin-bedded Limestone. 2. Thick-bedded ditto. 3. Botryoidal ditto. 4. Marl-slates.
Grits and flags.	▲	5. Red flags. 6. Red and white grits.
Fossiliferous bed.	+	7. Encrinite flags. 8. Fossil bed. 9. Hard bed.
Arenaceous flags, etc.	♦	10. Upper flags. 11. Lower flags.

Limestone, also fossiliferous. A quarry of this may be seen at a short distance from Fountain's Hall, on the road to Sawley.—I am, Sir, yours truly.

J. S. Tute.

Markington, Ripley, Yorkshire.

MISCELLANEOUS.

The Geological Survey of India.—India has often been described as a country of mystery; but it is not the fault of India if too little is known here in the west of what she is doing. Her railway system is something to wonder at, yet it attracts but scant attention, except among those who buy or sell railway shares. The great Trigonometrical Survey of India will be, when completed, the greatest, the most accurate, and most fruitful in scientific results of any in the world. Another great work is the Geological Survey, commenced ten years ago, under the direction of Dr. T. Oldham, which, as in the case of our own Geological Survey, is dependent for its progress on the maps published by the trigonometrical surveyors. In the ten years, however, an area more than double the extent of Great Britain, chiefly in Bengal and Central India, has been carefully examined and mapped, with most valuable results. The extent of the Indian Coal-measures, and the quality of the Coal, have been ascertained; the best being the Assam Coal, which lies near the river Brahmapootra, convenient for transport by water, when once the mines shall be in work. The quality is said to be equal to that of the best Newcastle coking coal. Another series of Coal-strata approaches, by one of its extremities, within eighty miles of Calcutta, and these are described as similar to the Upper Coal-measures of Europe. The fossil plants and reptiles with which they abound are represented by numerous specimens preserved in the Geological Museum at Calcutta. Besides this, the relations of all the various strata to one another over the whole area of the Survey have been made out with much advantage to palæontological science, and with reconciliation of many apparent contradictions. The fossils of the Cretaceous rocks may be instanced as evidence of the knowledge, skill, and labour bestowed on the survey; and these with specimens of the minerals hitherto collected, are arranged in the Museum above mentioned, where their value is increased by a good library, accessible to students. The results of the survey are further made known by the publication of reports and memoirs, with maps and other illustrations, and by a highly important work, "The Palæontologia Indica," in which the descriptions are written by some of the ablest of English naturalists. We may add to this, that the Topographical Department of the Indian Government is making a Topographical Survey, which is to embrace the whole Empire, and publishing the result in a series of maps. These maps are remarkable for the fidelity with which the features of the country are delineated; those of the mountain district in particular present many interesting subjects of study. Another series of maps, intended for the use of the Revenue Department, shows every village and every field.—*Athenæum*, Feb. 17.

Petroleum at Chicago.—The sinking of an Artesian well at Chicago has brought to light the existence of oliferous strata beneath that enterprising city. In the first forty feet the rock is Upper Silurian, and so charged with petroleum that it burns freely, and 100 gallons of oil, which accumulated in the shaft, were pumped out. A compact yellowish-white stone, 200 feet thick, but showing no trace of oil, was next penetrated. Then came 200 feet of grey Limestone, with oil in thin seams, succeeded by a bed of shale, 156 feet in thickness, saturated with petroleum, and yielding much oil where it rests on the Lower Silurian. Below this occurs a reddish Sandstone, 71 feet thick, also containing oil; and at a depth of 711 feet a stream of water was tapped, of good quality, which delivers through the $3\frac{1}{2}$ inch bore 500,000 gallons a day.—*Athenæum*, Feb. 17.

New Cornish Minerals.—At the meeting of the Chemical Society, on the 1st of March, Professor Church gave some further particulars regarding his chemical researches on New and Rare Cornish Minerals. The following is an abstract of his results;

Erinite. A minute fragment of this rare arseniate of copper has been found among some undoubtedly Cornish specimens.

Marmalite. This black variety of blende occurs sparingly in quartz. The analyses pointed to the formula 4 Zn S, Fe S, the expression to which the results obtained by Boussingault with specimens from Marmato have led.

Woodwardite. A new basic sulphate of aluminum and copper has been lately detected. Prof. Church proposes to name it Woodwardite, in honour of the late Dr. S. P. Woodward. It occurs in crusts of varying thickness, and with a rippled surface. It is subtranslucent, and occurs in the form of minute botryoidal aggregations of a greenish-blue colour. Its density is about 2.38. It dissolves in dilute acids, but is insoluble in water. Dried in vacuo over oil of vitriol, Woodwardite gave on analysis constant results agreeing with the formula.

$$2\,Cu\,SO_4,\ 5\,Cu\,H_2\,O_2,\ 4\,Al\,H_3\,O_3 + 4\,H_2\,O.$$

The four outstanding atoms of water are driven off at 100° C. This mineral differs most widely from Lettsomite, its nearest ally, by containing twice as much alumina as that species.

If, instead of using the higher atomic weights as in the formula given above, we make use of the older values and the mineralogical notation, Woodwardite may be expressed by the formula—

$$2\,\dot{Cu}\,\dddot{S},\ 5\,\dot{Cu}\,\dot{H},\ 2\,(\dddot{Al}_2\,3\dot{H}),\ 4\,\dot{H}.$$

Mines of Nova Scotia.—The Report of the Chief Commissioner of Mines for the province of Nova Scotia, for 1865, contains some interesting statistics of the mineral produce of that country. The amount of gold upon which Royalty has been paid is, for the year ending 30th September, 24,867 oz. 5 dwt. 22 gr., being an increase of 6123 oz. 0 dwt. 10 gr. upon that obtained to the end of the previous year, 1864. The average yield of gold per ton of quartz shows an increase over the preceding year of about five per cent., a fact stated to confirm the prevalent impression, that the deeper mining is carried, the richer will be the quartz. As explorations are extended it becomes more obvious that the possibility of profitable mining is not confined to the isolated localities which constitute the heretofore proclaimed gold-districts, but it seems to be almost certain that the great band of Metamorphic rocks which extends along the Atlantic coast, the whole length of the province, is auriferous, and to such a degree as to render gold-mining highly remunerative. The general results of Coal-mining have been no less satisfactory than those of gold-mining, there being thirty collieries in operation, which have yielded 652,854 tons of fuel during the year.—H. B. W.

British Association.—At a meeting of the Council of the Association, held at Burlington House on the 23rd February, the following Lord and Gentlemen were appointed Presidents of the Sections at the Nottingham meeting. Section A, Mathematical and Physical Science, Professor Wheatstone; B, Chemistry, Professor Frankland; C, Geology, W. J. Hamilton, Esq.; D, Biology, Professor Huxley; E, Geography and Ethnology, Sir Charles Hamilton; F, Economic Science and Statistics, Lord Belper; G, Mechanics, James Nasmyth, Esq.

New Greek Island.—A new island began to rise above the level of the sea in the Bay of Thêra (Santorin) on February 4th, and in five days attained a height of from 130 feet to 150 feet, with a length of upwards of 350 feet, and a breadth of 100 feet. It is mainly composed of a black lava, and continues to increase. The emergence of the island was preceded, on January 31st, by "a noise like volleys of artillery," and on the following day flames issued from the sea, rising at intervals to the height of 15 feet. On February 4th the eruptions became more violent, and the sea more disturbed, and the new island was visible next morning. It has been visited by Dr. Dekigalla, an able observer, who will record all the phenomena connected with the eruption. Other islands situated in the same bay have risen from the sea in historic periods.—*Times*, February 23, 1866.

Scientific Opinion.—Number one of a new weekly periodical is announced for April 4th, entitled "Scientific Opinion." It is intended "to effect for scientific readers what 'Public Opinion' has achieved for those who are interested in politics and general literature. In its pages will be found extracts from the more important articles published in the scientific periodicals of England, the Continent, and America. It will not be devoted exclusively to any special branch of science, but will give discriminately-selected quotations from the leading periodical publications on Agriculture, Archæology, Astronomy, Botany, Chemistry, Ethnology, Geography, Geology, Palæontology, Medicine, Mechanics, Meteorology, Mining, and Mineralogy, Microscopy, Photography, Physics, Zoology, and Comparative Anatomy. Nor shall technical science alone receive consideration, but selections will be made from such essays in the 'Magazines,' Popular Science Journals, and 'Reviews,' as may appear to the Editors to be of interest or importance." Living, as we do, in an age of scientific discoveries, when few men can grasp even the literature of any single science, but, at the same time, when every well-informed gentleman is expected to be acquainted with all the leading questions of the day, we see no other method except to obtain such a Journal as the above, which might also give a well-digested résumé of scientific progress from week to week, or if that be too often, let it be monthly; only, when done, let it be *well done.*

North London Naturalists' Club.—We are glad to see the announcement of the formation of a Field-Club in the North of London, and we heartily wish it all success. It is, we believe, the only club in the neighbourhood of London devoted to the study of Natural History.

OBITUARY.

We have to record the death of Dr. Whewell, on Tuesday, the 6th March, from injuries occasioned by a fall from his horse some days previous. The Rev. William Whewell, M.A., D.D., F.R.S., F.G.S., Hon. Mem. R.I.A., etc., Master of Trinity College, and Professor of Casuistry in the University of Cambridge, was born of humble parentage, at Lancaster, in 1794 (or 1795). His writings have been both numerous and important, amongst which are, "A History of the Inductive Sciences," "The Philosophy of the Inductive Sciences," "Novum Organon Renovatum," "The Philosophy of Discovery," "The Bridgewater Treatise on Astronomy," "Indications of the Creator," etc., as well as works on Moral, Mathematical, and Architectural subjects. He contributed papers to the Royal, Geological, and Cambridge Philosophical Societies. In 1837 he was elected President of the Geological Society of London, and delivered Addresses at the Anniversary Meetings in 1838 and 1839. He was President of the British Association at the meeting at Plymouth in 1841; he also delivered an Address when acting as Secretary to the meeting at Cambridge in 1833. Until the day of the accident which proved fatal to him, Dr. Whewell retained possession of all his intellectual powers unimpaired, although upwards of 70 years of age.

Col. T. S. Heneken, F.G.S., who has contributed largely to our knowledge of the Geology of San Domingo, is reported as deceased. The results of his observations are published in the Geological Society's Journal for 1850 and 1853.

THE

GEOLOGICAL MAGAZINE.

No. XXIII.—MAY, 1866.

ORIGINAL ARTICLES.

I.—On the Origin of Valleys.

By G. Poulett Scrope, Esq., M.P., F.R.S., F.G.S., etc.

A CONTROVERSY appears to be carried on between geologists as to the causes of the excavation of valleys, and the degree in which marine denudation on the one hand, or the eroding power of rain and rivers on the other, have been concerned in the process. To this controversy Mr. D. Mackintosh has contributed two papers, in recent numbers of this Magazine.[1] I am desirous of recalling to the recollection of its readers certain facts which demonstrate, beyond the possibility of doubt, how vast is the error of those writers who, like Mr. Mackintosh, speak of "the impotence of rain as a denuding agent."[2]

Few persons, I think, can have watched the effect of a single heavy shower of rain, lasting perhaps less than an hour, on an exposed surface of earth, sand, clay, or gravel, or even on a hard road, without being struck by the wearing power of the direct fall of the rain-drops, and the escape of the water towards the lowest accessible levels, carrying with it the solid particles it has abraded from the surface. The general surface is more or less lowered, and grooves and channels formed, opening out into miniature ravines and valleys. And no one can doubt that the multiplication of such influences through an indefinite period of time must produce an amount of superficial denudation well worthy of consideration by the geologist as a possible cause of many, if not most, of the depressions observable in the subaerial surfaces of the earth.

Examples on a larger scale are among others found in the newly-formed valleys in Georgia and Alabama, described by Sir Charles Lyell (Principles, ed. 1843, p. 204), where within twenty years ravines have been formed, in what was, previously to the destruction of the forests, an even plain, some of them 55 feet in depth and 180 in width.

[1] Vol. iii., p. 63, No. 20, for February, 1866; and *ib.*, p. 155, No. 22, for April, 1866.
[2] Page 155, supra.

A still more striking instance occurs in the celebrated earth-pyramids of Botzen, in the Tyrol. Here, that a valley of very large dimensions has unquestionably been excavated by subaerial forces, chiefly by the direct descending force of rain, is proved by the remnants left of the material originally filling the hollow—a coarse gravelly conglomerate—in the shape of sugar-loaf-shaped masses, some of them forty to sixty feet high, which have evidently been preserved from destruction by the protecting covering of some great boulder which still caps, or till recently capped, each separate pyramid, and in the first case overhangs on all sides its precipitous sides. Just in the same way the larger blocks on the surface of a glacier have often acted as a shield or umbrella to the ice beneath them, while the more exposed surface of the ice-field has been worn down many feet lower by the rain-fall (See Forbes on the Glacier-tables of the Alps. Travels, 1843, p. 25).

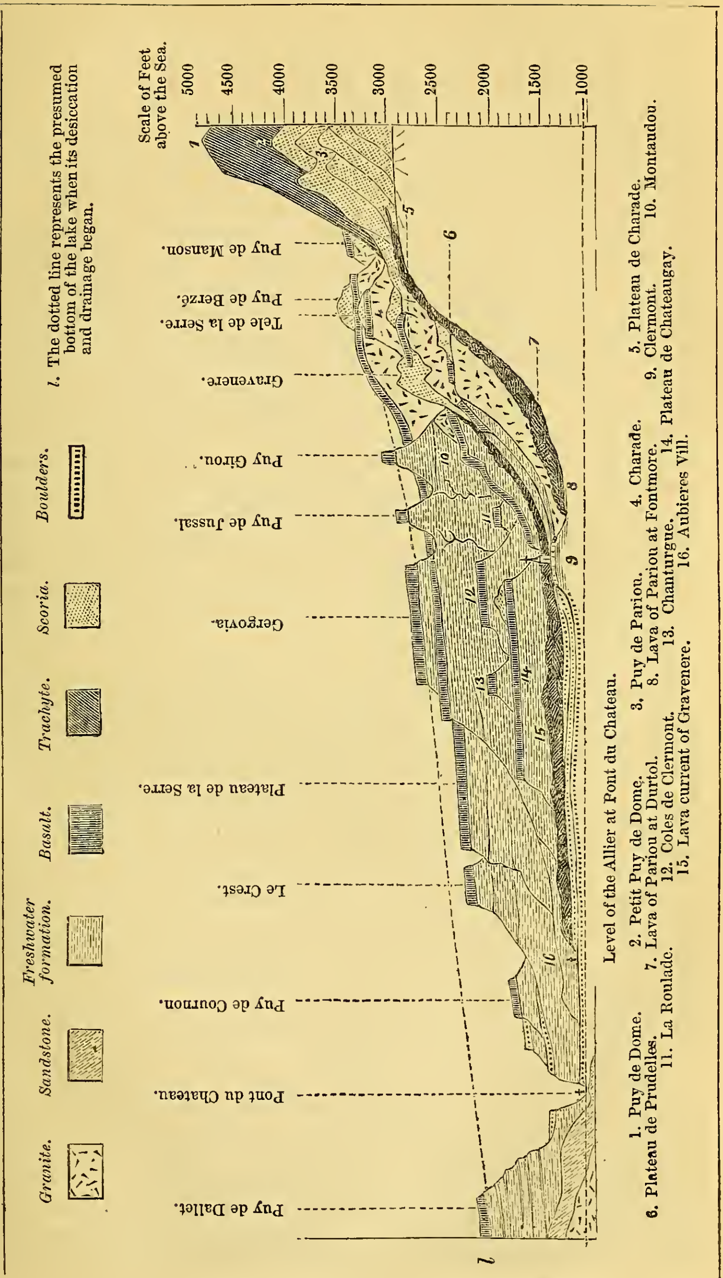
These are some of the well-known examples of the denuding agency of rain, in which it is impossible to attribute the result to any other cause. But my chief object in this paper is to recal to the attention of geologists who take an interest in this question, the very remarkable and convincing evidence of the kind exhibited by the valleys of Auvergne, into which, at various intervals during the process of their excavation, streams of liquid lava have flowed from neighbouring heights, flooding surfaces which must at the epoch of each successive lava-flow have formed the lowest levels of the valley. This evidence was brought forward by me in the first edition of my Description of the Volcanoes of Auvergne, as far back as 1825, and the inferences I deduced from it confirmed and endorsed from their own observations by Sir C. Lyell and Sir R. Murchison a few years later.[1] But I do not think due weight has been allowed to it in the consideration of the controversialists on this disputed question. Perhaps, therefore I may be pardoned for recalling their attention to the crucial facts which this local coincidénce of volcanic and fluviatile or meteoric phenomena afford.

"It is impossible," I wrote at that time, "to observe the many strips of the originally continuous fresh-water formation which rise from the valley-plain of the Limagne in long tabular hills, transverse to the general course of its main drain, the River Allier, without being convinced that each of these hills owes its preservation from the destruction which has swept away the remainder of the formation to its capping of basalt, which, by reason of its superior hardness, would naturally protect the softer underlying strata from *weathering*, that is to say, from the rain, frost, and other meteoric agents to which the uncovered intervals of the marly plain left by the emptying of the lake were exposed." "These plateaux of basalt are found at all heights from 1,500 feet downwards above the water-channels of the neighbouring valleys; and some even of the most different in point of level are situated geographically close to one another."

"Take for instance the two neighbouring basaltic platforms of

[1] On the Excavation of certain Valleys in Auvergne. Phil. Mag. for April, 1829.

PROFILES OF THE PRINCIPAL HEIGHTS NEAR CLERMONT: PUY DE DÔME.
(Horizontal extent of Profile, about 12 miles.)



Gergovia and La Serre, and the bed of basalt which occupies the bottom of the narrow valley between them, and which has flowed out of the recent volcanic vent marked by the Puy Noir. Here are three long sheets of basalt, each of which, by its gradual inclination, all in the same direction, and by the remains of the cone of scoriæ marking the vent from which it was erupted, is proved to have flowed in a state of liquidity from the high granite platform into the basin of the fresh-water formation. Each must necessarily have occupied the lowest levels of that basin to which it had access. And hence it is certain that at the period when the lava of Gergovia flowed into its present position, there could have been no lower depression in its immediate vicinity. The hollow therefore into which the lava of the neighbouring plateau of La Serre flowed must have been subsequently excavated; for the base of that bed is everywhere —that is, on every line drawn transversely across both plateaux— lower by from 300 to 500 feet than that of Gergovia, which is parallel to it, not above three miles distant. Again, by the same reasoning, it is evident that the intervening valley of Chanonat, the bottom of which is now covered by a still more recent bed of basalt, must have been excavated since the production of the lava of La Serre, which overhangs it at the height of more than 500 feet. Here then are three distinct steps in the process of excavation. Indeed it should be said four, since the rivulet of the valley of Chanonat has worn away a new channel some twenty to fifty feet in some places below the level of the pebble-bed on which the most recent of the three lava-currents reposes."

"In its mineralogical aspect the basalt of these different lava-flows affords confirmatory proof that their relative ages correspond with their relative heights. That of Gergovia is compact, partly amygdaloidal, and much decomposed externally. That of La Serre has a far fresher aspect, though still possessing the distinctive features of the older basalts. That of the inferior current of Chanonat is scarcely less recent in appearance than many of the lavas of Etna, of which the date is known. Again the scoria-cone (with its crater) whence the last flowed out is entire and undisturbed. That which gave birth to the lava of La Serre has been much degraded, the heavier and more massive scoriæ, bombs, etc., alone remaining. The source of the basaltic current of Gergovia, the Puy de Berzé (for though separated from it now by a deep transverse ravine, at the junction of the granite with the marls, I have no doubt of the two having been once united), retains the character of a vent of eruption, but is worn down to a mere stump."

"Many similar examples might be adduced were it necessary, from the same district, leading inevitably to the conclusion that the vast abstraction of matter which has occurred from the fresh-water formation of the Limagne, since the drainage of its lake, was effected *gradually* and *progressively*, and went on hand in hand with the occasional flooding of parts of this valley and its tributary ravines by lavas emitted in the eruptive paroxysms of the neighbouring volcanoes. In the absence of the sea, and the lake having evidently been drained towards the commencement of the volcanic era, there are no other causes to which we can refer this gradual excavation than those which are still seen in operation wherever rains, floods, frosts, and atmospheric decomposition act upon the surface of the earth. To these agents, then, we must refer the effects in question, of which with an unlimited allowance of Time, no one will pronounce them incapable." (Scrope, on the Geology of Central France, 1827.)

The facts, on which this argument is based, may be observed in the models in relief of this district, which I have deposited in the Jermyn Street and South Kensington Museums, as well as in the accompanying Plate, in which the profiles of the principal heights, within the distance of about seven miles north and south of Clermont, are brought together. All these form distinct steps in the evidently gradual process by which the freshwater formation has been excavated, and the main valley of the Allier with its tributaries formed. Each hill is capped by a plateau of basaltic lava, which acting as a protection to the mass beneath it against the erosive power of the vertical fall of rain, has preserved the portion of the surface which it covers in the state at which it existed at the period when it was flooded with lava from the neighbouring heights.

I showed in the same work that the same inference was deducible from an examination of the lava-currents of the Bas Vivarais, and of those in the vicinity of Le Puy, namely, that "the erosive force of the streams which now border or intersect them, together with the action of rain, frost, and other atmospheric forces, have alone hollowed out there extensive systems of deep, and in some instances (as that of the Loire itself near Le Puy) wide valleys."

Mr. Mackintosh, as well as some other writers who depreciate the erosive influence of "rain," though admitting to some extent that of "rivers," seems to forget that intermediately between the two there are constantly at work the millions of rills, rivulets, brooks, and torrents, which convey the pluvial water through rivers to the sea, and in seasons of flood are constantly carrying solid particles, silt, sand, pebbles or stones along their beds, which grinding against the rocks that form the sides or bottom of these, exercise a very considerable force upon them. Those who have watched the descent of floods in any mountain region, such as the Alps or Apennines, especially after violent local rains, or the fall of a waterspout, will have observed that the torrent appears to be composed as much of stones as of water. Every pebble and boulder is in motion, all descending more or less rapidly to a lower level; all exerting an abrading force upon other stones, or on the banks of the stream. In the Vivarais I have seen blocks of granite, many tons in weight, moved to considerable distances by torrents which are dry in summer. The large prisms of basalt, separated by the action of frost, or an undermining stream from a cliff of this rock, lie for some time perhaps at its base, but are soon carried lower by a flood, and at the distance of a mile or two are seen to have been worn down to rounded blocks. Further down they appear as boulders, and still further as pebbles, which sooner or later find their way into the Rhone, and ultimately, in the shape of sand or silt, to the sea.

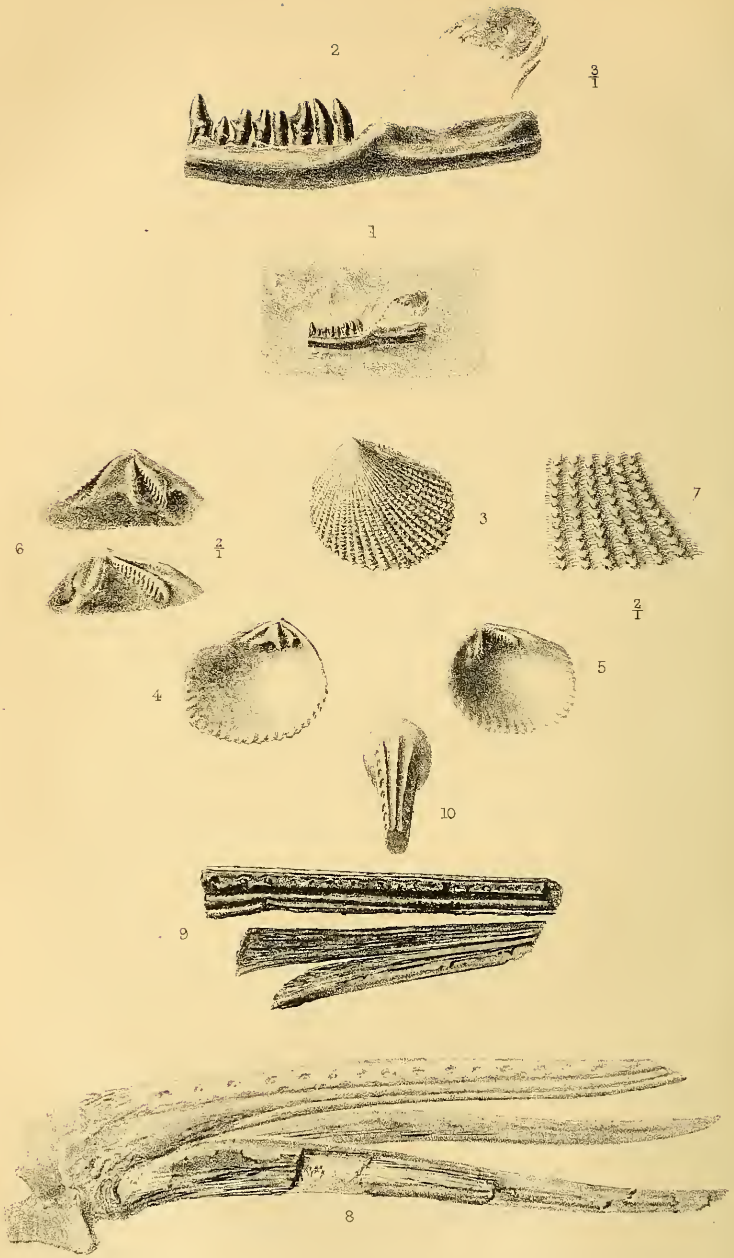
But, of course, while 'Rain and Rivers' were doing so much in the neighbourhood of the volcanos of Central France, they were not idle elsewhere, in the Alps, or the Pyrenees, in the British isles, in fact wherever land lay exposed to their influence above the protecting surface of the great waters.[1] That the abrading action of the sea-waves may have in many instances widened many of the larger valleys to which it obtained access during temporary depressions of the land, I am far from denying. But I am confident that this last doctrine is pushed much too far by those who find a *sea*-worn cliff in every steep hill bordering a valley.[2] Why there is scarcely a river to be found anywhere, that is not now engaged, in one or more parts of its course, in undermining its hilly banks on one side or the other, and fashioning them into cliff-like bluffs. The most pregnant example of this kind with which I am acquainted is the valley of the Moselle, where it traverses the high plateau of Devonian Slate-rock above Treves. Here the entire valley serpentines in repeated curves, some of them almost completing the circle, so that after a sweep of twelve or fifteen miles the river returns to within a few hundred feet of the same spot; and a person may stand on the high isthmus separating the two extreme points of the curve, and fling a stone into the water on either side five or six hundred feet beneath him. In all these curves the concave bank is a steep bluff which the stream is still engaged in undermining; the convex one, a sloping fan-shaped pebble-strewn talus, just as is seen, on a smaller scale, in the similar windings of many streams through an alluvial plain. And it is evident that the erosive action of the river-floods has alone in the one case as in the other excavated the entire channel. The action of the sea, even if it could be supposed to have penetrated at any epoch the valley of the Moselle (of which there exists no sign), could never have eaten out the slate-plateau in these symmetrical and regular curves.

"The time that must be allowed for the production of effects of this magnitude by causes so slow in their operation is indeed immense. But it is now generally recognised by geologists that the periods which to our narrow apprehension, and compared with our ephemeral existence, appear of incalculable duration, are but trifles in the calendar of Nature. Every step we take in geological pursuit, forces us to make almost unlimited drafts upon antiquity. 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!"[3]

[1] See Dr. Rubidge's paper on the Denudation of South Africa. Geol. Mag., vol. iii. p. 88.

[2] And, I may add, Raised Beaches in the plough-worn *lynchets* of our downs. As well see them in the vine-terraces of the banks of Rhine or Moselle! See Mackintosh, Geol. Mag., vol. iii. pp. 69 and 155.

[3] Geology of Central France. Ed. 1827. It is very satisfactory to me to find (see the last number, April, 1866, of the Journal of Science, p. 208) that my old friend and fellow labourer in the Volcanic Department of Geology, Dr. Daubeney, has acknowledged at last the correctness of the views I was led to entertain upon



Fielding del. Day & Son (Limited) Lith.

FIGS. 1. 2. NEW PURBECK MAMMAL.
3. 7. TRIGONIA LAMARCKII, *Mathn.*
8. 10. TAIL-SPINES OF CERATIOCARIS, WENLOCK SHALE &c.

But, indeed, as respects the controversy as to the comparative influence exercised by marine or atmospheric erosion in moulding our present land-surfaces, an equally vast lapse of time must in either case be assumed. The object of this paper is simply to suggest that the two denuding agencies have been always at work upon the surface of the earth, and that there is ample reason to consider the one to have produced effects quite as considerable as the other.

II.—Description of Part of the Lower Jaw and Teeth of a small Oolitic Mammal (*Stylodon*[1] *pusillus*, Ow.)

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

(PLATE X., Figs. 1, 2.)

I HAVE been favoured by the Rev. Peter B. Brodie, M.A., F.G.S., with part of the lower jaw, including eight back teeth (Pl. X., Fig. 1, natural size), of a small mammal, nearly allied to *Spalacotherium tricuspidens*, Ow., and from the same formation and locality, viz., the Marly bed Upper Oolite, Purbeck, Dorsetshire.

The part of the lower jaw is embedded in a small block of the matrix, with the outer surface exposed: it includes the proportion of the ascending ramus supporting the coronoid process, a film of which only remains in the depression of the matrix, mainly indicating its size and shape, and so much of the horizontal ramus as includes the alveoli of the nine posterior teeth, eight of which are *in situ*. The articular and angular processes, and the fore part of the ramus, have been broken away, and there is no indication in the matrix of the entire ramus having been imbedded therein; so it may be inferred, therefore, that the mutilation took place prior to imbedding. Enough, however, has been preserved to demonstrate the class-characters of the animal to which the fossil belonged, and to enable us to add another genus and species to the small category of mammalia of the Mesozoic period.

The continuous unity of bone at the part of the mandible which would show most of the sutures in a lacertian jaw—the height, breadth, and contour of the "*processus coronoideus*"—and the implantation of one, at least, of the teeth by two fangs in a double socket, concur in testifying to the warm-blooded, air-breathing, viviparous, and lactiferous class of the animal. The base of the coronoid process shows the raised boundary of the lower part of the depression for the insertion of a temporal muscle of mammalian proportions. The lower margin of the ascending ramus has a degree of thickness and

this question, which views he had previously disputed. "From the description," he says, "given by Mr. Scrope, Sir C. Lyell, Sir R. Murchison, and other competent authorities, it plainly appears that the valleys of Auvergne were excavated not at one, but at several successive periods—or, more correctly speaking, that although water was instrumental in their formation, yet that they must have been scooped out, not by any violent movement or sudden passage of a flood over the country, but *by the long-continued action of the rivers now in existence*."

[1] στύλος, pillar; οδους, tooth.

flatness suggestive of marsupial affinities; but the angle itself is broken off. As, however, the alternative is the almost equally low "lessencephalous" sub-class, to which the present little insectiovore must be referred, if it be not "lyencephalous," it adds another to the prevalent testimony of the low condition of Mesozoic mammalian life.

The crowns of the teeth, encased in lustrous enamel, are long or high in proportion to their breadth and thickness. They manifest this proportion, indeed, in a higher degree than do the teeth of *Spalacotherium*, and, being rounded or cylindroid at the aspect exposed, have suggested to me the generic name *Stylodon*, signifying "pillar-tooth." The hindmost in place, supported apparently on a single columnar fang, which is partly protruded from the socket, and covered with a darker and duller cement, has a longish conical crown, with the fore part of the base rather more produced than the hind part: the crown of the next tooth is somewhat longer: that of the antepenultimate has a broader base, produced anteriorly into a minute angle, and slightly thickened behind, but not developed into a continuous cingulum. The apical half of the crown is broken off in the three teeth next in advance. Each has a small anterior basal "talon," and a single columnar root, so far as it is exposed; they are, likewise, severally smaller than the antepenultimate tooth. The seventh tooth, counting forward, is more abruptly smaller than the rest, with a simple conical crown, indicating only a feeble prominence of the fore part of the base. Then rises the crown of the largest tooth of the series, laniariform, subrecurved, or seeming to be so, from the convexity of the front border, and the minor concavity of the hind one, where the base is a little thickened and produced,—this crown is supported on two divergent fangs. The convex surface of the jaw beneath these teeth is entire—shows no neurovascular outlets—the main anterior one has gone with the missing fore part of the ramus.

Any attempt to determine the nature of the above described eight teeth, in the absence of information as to their relations to deciduous teeth, must be made on unsatisfactory and uncertain grounds. Guided by their shape and proportions, we might view the foremost as a "canine," the next four as "pre-molars," the last three as "true molars," and thus infer an example of placental diphyodont dentition. The objection to the two-fanged character of the canine would be met by the same mode of implantation of the canine of the common mole (*Talpa*), the proportion of which tooth to the succeeding premolar is very similar to that presented by *Stylodon*.

But the proportion of the preserved dentigerous part of the present fossil to the part behind indicates a greater number and size of teeth in advance of the laniariform tooth than the three small incisors of *Talpa*. The closer similarity of the narrow columnar hinder molars to those in the Cape mole (*Chrysochloris*, Cuv.), and the very probable addition of an eighth such molar to the seven in place behind the laniariform tooth of the fossil, warn us of the deceptive character of the analogy of the dentition of the common mole. It is more likely that *Stylodon*, like *Spalacotherium*, and *Chrysochloris* (unique in this respect among existing *Insectivora*), exemplified that excess of number of teeth, which, in *Marsupialia*, as in *Insectivora*, is seen in a single known existing genus (*Myrmecobius*), but was common in the similar small insectivorous pouched mammals of the older Oolitic deposits. *Spalacotherium* had ten molar teeth on each side of the lower jaw, of which the last six had tricuspid crowns, with proportions and spacing similar to those in the Cape mole.[1] The corresponding teeth of the present genus and species are in closer contact with each other, and are of more simple shape, and apparently more simple implantation.

The grounds for adding another genus and species to the Purbeck Mammalian catalogue (*Spalacotherium, Triconodon, Plagiaulax*) are sufficient, and also, as it seems to me, to determine the genus to have been either less- or ly- encephalous; but, with the known range of diversities of dental character in recent and extinct marsupial and placental *Insectivora*, I feel a need of further evidence before pronouncing on the sub-class or order of *Stylodon.*

EXPLANATION OF PLATE X.

Fig. 1.—Portion of lower jaw and teeth of *Stylodon pusillus*, Ow., as embedded in the matrix, nat. size.

Fig. 2.—The portion of jaw and eight teeth in place, magnified three times.

III.—On the Occurrence of a Recent Species of *Trigonia* (*T. Lamarckii*) in Tertiary Deposits in Australia.

By H. M. Jenkins, F.G.S.

(PLATE X., Figs. 3–7.)

In No. VI. of the "Quarterly Journal of Science" I gave a brief account of the *Trigonia semiundulata*, M'Coy, MS., which has been found in certain Tertiary strata in the Colonies of Victoria and South Australia, and which had been named, but not described, by Professor M'Coy. This species differs altogether from the recent forms, and approaches very closely in its essential characters to the members of the group "costata," characteristic of the Oolites. It was therefore remarked, in the communication referred to, that its occurrence in Tertiary strata in Australia added another link to the chain of evidence which connects the recent fauna of that region with the Oolitic fauna of Europe. But doubt may be expressed as to the exact value to be assigned to this similarity in facies between two faunæ so widely separated in time; and it is a fair question whether the discovery of this *Trigonia* does not diminish, rather than add to the apparent peculiarity of the existing Australian fauna.

Having recently received a large collection of fossils from the Tertiary strata of Victoria, and the specimens having been collected and labelled by the officers of the Geological Survey of the colony,

[1] Proceedings of the Geological Society of London, June 1854, p. 425.

so that no doubt can be raised as to their validity, it was with much interest that I sought to ascertain the exact place in the Tertiary series of Australia of a species having so decidedly a Jurassic facies as this *Trigonia semiundulata.* The information at my command does not, however, enable me to assign the fossil to its exact position in the series, as the specimens I received were obtained from the detached out-crops of Tertiary beds in the neighbourhood of Geelong and Port Philip Bay. But in searching for this evidence I was astonished to find amongst the collection of fossils from the same *set of beds*—though not from the same stratum as that containing *Trigonia semiundulata*—two specimens of *Trigonia* undistinguishable by characters of specific value, from the recent *T. Lamarckii* now inhabiting the Australian seas. Although, possibly, naturalists who consider minute differences of degree, or an extended range in time, sufficient for the foundation of a new species, may be able to separate this fossil from *Trigonia Lamarckii,* yet to the palæontologist the value of the discovery will remain unchanged; for while the only Tertiary *Trigonia* hitherto known belongs to a group, differing in every essential character, not generic, from the recent species, we have now evidence of another *Trigonia* having lived within the limits of the same Geological period as the former, which is absolutely identical with a species which now inhabits the Australian seas.

The species of *Trigonia* described and figured by Mr. Lovell Reeve in his *Conchologia Iconica* are as follows :—

1. *Trigonia Lamarckii* (*T. Jukesii,* Adams) ; Australia.
2. ,, *uniophora,* Gray ; Cape York, Australia.
3. ,, *margaritacea* (*T. pectinata,* Lam.) Tasmania.
4. ,, *Strangei,* Adams ; Sydney, N.S.W.

In general character, especially in the size, shape, number, and ornamentation of the ribs, and obtuse truncation of the posterior extremity, the fossil approaches most nearly to *T. Lamarckii,* the first-named species or variety, which is also the most abundant. On the other hand, it undoubtedly presents some differences, being slightly flatter, rather longer in proportion to its breadth, and somewhat more inequilateral. The fossils are also all small specimens ; but it cannot yet be certainly stated that, in Tertiary times, no individuals of the species attained the size of adult recent examples. With every disposition to make the most of the differences enumerated, I cannot regard them as of even varietal value; they seem, in fact, to be merely such slight individual peculiarities as can be traced in the members of almost every species, added to a certain *caste* which, probably, often distinguishes those which inhabit one locality from the population of another. Indeed, the same kind of slight variation may be noticed in the specimens from the two localities which have yielded the species in the fossil state, namely, near Sherbrook River,[1] and Mordialloc,[2] both in the Colony of Victoria.

[1] Mapped as Miocene by Mr. Selwyn. [2] Mapped as Older Pliocene by Mr. Selwyn.

I have hastened to give publicity to this, the earliest known occurrence of a *Trigonia* of the recent type, that palæontologists who speculate on the orgin of recent faunæ may be acquainted with the fact, and give figures of the specimens, that those who are doubtful of their identity with a recent species, may satisfy themselves of the validity of my determination. In conclusion, I will merely add that the suite of fossils sent to me is so extensive that, when their examination is completed, I hope to be able to give a more definite opinion as to the probable contemporaneity of the Oolitic and recent types of *Trigonia*, as represented by *T. semiundulata* and *T. Lamarckii.*

PLATE X.—EXPLANATION OF FIGURES 3–7.

Trigonia Lamarckii, Mathn., natural size.
Fig. 3.—Exterior of left valve of shell.
„ 4.—Interior of left valve.
„ 5.—Interior of right valve.
„ 6.—Enlarged view of the hinge.
„ 7.—Enlarged view, showing the ornamentation of the ribs.

IV.—ON THE OCCURRENCE OF *CERATIOCARIS* IN THE WENLOCK FORMATION (UPPER SILURIAN) OF ENGLAND.

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

(PLATE X., FIGS. 8–10.)

AMONG the many beautiful fossils from the Silurian strata of Bohemia, obtained by M. J. Barrande, there have been discovered numerous detached spines, measuring from six to seven inches in length, which, from their resemblance to the genus *Leptocheles* of M'Coy, have received the MS. name of *Leptocheles Bohemicus* (Barr).

Similar organisms from the Upper Ludlow Rock, Ludlow, were first described by Professor Agassiz, who determined them to be fish-defences, and included them in his genus *Onchus.*[1] Professor M'Coy minutely distinguished them from ichthyodorulites, but supposed them to be the slender pincers of some large crustacean.[2] M. Barrande also recognised their true crustacean character; but having better specimens, he determined them to be the tail-spines, and not the pincers, of some unknown crustacean.[3] Mr. Salter, at a later date, with the advantage of the materials collected by Mr. J. Slimon, of Lesmahagow, showed them to be the trifid tail-spines of *Ceratiocaris.*[4] "It is curious to see," says Mr. Salter, "how gradually we have arrived at our present knowledge of its structure."

It is now sixteen years since Professor M'Coy established the genus *Ceratiocaris*,[5] for certain bivalved crustacea from the Upper Silurian of Benson's Knot, Kendal (a fine series of which, collected by Mr. John Ruthven, may now be seen in the British Museum.)

[1] Agassiz, in Murch. Sil. Syst., p. 607. [2] Quart. Journ. Geol. Soc., Vol. ix., p. 13.
[3] Salter, Quart. Journ. Geol. Soc., Vol. xii., p. 34. [4] Salter, *Ibid.*
[5] M'Coy, Pal. Foss. 1850. (Four species described.)

Only the carapace of this curious pod-shrimp was recognised by him, but it has been quite restored by Mr. Salter's[1] skill; and even the dentition is now well known to us.[2] It is not, however, to these almost perfect examples that I would now direct attention, but rather to some fragmentary remains from Westmoreland, Yorkshire, and Worcestershire, which have lately been submitted to me for examination.

I received the first, and by far the most perfect, example from Mr. E. Hollier, of Dudley, who obtained it from the Wenlock shale, Dudley. (See Plate X. Fig. 8). It exhibits the strong tail-spine, deeply grooved longitudinally, and having a row of punctations on either side of the two uppermost furrows, with the two lateral spines attached to it, also striated longitudinally, but not ornamented with punctations. A portion of the last body-segment remains still articulated to the broad proximal end of the telson.

The fossil is about four inches in length, and was probably two inches longer, as the pointed extremities of the spines are broken off.

The tail-spine of *Ceratiocaris* does not appear to have been quite straight, but somewhat curved in profile, as seen in the figure (Plate X. Fig. 8).

The lines of punctations along the telson, evidently indicate where spines, or bristles were implanted, as observable in the limbs of Decapod Crustacea from the Lias and Oolite. (See Geol. Mag., Vol. III., p. 11, Plate I.). The specimen from Dudley has been partially worked out on the upper edge of the slab of shale on which it rests, so as to expose both sides of the central spine (telson), and although much flattened, it exhibits another row of punctations corresponding to that seen in the plate, and two intermediate dorsal furrows.

The end view of a small specimen, *not crushed*, from the Upper Silurian of Bohemia, has been figured in order to show the longitudinal furrows, and the row of punctations on either side of the telson. (See Plate X. Fig. 10). This appears to be a persistent character of the telson in most of the larger forms. In the "Annals and Magazine of Natural History," for March 1860, Mr. Salter describes and figures,—

1. *Ceratiocaris papilio*, from the Upper Silurian of Lesmahagow, Lanarkshire, and appends description of the following species:—
2. *Ceratiocaris stygius*, Salter, U. and L. Ludlow Rock; Lanark.
3. ,, *inornatus*, M'Coy, U. Ludlow Rock; Benson Knot.
4. ,, *Murchisoni*, M'Coy, sp. U. Ludlow Rock; Ludlow.
5. ,, *leptodactylus*, M'Coy, sp. U. Ludlow Rock; Ludlow.
6. ,, *robustus*, Salter, U. Ludlow Rock; Leintwardine.
7. ,, *decorus*, Phillips, Ludlow Rock; Pembrokeshire.
8. ,, *ensis*, Salter, Lr. Ludlow Rock; Leintwardine.
9. ,, *vesica*, Salter, Lr. Ludlow Rock; Leintwardine.
10. ,, *cassia*, Salter, Lr. Ludlow Rock; Leintwardine.

[1] Ann. and Mag. Nat. Hist., March 1860, p. 153. (Eleven species described).
[2] Geological Magazine, Vol. II., p. 401, Pl. XI.

From the foregoing list it will be seen that all the ten species enumerated belong either to the Upper or Lower Ludlow Rock; but I find that Mr. Salter, so far back as November 1855, was aware of an older species, for he says (Quart. Journ. Geol. Society, Vol. xii., pp. 33 and 34) "the occurrence of body-rings in the Dudley Limestone has been for some time known; and in the Ludlow Museum I lately saw such body-segments connected with the long triple tail-spines now known under the name of *Leptocheles*." And, again, "the carapace and some of the body-joints were found near together by Mr. John Gray of that place (Dudley)." In his paper in the "Annals" (in 1860) already quoted, Mr. Salter observes,—"I believe there are other forms of the genus even in Britain, besides these nine or ten species which have all turned up in the course of a year or two. Abroad still larger specimens have been found in Upper Silurian rocks. M. Barrande has figured the tail-spines of three species, of which *Leptocheles Bohemicus* has the greatest resemblance to our *Ceratiocaris Murchisoni*; and a large species, *C. Dewii*, has been figured as a fish-defence, by Hall, from the Niagara Limestone of New York. Our own Dudley Limestone contains one species; but the metropolis of this curious Silurian 'shrimp' is in the Lower Ludlow Rock, where it keeps company with *Pterygoti* and other large crustacea.[1] It appears not to have been a long-lived genus, for, as yet, none have been detected below the Wenlock Limestone, or above the Upper Ludlow rock."

It thus will be seen that Mr. Salter has anticipated the announcement of the occurrence of *Ceratiocaris* in the Wenlock Limestone, although he does not refer it to any one species.

There is little doubt that this is one of the largest British forms of *Ceratiocaris*, but in the absence of the carapace and body segments, I do not feel justified in adding another species to the burden of palæontological nomenclature. The characters seen in this telson appear to be common alike to *C. Murchisoni*, *C. robustus*, and *C. Bohemicus*. If it must be christened, I would recommend the adoption for it of the name of Sir R. I. Murchison (King of Siluria), as the oldest and best known.[2] Any apparent difference in the specimens figured is due to the difference of condition in which they are preserved—Fig. 9 being only a cast, whilst Fig. 8 still retains its shelly structure.

I have not figured the fragment from the Coniston Grit (Lower Wenlock), Helm Knot, Dent, Yorkshire, as it was too small. The specimen from Kirkby Lonsdale (Fig. 9) gives us a new locality, and a fresh horizon, which Mr. Hughes kindly describes. Fragmentary as these remains may appear, yet they nevertheless point to a further extension in time of the genus *Ceratiocaris*, and may be the means of exciting the search for more perfect specimens.

[1] Not only do we now find spines of *Ceratiocaris* in the Wenlock Limestone, but numerous portions of *Pterygoti* have been met with by Messrs. John Gray, C. Ketley, L. P. Capewell, E. Hollier, and other gentlemen, at Dudley, and its vicinity.—H. W.

[2] In the second edition of "Siluria," these striated tail-spines are represented in Plate 19, Fig. 1 and 2, from the Uppermost Ludlow Rock, Ludlow, and are there correctly named *Ceratiocaris Murchisoni*, by Mr. Salter.

V.—Note on the Silurian Rocks of Casterton Low Fell, Kirkby Lonsdale, Westmoreland.

By Thomas McKenny Hughes, B.A., F.G.S.

I SHOULD not have presumed to publish an opinion as to the geological position of the rocks of Casterton Low Fell without having examined the typical region of Coniston and Windermere, had not Mr. Woodward thought it desirable to notice the occurrence there of a species of *Ceratiocaris* and asked me to furnish him with a note on the bed from which I obtained it. Having therefore collected all the evidence I could in that limited and complicated area, I now, with the permission of the Director of the Survey, send him some extracts from my notes, which may be of interest, as showing the character and relations of the rocks there seen.

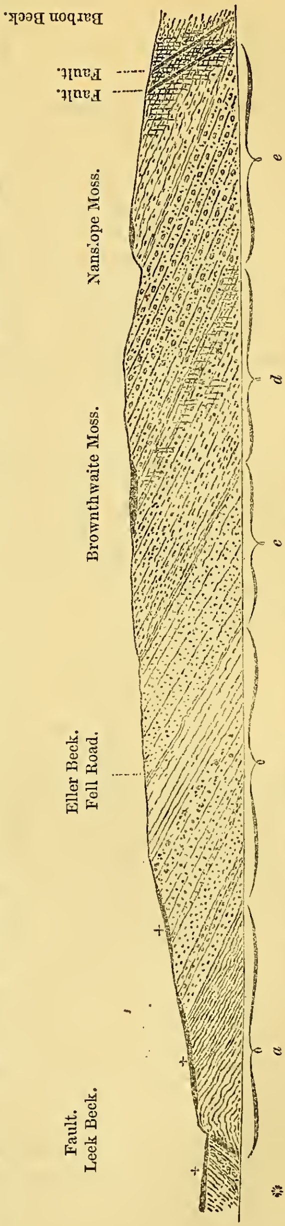
The Silurian Rocks of Casterton Low Fell, and Barbon Low Fell, are bounded on the West and South by a great fault which brings various parts of the Old Red, Carboniferous, and Permian, against the Silurian Rocks. This may well be seen in Barbon Beck, near the church; where the Old Red is faulted against the Carboniferous Limestone, and this again, in less than fifty yards, is faulted against the Silurian Rocks. The fault runs in a southerly direction bending round to the S.S.W. by Whelprigg, where the Old Red Conglomerate is seen, not in contact with the Silurian, but very close by it. From this point the boundary is entirely obscured by drift till we come to Leck Beck where the Permian beds are thrown against the Silurian. Here again they are not seen in contact, but they occur near one another in such a manner that we cannot explain the phenomena by the unconformity of the Permian on the Silurian. On the East and South East of this the ground is entirely covered by drift, but proceeding up the stream to Bullpot we soon find evidence of a great double fault, like that seen on the other side of the hill in Barbon Beck, running North and South, and bringing the Yoredale Rocks against the Mountain Limestone, and that in a few yards more against the Silurian. These two sets of faults are connected by a series of transverse faults, running nearly W.N.W. and E.S.E. on the South side of Barbon Beck. Thus it will be seen that the Silurian rocks of the area under notice are cut off all round by enormous faults, and therefore that their age must be determined by the evidence we can obtain within that area. I have frequently searched for fossils in company with Mr. Gibbs, Fossil Collector to the Survey, and also with Mr. Hindson, and Mr. Haythornthwaite of Kirkby Lonsdale, but the number, both of species and of individuals, that we were able to obtain, was small.

The accompanying section is drawn from the Permian beds in Leck Beck, due North, to beyond the second of the set of faults on the North slope of Barbon Low Fell, about a quarter of a mile South of Barbon Beck.

The first beds seen are dark grey coarse flags; the dip is at first irregular, but afterwards tolerably steady in a North-Westerly direction at from 20° to 30°, and this dip prevails with small minor variations all along the ridge. In the lowest beds *Graptolites*, probably *G. priodon*, and an *Orthoceras*, like *O. tenuicinctum*, occur. Further North we find these flaggy beds succeeded by alternations of a coarse greywacke,[1] with joints at right angles to the bedding and a roughly cleaved, distinctly bedded sandstone. All this part of the series I have included under (*a*), and would estimate its thickness at about 1000 feet.

It it succeeded by about 1200 feet of unfossiliferous greywacke (*b*), with occasional bands of red earthy nodules in the upper part, and alternations of finer sandstone sometimes roughly cleaved.

These are succeeded by a set of dark grey shivery sandstones (*c*), (*d*) and (*e*), about 3000 feet thick, with occasional beds of tough greywacke and generally a rough cleavage in the softer beds. *Cardiola interrupta* occurs all through (*c*) and (*d*), but the specimens are not so fine or so numerous in the middle part (*d*) as in the lower (*c*). I procured many fine ones from the Fell Road side near where it crosses Eller Beck. In the middle part (*d*) a very interesting set of fossils occurs, among which the following have been determined by my colleague, Mr. Etheridge :—



North and South Section across Casterton Low Fell and Barbon Low Fell.

(Length of Section, 3 Miles.)

* Permian. + Drift.

a. Dark-gray coarse flags, with alternations of coarse Greywacke and roughly-cleaved, distinctly-bedded Sandstone—about 1000 feet.
b. Unfossiliferous Greywacke, with red nodules and alternations of finer Sandstones—about 1200 feet.
c. d. e. Dark-grey shivery Sandstones, about 3000 feet thick, with occasional beds of tough Greywacke: fossiliferous.

[1] I use the word greywacke merely as a lithological term for the rough, tough, gritty sandstones, so common in the Palæozoic rocks; the term grit being required for the coarse-grained rock intermediate between sandstone and conglomerate, *e.g.* Millstone grit.

Acidaspis, n. sp.
Phacops, sp.
Petraia elongata
Heliolites interstinctus
Pterinea tenuistriata
Pterinea, sp.
Cardiola interrupta
Orthoceras, sp. like *tenuicinctum*
Graptolites priodon

and the *Ceratiocaris* now described by Mr. Woodward.

The general character of the rock in the upper part (*e*) is very similar to that in (*c*) and (*d*), but I was unable to procure many fossils except a *Graptolite*, probably *G. priodon*, and an *Orthoceras*, like that found all through the series.

On the whole, I find that the lithological character of the rock is very similar throughout, except that at the bottom the tough greywacke passes into dark blue flags, and towards the top there is more of the roughly cleaved dull dark grey sandstone which alternates with the harder beds all through.

Prof. Ramsay at once pointed out the general resemblance of these beds to the Denbighshire grits, and the fossils seem to bear out this suggestion.

The micaceous flags of Benson Knot, from which the specimens of the carapace of *Ceratiocaris* in the British Museum were obtained, belong to what are locally called Kirkby Moor Flags—*i.e.* Upper Ludlow—and are separated from the beds of Casterton Fell by an enormous series, the exact position and thickness of which I shall not be able to determine until I have worked much further north into a clearer country.

VI.—Note on Coal and Cannel.

By Jno. Rofe, F.G.S.

Although many theories have been suggested to account for the formation of coal-beds, all of which agree in the vegetable origin of the coal itself, none have yet appeared which meet many of the difficulties which surround the subject of their origin, and probably they have been deposited under so many varying conditions that no one supposition would account for the difference in the constituents of the mineral, or for the mode of its formation in different localities. From the *Stigmaria* found in the underclay, in the great majority of cases, it seems fair to assume that the vegetation from which the coal above it was formed, grew where the coal is found, and there are other reasons for coming to the same conclusion in these cases, but in some places, where the underclay is wanting, this may be doubtful.

There can, however, be but little doubt that coal and cannel must have been deposited under different circumstances, and yet in some places they are found interstratified and in contact.

This subject was named at the meeting of the British Association at Birmingham, when one of the speakers suggested that the vegetable matter of the cannel was so far decayed as to be reduced to a pulp, like thoroughly rotted peat, which gave the cannel its homogeneous structure, whilst that from which the coal was formed was less decomposed, so that coal was more like consolidated lignite. It is, however, difficult to conceive how, in the same bed the vegetable matter could have been first partially decayed, then a layer thoroughly rotted, and then another only partially decomposed; and yet, if this theory be correct, such must have been the case where the two varieties are interstratified, as they are found near Blackrod in the Wigan coal-field.

But there is in most, if not in all, cases a well-marked distinction between coal and cannel. Though they both are undoubtedly of vegetable origin, the fossils found in them differ. In the *body of the coal* itself, what fossils are found are almost, if not entirely, vegetable, whilst in the cannel, at least in that of Lancashire, fish-remains not unfrequently occur. Besides this, in the destructive distillation of cannel for gas-making, it is necessary to have the pipes from the retorts much larger than when common coal is employed, because, in the former case, these pipes are very liable to become choked by a deposit, which at first was supposed to be pitch, but which on examination is found to be formed of crystals of *chloride of ammonium*, agglutinated by tar, from which they may easily be washed out and re-crystallized. May not this large quantity of chloride of ammonium be accounted for by the cannel bed having been deposited in saltwater, the habitat of the fish found in the cannel; the seawater furnishing the chlorine for this salt. I am fully aware that the distillation of common coal gives salts of ammonium, but they are principally carbonate, sulphate, and sulphide with very little chloride, and these are all found in what is technically called the ammoniacal liquor. The cannel also gives these salts in solution in the liquor in addition to the crystals sublimed into the pipes as above stated.

There would be nothing very unreasonable in supposing the growth of a rank vegetation in a swamp on the margin of an estuary, sufficient to form a bed of coal; that this, either by subsidence or by the breaking of a bank, became covered by the sea, and from a fresh became a marine swamp like the mangrove swamps of the tropics (under which fish feed), and thus accumulate another stratum under seawater, and probably from a different class of plants, until by some fresh alteration of level or by the acumulation of another bank to exclude the sea, the original state of things was restored and another freshwater deposit is formed. There might then be a bed of cannel between two beds of coal, and that such alterations of levels may take place, or have taken place, can scarcely be doubted by any geologist.

It does not appear possible, under the supposition that coal results from transported materials, to account for the interstratification above referred to.

Possibly, in some instances, independent beds of cannel may have been derived from a deposit of sea-weed, such as the great weed-bed of the Atlantic.

VII.—On the Junction of the Chalk with the Tertiary Beds in East Kent.[1]

By George Dowker, F.G.S.

The Junction of the Chalk with the Lower Tertiaries is nearly always marked by the presence of green-coated flints; and in East Kent, where the Thanet Sands rest on the Chalk, numerous junction-sections are exposed, exhibiting the peculiarities which I now lay before you.

Mr. Prestwich, in his paper on the Thanet Sands,[2] speaking of these green-coated flints, says, "A marked feature of that formation is the constant occurrence at the base of the deposit, and immediately reposing on the Chalk, of a layer of flints of all sizes, just as they occur in the underlying Chalk, from which in fact they appear to have been removed comparatively without wear or fracture, for they are almost as perfect as the undisturbed flints, but present this difference, that instead of their usual white or black coating these flints are almost invariably of a deep bright olive-green colour externally; the white outer coating, which is often very thick, seems removed (as though by an acid), and the flint then stained green. So strong is the colour, although it forms a mere film, that flints removed by denudation from this bed, subjected to great wear and many changes, and imbedded in fresh beds, whether of the Tertiaries or the Drift, can always be recognised by the peculiar green colour which they invariably retain." These flints occur in East Kent, in a bed of Sandy Clay of a dark ferruginous colour immediately on the Chalk, passing upwards into a distinct Sand of a dark green colour, varying in thickness from five or six inches to two or three feet, though the Clay bed with the flints rarely exceeds five inches. It is a matter of conjecture how far this Sand may belong to the Thanet, or an intervening formation. It may generally be distinguished from the lower beds of the Thanet in East Kent, which are very argillaceous; but it is evident that the green-coated flints do not belong to the Thanet beds, as they occur where this formation is absent.[3] Associated with this sand are found angular fragments of flint, generally not more than one inch in width, remarkably sharp and unrounded, though they appear to have undergone some solution, their surfaces presenting a somewhat resinous look, in other respects resembling the fragments of flint sometimes found in the vertical fissues in the Chalk immediately below the Thanet Sand, filled with tabular flint; these fragments are not green-coated.

Another peculiar feature of these junction-sections of Chalk and Thanet Sand, as seen in East Kent, is that the green-coated flints nearly always rest on a semi-tabular mass of Chalk flint,[4] which ex-

[1] See also Report of Proceedings of Geol. Soc., London, March 21, for two other papers on similar subjects at p. 223.

[2] Quart. Journ. Geol. Soc., Vol. viii., p. 243.

[3] See Prestwich, paper on Woolwich and Reading Series. Quart. Journal of Geological Society, Vol. x., p. 95. Mr. Whitaker in Geological Survey Memoirs, on Sheet 13, and on Sheet 7.

[4] See Mr. Whitaker's paper in Quart. Journ. Geol. Soc., Vol. xxi., p. 397.

hibits numerous fractures, that have been recemented by siliceous matter; these fractured surfaces are often shifted laterally and joined, though the original opposed surfaces are not in contact. In many cases there intervenes between the surfaces a layer of white-coated flint, of a chalcedonic structure. Sometimes these masses of flint appear to have been crushed and the fragments re-cemented, though only partially, with siliceous matter.[1]

The more tabular flint at the top of the Chalk is not green-coated, but the upper surface has often a ferruginous stain.

All the green-coated flints, though not rounded, exhibit the appearance of having undergone solution, and are not so large or uneven as those found in the underlying Chalk. Professor Morris, in a paper read before the Geological Society,[2] drew attention to the fact of the mineral Allophane occurring associated with the green-coated flints, and in fissures of the Chalk immediately under them. This Allophane is Hydro-silicate of Alumina; the analysis, as given by Mr. Dick, being, silica 18.89, alumina 32.52, water 42.73, lime 1.67, carbonic acid 2.51, and a trace of organic matter.

From the researches of eminent chemists it would appear, that under certain conditions Silica becomes soluble, and capable not only of making combinations with other substances forming silicates, but also of replacing them.

"It is very deserving of notice (observes Bischof) that Carbonate of Lime may be displaced by almost all siliceous substances; and consequently it is possible that entire layers of Limestone may be displaced by Silica."[3] . . . . . "Organic matter seems to have a marked action on the silification of bodies."[3]

Nature accomplishes what the chemist in his laboratory is unable to perform, because the conditions of time, space, and pressure are not within the reach of the latter. The appearance of the green-coated flints may be the result of the long-continued action of natural causes.

Mr. Whitaker has stated that in the eastern part of Kent the Thanet beds rest conformably on the Chalk.[4] Should this be the case, it would be difficult to account for the presence of this bed of flint as the result of marine denudation. On the other hand, what solvent process would remove such a mass of Chalk as to remove the *débris* represented by these green-coated flints, and still leave them conformable to the underlying bed? It appears that there is a great break (in this country) between the Secondary and Tertiary formations. It is natural to suppose that marine denudation has been at work during the interval, removing the upper part of the Chalk; some such action might account for a bed of worn flints; but the angular flints could not

[1] For a beautiful example of a fractured flint, re-cemented by infiltrated silica, see the late Dr. S. P. Woodward's paper "On the Nature and Origin of Banded Flints," in Geol. Mag., Vol. I., p. 145, Pl. VIII. Fig. 4.—Edit.

[2] See Professor Morris's paper, Vol. xiii., p. 13, of Quarterly Journal of the Geological Society.

[3] Chemical Geology, Vol. ii., p. 480, English Translation (Cavendish Society).

[4] Op. cit.

be accounted for by this means. The occurrence of a bed of semi-tabular broken flints points to upheaval and fracture, and it is evident, from the numerous small faults which appear in the Chalk, that much disturbance has taken place. The re-cemented flints appear as if fractured by some such means, and the surfaces presented to each other being re-united, would imply some slow action, during which the opposing surfaces have been re-combined.

The green-coating of the flints and the Allophane, the result of a chemical combination of Iron with Silica, and Silica with Alumina, point to periods during which solution and re-combination have taken place. It would seem that the junction of the Chalk with the Tertiary sands favours the solution of the latter. Mr. Prestwich mentions the occurrence of the Websterite and Hydrate of Alumina in immediate contact with the Chalk,[1] and also the singular fact noticed in the "Annales de Mines," that the mottled clays of the Argile Plastique (of the Paris Basin), contain a very considerable portion of gelatinous or soluble Silica. Should the Chalk, immediately below the Thanet, have been subjected to subaërial action previous to the deposition of the latter, organic matter would have been deposited on its surface; and, allowing vast periods of time, during which solution of the Chalk had been brought about, the insoluble flint alone would remain, together with the products of the decomposition and re-combination of the soluble portion. This, I take it, would efface, in great measure, the effects of the subaëral action, and would leave a tolerably uniform surface. The fractured flints, by the presence of soluble Silica, might again be re-cemented.

The faults in the Chalk have most of them taken place subsequently to the deposition of the Tertiaries. The bed of tabular flint found in East Kent, immediately below the green-coated flints, is the bed most subject to fracture; and it is to be observed that when these flints are taken from the Chalk they are particularly brittle, and, for the most part, rejected by the road-makers on that account. If it is possible, as stated in "Bischof's Chemical Geology," that Carbonate of Lime may be *entirely* replaced by Silica, it may be that the entire mass of this tabular-bed derives its origin from the liberated Silica of the overlying Tertiaries. Whether this is the case or not these facts are worthy the attentive study of the chemist and geologist, and may tend to explain several of the phenomena presented to the latter, such as the nature of the tabular flint in the Chalk, and the absence of sand in that formation; the re-cementing of fractured flints I believe to be going on at present.

The great gap (if it be so large as generally represented) between the Secondary and Tertiary strata may represent a period during which the Chalk has been subjected to marine denudation and subaërial influences, leaving the upper and re-stratified Chalk so mixed with siliceous and organic matter that mutual decomposition and re-combination of the substances therein contained may have been brought about, the organic matter playing an important part in this decomposition. The bed of green-coated flints with allophane and

[1] Quarterly Journal of Geological Society, vol. x., p. 123.

such like substances, I take to be the chips left by the hand of time, the only record of a period during which an entire fauna may have died out and been replaced by another; and they teach us not to calculate, from the thickness of the deposit, the centuries that may have elapsed.

NOTICES OF MEMOIRS.

I.—On the Fossil Animals of Pikermi, Attica.

By M. A. Gaudry.

In announcing the completion of the publication of his researches on the fossil bones of Pikermi, undertaken for the Academy of Sciences, Paris, during the years 1855–1860, M. Gaudry described the character of the specimens obtained, numbering 4940, which belong to 371 individuals, and 51 species.

At the time of Cuvier's works no fossil apes were known, but since then fourteen fossil species have been discovered. The remains of the *Mesopithecus* of Greece are so numerous that the author was able to figure the whole of its skeleton, and has determined it to be intermediate between the *Semnopitheci* and the *Macaci;* it has the skull of the former, and the limbs of the latter.

Besides apes, there have been found carnivora, the *Limocynon*, a small bear, a small dog, a small cat, and a genus called *Promephitis*, allied to the martens.

There have also been found at Pikermi, three civets of the genus *Ictitherium*, very closely related to the hyæna.

Gigantic bones have been found in Greece, belonging, as he has reason to believe, to the *Dinotherium;* they offer a very interesting relation, for the limbs are those of a Proboscidian, whilst the skull has analogies with those of aquatic animals, such as the Lamantins (or Manatees) now living in the Atlantic Ocean.

Formerly, the distinctions between the mastodon and the elephant were very evident; but the researches of English palæontologists in India have revealed species intermediate between these two genera. As species increase in number, their characters become so nearly related that it is difficult to avoid confounding them with simple varieties. In order to be able to recognise the different species of mastodon Dr. Falconer proposed to separate them into Trilophodons and Tetralophodons; but it is now found that the mastodon of Pentélique possesses teeth of both Trilophodon and Tetralophodon.

The rhinoceros presents no less curious transitions than the mastodon. The first fossil rhinoceros which Cuvier described appeared very different from the living species, for its nostrils were separated by a great partition; we know now of at least two species with a semi-partition, forming a passage between those that have a partition and those that have none. One species of rhinoceros, found at Pikermi, is intermediate between the two species which live in Africa; it has the skull of one, and limbs nearly identical with those of the other. Another species agrees closely with the rhinoceros now inhabiting Sumatra.

Hipparions were extremely abundant in Greece. M. Gaudry has determined 1900 fragments; the comparison of all these species has led him to perceive almost insensible gradations between them, and to refer them to but one species.

The wild-boar of Erymanthia is intercalated with species already known in Tertiary strata.

The giraffe of Attica forms a link which unites the living giraffe with fossil ruminants.

Pikermi is the first locality where great numbers of fossil antelopes have been discovered; they are allied to species living at the present day, thus the *Tragocerus* resemble the goat in its horns, although it is a true antelope; the *Palœoryx* has horns like the *Oryx*, but differs from that genus in its molar teeth; the *Palœorcas* approaches to the *Orcas* by its horns, and to gazelles by other characters.

M. Gaudry states that Pikermi is not the only locality where these fossil remains have been found, but that they are distributed over the whole country. He has drawn up tables, showing the geological range of all the species.—*Comptes Rendus*, Feb. 19, 1866.

II.—On some Stone Hammers of the Ancient Americans, used in the Working of the Copper and Native Silver Mines of Lake Superior.

By M. J. Marcou.

At one of the workings, called the "Mine de la Compagnie du Nord-Ouest," at Point Kievenau, some excavations were discovered, which indicate that this locality has been largely worked by the Indians. In these old workings were found a great number of stone hammer-heads of an oval or elliptical shape, weighing about two or three kilogrammes, and formed of such hard rocks as leptynite,[1] quartz, and porphyry. These hammers are heavy and difficult to handle, being only employed to break very hard rocks, and as no specimens set in hafts have been met with, the means employed by the Indians for fixing and using them is not known.

M. Marcou, however, states that, when crossing the prairies many years ago, he noticed in the possession of the Kioway Indians (the wildest and most uncivilized of all the tribes in North America) one of these stone hammers set in a handle. The hammer head was composed of quartz, and weighed about two kilogrammes, it was much worn, and one of the ends was chipped; it was bound to a handle with a strip of bison skin.—*Comptes Rendus*, Feb. 26, 1866.

[1] Composed of quartz and felspar.

III.—Note on a Bed of Fossils in Haute-Loire.

By M. Bertrand de Lom.

THIS stratum, called "Coupet," properly belonging to the neighbouring volcano, merits particular attention from geologists; for, independently of the Pozzuolana,[1] which is there found in inexhaustible quantities, and of the corundums and gems also met with, it yields a considerable number of bones of large and small mammals—pachyderms, ruminants, carnivors, and rodents—belonging, for the most part, to extinct species. The bones of the mastodon, and those of the elephant, are found there under conditions so similar as to lead to the conclusion that these animals lived contemporaneously, an opinion contrary to that held by most palæontologists.—*Comptes Rendus*, Feb. 26, 1866.

IV.—Fossils of the Aptien Stage of Spain.

By Prof. H. Coquand.

[Monographie Paleontologique de l'etage Aptien de L'Espagne, par H. Coquand, Professeur de Géologie et de Mineralogie. 8vo., Marseilles, 1866, pp, 221, 28 plates.]

THE Aptien stage, of D'Orbigny, is one of the lower members of the Cretaceous series, and the volume before us, describing its (invertebrate) fauna, is of the highest value. In his preface the author tells us that he has spared neither his time nor his money to render the work as perfect as possible, and the truth of this remark is well borne out in the manner in which it has been executed. It is the result of study during three months in the provinces of Teruel and Castellon de la Plana (Aragon), where the Aptien stage is best developed. Prof. Coquand confines himself to the Palæontology of the district he examined, reserving the Geology for another work. He commences by reviewing the previous labours of Geologists in this field, amongst whom MM. de Verneuil, Collomb, and Alcibar are foremost. He then gives short accounts of the Aptien, Gardonien, and Carentonien stages of the Cretaceous series, as an introduction to the more complete descriptions he intends to publish afterwards. He describes 231 species of Fossils from the Aptien beds, comprising 3 Annelids, 25 Cephalopods, 52 Gasteropods, 121 Conchifers, 9 Brachiopods, 14 Echinoderms, 6 Corals, and 1 Foraminifer; and gives lists of the Aptien Fossils of Switzerland, of the Aptien Fossils common to Switzerland and Spain, of those species common to Yonne and Spain, of those common to Provence and Spain, to England and Spain, to South America and Europe, and lastly, those common to North Africa and Spain.—H. B. W.

[1] Volcanic ash, used as mortar for building puposes. It derives its name from the town Pozzuoli, in the Bay of Naples.

V.—Geology of Bas-Boulonnais.

By M. E. Rigaux.

Notice Stratigraphique sur le Bas-Boulonnais, par E. Rigaux. [Bulletin de la *Société Académique de Boulogne*, No. 4, 1865.]

THE Bas-Boulonnais occupies a small Jurassic basin, resting on Palæozoic strata, in the Cretaceous area of the north-east of France.

M. Rigaux gives numerous sections of, and lists of fossils from, all the strata exposed in this region.

The Palæozoic formations are (1) the Devonian, which extends from Blacourt stream, near the road between Calais and Boulogne, and disappears near Fiennes (at Caffiers it is overlain by Gault); and (2) the Carboniferous, consisting of, first, a Dolomitic bed, then a mass of Limestone, then Coal, and above that another bed of Limestone, similar to the one below. This succession M. Rigaux believes to have been due to a disturbance which has caused an inversion of the strata, so as to make the same bed of Limestone appear above, as well as below the coal.

The Jurassic rocks, comprising the Bathonien, Callovien, Oxfordien, Corallien, Kimméridgien, Portlandien, and Wealden stages, are then described. A table of the strata is given, showing their lithological divisions, and the zones characterised by particular species of fossils.—H. B. W.

VI.—Quarterly Journal of Science.

THE April Number of this Journal opens with a long article, entitled "Darwin and his teachings," accompanied with a lithographed portrait of that distinguished naturalist. His writings, consisting of original observations on nearly every branch of Natural History, but principally his "Origin of Species," are here discussed.

There is also a paper "On the Antiquity of the Volcanos of Auvergne," by Dr. Daubeny, F.R.S., etc., and in giving a notice of his conclusions we cannot do better then quote the following paragraph:—

"Everything therefore concurs to bespeak a high antiquity for these formations, and to indicate a long-continued operation of denuding forces upon the beds of igneous matter since their eruption; and yet all these events must have been posterior to the formation of some at least of the fresh-water beds of the Auvergne country, formations which Sir Charles Lyell refers to the Eocene period. It seems, indeed, most probable that these eruptions of igneous matter had broken out at the time when the district was covered by extensive sheets of fresh water, like the great lakes of North America, and hence may have been derived their greater compactness, as compared with the more modern volcanic products before alluded to, an indication of their having been erupted under a pressure greater than that of the atmosphere."

Amongst other articles is one on "Comparative Philology as indicating the Antiquity of Man," by Mr. David Parkes.

REVIEWS.

THE GEOLOGICAL SURVEY OF VICTORIA.

VICTORIA, GEOLOGICALLY COLOURED. By ALFRED R. C. SELWYN (Government Geologist and Director of Mining and Geological Surveys). 8 sheets: scale 8 miles to 1 inch. Melbourne, July 1st, 1863.

GEOLOGICAL SURVEY-MAP OF VICTORIA: Sheets 1; 2, N.W. and S.W.; 3, N.W. and S.W.; 4, S.W.; 5, S.W. and S.E.; 6; 7, N.W., N.E. and S.E.; 8, S.W. and S.E.; 9; 10, N.W. and N.E.; 12, S.E.; 13, S.W.; 14, S.E.; 19, N.E. and S.E.; 20; 21, N.W.; 23; 24, N.E. and S.E.; 28, N.E. and S.E.; 29, N.W., N.E. and S.W.—47 quarter-sheets. Scale 2 inches to 1 mile. With an Index-map, scale 32 miles to 1 inch, showing the progress of the Geological Survey of Victoria up to May 1st, 1864.

GEOLOGISCHE KARTE DER PROVINZ VICTORIA: nach den offiziellen Aufnahmen unter der Direction von Alfred R. C. Selwyn. Reduzirt von A. PETERMANN. Scale 1 : 2,000,000 (about 31½ miles to 1 inch). Gotha, JUSTUS PERTHES, 1865.

REPORT OF THE DIRECTOR OF THE GEOLOGICAL SURVEY OF VICTORIA FOR THE PERIOD FROM JUNE 1863 TO SEPTEMBER 1864, WITH APPENDICES. Fol. 28 pages. Melbourne, 1865.

THE above list indicates very forcibly that in a colony like Victoria, which is rendered attractive to emigrants by the fame of its mineral wealth, the first efforts of a geological survey will necessarily be devoted to satisfying the popular demand for maps, more or less reliable, of as large an area as practicable in the shortest possible time. Pure science must therefore be expected to fare rather badly for some years, notwithstanding that so accomplished a naturalist as Professor McCoy is attached to the Geological Survey of Victoria, in the capacity of Palæontologist, and that Mr. Selwyn, the Director of the Survey, is especially desirous, without always having the opportunity, of doing his work thoroughly and scientifically as he progresses. Be it therefore understood that any adverse criticism would apply to the pressure put by the people and the government upon the surveyors and not to the survey itself. We have been led to these remarks by perusing the last Report of the Director of the Survey, but we are not likely to find fault with the execution of the maps notwithstanding the serious difficulties with which he had to contend. From Mr. Selwyn's preface to this document we see that he has endeavoured to impress upon the Executive Government that it is extremely undesirable to detach surveyors from their regular work of making "steady, detailed, and connected observations over economically very important, though perhaps limited, areas," in order to make hasty and imperfect explorations of larger tracts of country. This *coup d'œil* style of surveying appears to have been often tried and found wanting, for, as Mr. Selwyn observes, it is practically useless as regards the development of the mineral resources of the country, and in some cases appears to have led to directly injurious results, owing to the imperfect and partial information which hasty exploration enables the geologist to give.

This natural, and therefore almost universal, demand for maps by the Victorian colonists has, however, led to one very desirable result, namely, the publication by the government of a geological sketch-map of the colony, the lines having been drawn by Mr. Selwyn himself. This map, which is on the tolerably large scale of eight miles to the inch, gives a capital synopsis of Victorian geology, and so important has it been deemed on the continent of Europe that the enterprising scientific publisher of Gotha has employed Dr. Petermann to make a reduction of it. The contrast between this map and one of Great Britain is very great. We miss, especially, the evident lines of strike of the different formations, which we are accustomed to see exhibited with such regularity on maps of our own islands. Victoria seems to be formed of a great mass of Palæozoic rocks, through which protrude large areas of granite and trap, and upon which repose, near the coast, belts of Mesozoic and Tertiary strata, and volcanic products. On the margin of the map it is stated that remunerative goldworkings may be found, either in quartz-reefs or as alluvial deposits in the Lower Palæozoic, Metamorphic, Pliocene, and Post-pliocene strata, and in the Granitic and Upper Volcanic rocks.

The survey-maps, which are on the scale of two inches to the mile, are very creditable specimens of colonial chromo-lithography. Every attempt seems to have been made to render them as complete and accurate as possible, not only as geological and topographical maps, but also as guides to the physical geography and resources of the country. Besides the distribution of the formations, the indications of dip and strike, and other data usually inserted on geological maps, they contain a considerable amount of information as to the composition and fossil contents of the various strata, the mineralogy of the eruptive and volcanic rocks, and the localities in which gold-veins and gold-drifts have been or are profitably worked, including statistics as to the amount of gold per ton obtained by these different workings. The localities and numbers of the specimens obtained by the surveyors and deposited in the Melbourne Museum are carefully marked on the maps, and thus afford to the colonists valuable means of comparison; and as the boundaries and numbers of the numerous allotments are mapped with the same care as the outlines of the geological formations, no doubt the facilities thus given are duly appreciated.

A region, whose recent fauna and flora are so peculiar as those of Australia, might be expected to yield some geological puzzles. Accordingly we find that all the fossiliferous strata possess a very high interest to the palæontologist. The Lower Silurian beds yield Graptolites, agreeing genus for genus, and almost specifically, with those from the Skiddaw slates of England,[1] and bearing a remarkable resemblance to those from the Quebec group of Canada.

Of the British species we may especially mention *Diplograpsus pristis, Graptolites Ludensis, G. tenuis, G. latus,* and *G. sagittarius;*

[1] See Quart. Journ. Geol. Soc. vol. xix. p. 139.

while the most important of those common to Victoria and Canada are *Diplograpsus pristis*, *D. mucronatus*, *D. rectangularis*, *Phyllograptus typus*, *Didymograpsus caduceus*, *Graptolites Logani*, and many others. This community of fossils is, however, not confined to the *Graptolites*, but extends to other classes of animals, such well-known species as, for instance, *Orthoceras bullatum* and *Phacops longicaudatus*, occurring in the Upper Silurian rocks of Victoria.

Notwithstanding the occurrence of these fossils, the geological surveyors have not attempted, and we think wisely, to correlate the Victorian deposits with those of other regions more closely than is indicated by the terms Upper and Lower Silurian.

The Silurian rocks have been stated by Mr. Selwyn to be, so far as we know, "the source whence the whole of the gold now produced in Victoria has originally been derived." An inspection of Mr. Selwyn's map will show how large an extent of surface they now occupy, while the arrows indicating the dip reveal a considerable amount of undulation. It is therefore certain that a very large area of the same portion of the series has been subjected to denuding influences, and if that portion be the one containing the gold-veins,[1] or if the gold-veins occur throughout, as they appear to do, the hugeness of the great model-pyramid exhibited in the International Exhibition of 1862 will no longer surprise us, especially when we recollect that gold still occurs *in situ* over a considerable portion, if not the whole, of this area, and the auriferous drifts also occupy a great extent of country, and are even richer in the precious metal than the rocks whence they were derived.

The Devonian formation appears to be altogether absent from the colony, but the Carboniferous period is considered by Prof. McCoy to be represented by the formation which is mapped by Mr. Selwyn as Upper Palæozoic, and which has yielded species of *Phillipsia*, *Brachymetopus*, and *Bairdia*, with *Productus*, *Lepidodendron*, etc.—the first-named genera being characteristic of the Carboniferous formation in Europe.

These Upper Palæozoic deposits do not appear to possess any wide geographical range in Victoria, nor to yield minerals of economic value, although in certain localities they afford freestones suitable for building. In the "Victorian Essays" Mr. Selwyn stated that in several localities thick masses of conglomerate occur towards the base of the series; this conglomerate is composed of rounded pebbles, with occasionally angular fragments of all sizes,—of granite, greenstone, various porphyries, hard slate, gritty sandstone, grey quartz-rock, and quartz; and he remarked that the character of the beds is "suggestive of the results likely to be produced by marine glacial transport."

Regarding the Secondary rocks there has always been some considerable difference of opinion, the New South Wales geologists contending that their coal-formation is of Palæozoic age, notwithstanding the Oolitic-looking plants contained in it, while Professor McCoy says

[1] The gold-veins appear to run pretty constantly nearly N. and S.

that the Palæozoic fossils (including a *Lepidodendron*), said to have come from the same beds, have in reality been obtained from different strata. A palæontologist would no doubt be inclined to assume that such was the case; but, as all the New South Wales geologists aver the contrary, the assumption cannot be admitted as a valid argument, although there is doubtless something yet to be discovered explanatory of this strange association, and that something *may* turn out to be some admixture of the fossils or confusion of the beds, the probability of which is increased by the recent discovery of, to all appearance, a Tertiary (!) shell, thirty feet above the Newcastle (N.S.W.) coal and three hundred feet below the surface.

We might almost declare that Australian palæontologists are toiling under a Jurassic incubus, for is it more strange to find *Zamites* and *Tæniopteris* associated with *Conularia*, *Fenestella* and *Orthoceras*, than a "costate" *Trigonia* in the Tertiary formation? And the Jurassic element did not entirely disappear even in the Tertiary period, for it lingers still in the terrestrial fauna of the island-continent.

The strata termed Mesozoic by Prof. M'Coy, and mapped as Oolitic by Mr. Selwyn, comprise all, or nearly all the coal-bearing rocks of Victoria; the maps show that they occupy a considerable area in the colony, and bituminous seams of coal are stated to have been found at several localities, although we believe that in Victoria they have not yet been profitably worked, owing, probably, to the high price of labour. The series yields, however, a light-yellow banded sandstone, which is soft and easy to work, and becomes harder on exposure to the atmosphere. In some localities these properties, with its extreme durability and lightness of colour, constitute it a valuable and ornamental building stone (Sheet 9 S.W., note 8); but at Port Arlington it exfoliates so rapidly as to be quite useless for economic purposes.

The Tertiary deposits are the most varied in character and the most prolific in fossils of all the sedimentary rocks of Victoria; they possess also an unusual interest from the fact of their necessarily being the key to the origin of the recent fauna and flora of the Australian region. In Australia, and to a less extent in the seas which surround it, we find at the present day the nearest allies to those animals which were dominant in Europe during the Oolitic period. The question therefore arises, how far can these Marsupials, *Trigoniæ*, etc., be traced back in the Australian region? Having seen that the Mesozoic strata are so imperfectly represented in Victoria, it is important to state, for the satisfaction of the philosophical naturalist, that the Tertiary deposits occur in great variety, are very fossiliferous, and will, doubtless, some day yield important results bearing on many recondite palæontological questions. The Geological Survey of Victoria have already named certain strata Post Pliocene, Newer Pliocene, Older Pliocene, Miocene, and Eocene (Mt. Eliza Beds); but although these names probably represent the order of succession which they have *inter se*, it may be questioned whether any data are yet known which would warrant their correlation, even homotaxeously, with the similarly designated deposits occurring in Europe. If such are in the possession of Prof. M'Coy we would urge him to make them known without delay.

The igneous rocks associated with these deposits are stated by Mr. Selwyn[1] to be strictly volcanic, and in no instance of older date than the Miocene period; but their greatest development took place during the deposition of the Pliocene series.

The occurrence of gold-drifts renders the Tertiary formation of vast importance to the colony in an economic point of view; but geologically they have a subordinate interest to that of the fossiliferous strata associated with them. On the maps they are divided into four groups designated, respectively, Miocene, Older Pliocene, Newer Pliocene, and Post Pliocene, or Oldest, Lower, Middle, and Upper Gold-drifts; the three upper stages sometimes all occur in one locality, but their relation to the underlying deposits does not appear to be well made out.

In a marginal note on the maps it is stated that deposits of sand, clay, and gravel of the age of the Upper Gold-drifts (Post-Pliocene) occur at intervals along the courses of all the valleys; they are frequently cut through and redistributed by the existing rivers during floods.

Amongst the numerous other notes on the margins of the Survey-sheets, we may especially mention those on No. 7, N.W., which, with the accompanying section, plan, and view, elucidate the position, structure, and contents of an important cave at the head of the Toolam Toolern Creek, which was explored in 1857 by Mr. Aplin. This cave is in a basalt-dolerite belonging to the Upper Volcanic group (Pliocene) on the side of a ravine excavated in that rock, and exposing the underlying contorted Lower Silurian rocks at the sole of the valley; it has yielded specimens of *Canis Dingo*, *Phalangista vulpina*, *Dasyurus viverrinus*, and *Perameles obesida*, all being species now existing in Australia; also *Diabolus ursinus* (the Tasmanian Devil) no species of which genus is at present known in the island-continent. Besides these there are new species of *Dasyurus*, *Phalangista*, *Hypsiprymnus*, and *Macropus*, more or less allied to, but distinct from, the existing forms, together with a representative of a new genus of carnivorous *placental* mammals, of whose affinities no indication is given. All the bones from this cave are strongly adherent to the tongue, and have quite lost their animal matter.

In conclusion we will just call attention to the singular fact that, whether we examine the fossils from the Silurian, Carboniferous, Oolitic, or Tertiary formations of Australia, we cannot help being struck by the remarkable resemblance, often even identity, which they bear to fossils from strata passing under the same names, and occurring in distant regions of the earth.

H. M. J.

[1] Victorian Essays.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. March 21, 1866.—Warington W. Smyth, Esq., President, in the Chair. The following communications were read:—1. "On the Fossil British Oxen.—Part I. *Bos Urus,* Cæsar." By W. Boyd Dawkins, Esq., M.A., F.G.S.

The problem of the origin of our domestic races of cattle was considered by the author to be capable of solution only after a careful examination of each of the three European fossil species of Oxen, namely, *Bos Urus* of Cæsar, *B. longifrons* of Owen, and *B. bison* of Pliny. In this paper he began the inquiry with *Bos Urus,* Cæsar, being the *Bos primigenius* of Bojanus, and he arrived at the conclusion, that between this species and *Bos Taurus,* or the common Ox, there is no difference of specific value, though the difference in size and some other characters of minor value render the bones of the two varieties capable of recognition. After giving the synonymy of *Bos Urus* in some detail, and measurements of the different bones as represented by specimens from a number of localities, Mr. Boyd Dawkins described the range of the species in space and time, showing that it coexisted in Britain with the Mammoth, *Rhinoceros leptorhinus, R. megarhinus* and *R. tichorhinus,* and was associated with *Elephas antiquus, Felis spelæa, Ursus spelæus, U. arctos, Bos priscus, Megaceros Hibernicus, Cervus elaphus, C. tarandus, Equus fossilis,* etc., and held its ground during the Prehistoric period, after most of these animals had become extinct or retreated from this country. The precise date of its extinction in Britain was stated to be somewhat uncertain, although the author inclined to the belief that it existed in the wild state as late as the middle of the 12th century; while on the continent it seems probable that it lingered until the 16th century. The author then endeavoured to explain its gradual diminution in size by the progressive encroachment of cultivation on its old haunts; and in conclusion, stated his belief that at least the larger cattle of Western Europe are the descendants of the *Bos Urus,* modified in many respects by restricted range, but still more by the domination of man.

2. "Further documents relating to the formation of a new island in the neighbourhood of the Kameni Islands." By Commander G. Tryon. Communicated by the Lords Commissioners of the Admiralty.

A detailed account was here given of the formation of the new island, named "Aphroessa" by the Greek Commissioners; it was stated to be 100 yards long by 50 wide, and to be daily increasing in size. Volcanic eruptions had taken place in two localities, one in the new island, and the other in what was called Mineral Creek, which is about two-fifths of a mile distant, and which had been completely filled up with lava. Considerable concussions were experienced at Patras and other parts of Greece, which were by some attributed to an earthquake, and by others to volcanic explosions; but, with these exceptions, no earthquake had attended the eruptions or the formation of the island.

3. "Note on the Junction of the Thanet Sand and the Chalk, and of the Sandgate Beds and Kentish Rag."[1] By T. M'Kenny Hughes, Esq., B.A., F.G.S.

At the bottom of the Thanet Sand there is always a bed of green-coated flints in a green and rust-brown clayey sand, which the author is of opinion was derived from the decomposition of the chalk by the percolation of carbonated water, after the deposition of the Thanet Sand, as none of the flints are water-worn, and only chalk fossils have been found in the bed.

At the base of the Sandgate beds, and resting on rubbly Kentish Rag, there is generally a bed of green sand; it may be seen in the quarries, near Maidstone, where it occupies furrows of the nature of pipes. Mr. Hughes endeavoured to show that this bed has been derived from the decomposition of the Rag after the deposition of the brick-earth, and that the rubbly limestone below it is the same in process of decomposition. He remarked, in conclusion, that conformabilities or unconformabilities of beds must not be inferred from an examination of the line of junction only, as that may have been very much modified after the deposition of the newer formation.

4. "On the Lower London Tertiaries of Kent." By W. Whitaker, Esq., B.A., F.G.S.

This paper gave the general results of the Geological Survey work in the Tertiary district of Kent, chiefly by the author, who expressed his agreement with Mr. Prestwich's paper, except in a few matters of mere detail.

Five different members of the Thanet Beds were distinguished, the only constant one being the "base-bed," the possible formation of which, after the deposition of the sands, etc. above, worked out in detail by Mr. Hughes, had occurred also to the author. It was shown that the fine Thanet Sand of West Kent was replaced eastward by beds of fossiliferous sandy marl and sand, which came on in succession above it.

Of the overlying Woolwich Beds, only the lower part is present in the eastern part of the county, the middle (the estuarine shell-beds) and upper parts being limited to the western and central districts.

The sands of East Kent, which Mr. Prestwich had somewhat doubtfully classed with the basement-bed of the London Clay and the pebble-beds of West Kent, part of which had been classed with the Woolwich series and part with the basement-bed, the author had been led to look upon as a distinct division, to which he gave the name "Oldhaven Beds," and which are separable alike from the London Clay above and from the Woolwich Beds below.

The basement-bed of the London Clay, in the limited sense in which it is understood by the author, changes its structure according to that of the underlying beds.

The author corrected some mistakes that had been made in a

[1] See also Mr. G. Dowker's paper on this subject at p. 210.

paper printed in the Society's Journal, in which an undoubted Eocene bed, near Chislet, was classed with the Crag, on the strength of its fossils, many of which he believed to have been wrongly named.

It was then pointed out that the Woolwich and Reading series was known to be transgressive over the underlying Thanet Beds, and it was shown that the Oldhaven Beds were transgressive over both, so that outliers of the last might rest at once on the Chalk; and from this the author thought that, in the absence of good palæontological evidence, the occurrence of the isolated patches of sand on the North Downs, which Mr. Prestwich has classed with the Crag, might be explained by the Geological structure of the older Tertiaries, although he did not attempt to say that they belonged to that series. Should a more decided opinion be given on their fossils he was quite willing to take Mr. Prestwich's view.

The following specimens were exhibited:—Specimens of nine species of Miocene Foraminifera from Malta; presented by Capt. T. A. B. Spratt, R.N., C.B., F.R.S., F.G.S. Flints from the junction of the Thanet Beds and the Chalk; exhibited by George Dowker, Esq., F.G.S.

II. April 11, 1866.—Warington W. Smyth, Esq., President, in the chair. The following communications were read:—1. "On the Brown Cannel or Petroleum Coal-seams at Colley Creek, New South Wales." By William Keene, Esq., F.G.S.

In this paper, the author described the geological position of the Brown Cannel or Petroleum-coal of Colley Creek, Liverpool Plains. From an examination of the rocks, he stated that he had been able to determine that this Cannel is below the Coal-seams worked in the Newcastle Coal-field. It appeared to form the very base of the Coal-measures, and to be in such close contact with the Porphyries, that these latter seemed mixed up with the lower portion of the Cannel Coal. There are two parallel seams of workable thickness, which are tilted at a high angle, and run north and south. In appearance, the specimens are identical with the Brown Cannels from Hartley, and are but little different from the Boghead coal of Scotland.

At Scone, near the Kingdon Ponds, a section was noticed, in which the marine fossiliferous bed is proved to overlie the coal-seams, affording, as the author remarks, conclusive testimony as to the high antiquity of the Coal-beds.

2. "On the Occurrence and Geological Position of Oil-bearing Deposits in New South Wales." By the Rev. W. B. Clarke, M.A., F.G.S.

The author first described the oil-producing schists and cannels of New South Wales as they exist at Colley Creek, at the head of the Cordeaux River (Illawarra shales) at various places in the Wollondilly and Nattai valleys, at Reedy Creek (Hartley Cannel), Stoney Creek, and elsewhere; as well as a substance resembling "Bog-butter," occurring at Bournda, and probably of very recent date. Respecting the Colley Creek Cannel, described in the previous paper, Mr. Clark observed that he saw no porphyry near it, but that a seam or mass of the Cannel, which here contains numerous scarcely rounded grains of quartz, was passed through in the midst of a series of layers of black, partly unctuous clay, which also contained many similar quartz-grains; these grains gave to the clay a porphyritic aspect, so that by sight alone one might be led to consider them a decomposed porphyry. The chief conclusions at which the author arrived were, (1) that, with the exception of the Stoney Creek Cannel, all the oil-producing deposits occur in the Upper Coal-measures, and that the Cannel of Stoney Creek, on the River Hunter, occurs in the Lower Coal-measures, which are above the Lower Marine Beds with Trilobites, below which again are numerous fossiliferous beds before the porphyry is reached; and (2) that the Cannel belongs to beds in which *Glossopteris* occurs, and therefore may be a slight additional evidence of their antiquity, as it is an analogue of the "Bog Head" Cannel of Scotland.

3. "Remarks on the Copper Mines of the State of Michigan." By H. Bauerman, Esq., F.G.S.

The author described briefly the different conditions under which native copper is found in the trappean belt of the Upper Peninsula of Michigan, on Lake Superior. The district in question is a narrow strip of ground about 140 miles long, and from two to six miles in breadth, made up of alternations of compact and vesicular traps, with subordinate beds of columnar and crystalline greenstones, conformably interbedded with sandstones and conglomerates. Three different classes of deposits are known, namely, transverse or fissure lodes in the northern district, cupriferous amygdaloids and conglomerates following the strike in the central or Portage district, and irregular concretionary lodes also parallel to the bedding, in the southern or Ontonogon district. In the fissure-veins copper occurs either spotted through the vein-stuff, or concentrated in comparatively smooth plates, or lenticular masses, of all sizes up to 500 tons. In the Ontonogon lodes the masses are also large, but of much more irregular forms. In the Portage district, on the other hand, only small masses are found, the great production of the mines of this region being derived from the finely divided spots and grains interspersed through the amygdaloids and conglomerates.

After giving details of the phenomena observed in the lodes of particular mines, and a list of the principal alternations of minerals, chiefly zeolites with quartz, native copper, and calcite, the latter mineral being both newer and older than the copper, the author proceeded to notice the various hypotheses that may be framed for elucidating the occurrence of native copper in the Lake Superior traps. Two principal sources were indicated, the first on the supposition that protoxide of copper may have originally formed part of the felspathic component of the trap, or that the same rock may have contained sulphuretted compounds of copper mechanically intermixed; while, according to the second view, the overlying sandstones may have contained small quantities of copper-bearing minerals in a similar manner to the Kupferschiefer and other Permian and Triassic rocks in Europe. Supposing the trappean rocks to have been percolated by solutions carrying the products of the alternation of such minerals, it was suggested that the reduction to the metallic state was mainly produced by the action of substances containing protoxides of iron, which by higher oxidation have given rise to the dark-red colour and the earthy ochreous substances found in the vein-matter. The causes producing the metalliferous deposits in the trap were stated to have evidently acted throughout the whole system, and the absence of copper from the compact beds is, probably, rather due to the absence of cavities fit for the reception of such masses, than to any difference in chemical composition.

The following specimens were exhibited:—Copper-ores from the State of Michigan; exhibited by H. Bauerman, Esq., F.G.S. A piece of an iron water-pipe, containing a calcareous incrustation deposited from the water supplied to the City of Bath; presented by John Lawson, Esq., C.E., F.G.S.

Edinburgh Geological Society.—March 1st, 1866—David Page, Esq., F.R.S.E., F.G.S., Vice-President, in the Chair.—Mr. D. J. Brown read a paper "On the section of the Mid-Lothian Coal-field at Shawfair," and Mr. G. C. Haswell read the first part (introductory) of a paper "On the Crustacea of the Silurian beds in the Pentland Hills."

March 22nd, 1866.—R. A. F. A. Coyne, Esq., C.E., in the Chair.

1. Mr. George Lyon gave a short sketch of the "Geology of the Cowgate."

After alluding to some of the more prominent archæological features of the Cowgate, he stated that the hollow, in which this now extinct suburb of the city stands, is the result of the denudation of the Castle Rock, the denuding agent having scooped out two parallel and converging valleys, one on each side of the great central ridge on which the old town is built,—that which forms the Cowgate, being about sixty feet higher than the other which formed the Nor' Loch, now Princes Street Gardens, and the reason why this ridge is so sharp and well defined, arises from the soft nature of the rocks, principally shales, on which the denuding agent acted. The excavations recently made for the New County Buildings, laid open a section of the Boulder clay about twenty feet deep, in which were imbedded several boulders which had been transported by currents of water from the Castle Rock. Proceeding in a direction towards the Advocates Library, the pick and spade laid open the foundation and walls of old tenements and a thick mass of rubbish, containing bones of animals, shells of the oyster, cockle, and mussel, which showed that the inhabitants of former times deposited their refuse heaps at their doors, and the kitchen-midden must have been a prominent feature in the back alleys and garden enclosures.

The Cowgate never seems to have been a loch like its congener which now forms Princes Street Gardens. It probably existed only as a marsh. The drainage of the Cowgate, some years ago, opened up a larger section of the Boulder clay to the depth of about nine feet; no marl was found. Several trap dykes exist along this line of denudation which strike through the strata in a direction contrary to the dip.

2. Mr. Thomas Smyth read a short paper "On Shell-mounds, and on the discovery of shells in the superficial deposits in the Queen's Park near St. Anthony's Chapel." The age of shell-mounds is indicated by the remains found in them, and may by divided into four periods, which are now pretty generally recognised by archæologists. (1) The period of flint weapons rudely shaped; (2) that of flint weapons well-shaped, and of implements of polished stone; (3) that of bronze, and (4) that of iron, commencing with the dawn of the Roman empire and coming down to the present day. Several excellent geologists, who have not made archæology a study, consider that the term "shell-mounds" must be applied solely to those mounds which belong to the first period, that of flint weapons rudely fashioned; and that all shell-mounds must therefore be, like the Danish "Kjökken-mödding," or "kitchen-refuse heaps," pre-historical. Instead of belonging to any one period, many of those mounds belong to all the four, with centuries intervening, each addition to the refuse-heap, in the ascending scale, showing an improvement in civilization. On the other hand the author found so lately as the last century, the natives of the Andaman Islands, the inhabitants of Terra del Fuego, and other isles, used flint and stone weapons; and the descriptions given by travellers of the shell-mounds, which were then being formed, exactly corresponded with the pre-historic mounds which we have seen in Denmark. Along the eastern shores of the United States of America there are similar mounds not four centuries old. It would, therefore, be absurd to limit the age of shell-mounds to any precise point of antiquity; and he considered it would be more philosophical, and less confusion would arise, were all writers to describe those mounds, in Europe at least, as belonging to the periods, or the combination of periods, which the nature of the weapons found in them indicated.

In the second part of his paper Mr. Smyth stated that various deposits of shells had been found in the Queen's Park, Edinburgh, but he believed that they were all of very modern date. Last month he accidentally discovered one of these modern deposits on the slope of the hill below St. Anthony's Chapel. The shells, which consisted of the common oyster, were isolated, and lay, so far as he could observe, at the depth of from sixteen to twenty-six inches below the surface, he also found many bones of sheep and oxen in the place; and a gentleman has since discovered two Scotch coins (bodles) one of them of the reign of King James III., and the other of the reign of King James V., the former at a depth of two feet two inches, and the latter at a depth of one foot ten inches, both being in juxtaposition with the shells.—J. H.

Cotteswold Naturalists' Field-club.—At the Annual Meeting of this Club, held on the 21st of March, the members met at the residence of their esteemed President, Sir W. V. Guise, Bart., at Elmore Court, which is situated near the Severn, about four miles from Gloucester. The President commenced the business of the day by the reading the annual address, in which he reviewed, in an able manner, the leading features of interest observed by the Club in the excursions made during the past year, and congratulated the members upon the excellent papers which had been contributed, and which will shortly be published in the transactions. As the Club has undertaken to bring out some expensive illustrated papers of much interest, he recommended an increase of the annual subscription to 15*s*. The Secretary's account having been duly passed, the President gave up the chair to the Rev. W. S. Symonds.

Dr. Wright then proposed the re-election of Sir W. Guise, which was seconded by Major-General Younghusband, and carried unanimously.

The President, having again taken the chair, paid a high compliment to Dr. Paine, the Hon. Sec., who was also unanimously re-elected. Several members were proposed, and the Club is now full.

The suggestion of the President, to raise the subscription, was adopted; and the following places of meeting were arranged for the year:—Stroud, May 16th; May Hill, June 13th; Bath, July 18th; Evesham, August 15th; Malvern, September 12th.

At four o'clock dinner was served in the fine old Hall. Those present were Sir W. and Lady Guise, the Misses Guise, the Revs. W. S. Symonds, Lee Warner, Atwood, and Smithe, Major-General Younghusband; Major Barnard; Drs. Wright, Washbourn and Wilson; Messrs. P. B. Parnell, Etheridge, Nash, Middleton, Vowell, Ball, Wilton, Withered, Mitchell, Fisher, Silree, Lucy, Modin, and Dr. Paine.

Mr. Etheridge read a Paper "On the Physical Structure of the Northern part of the Bristol Coal Basin, chiefly having reference to the Iron Ores of the Tortworth area."

He referred to the enormous trade in coal and iron, which, in 1864, according to Mr. Robert Hunt, of the former amounted to 92,787,873 tons, the value of which at the pit's mouth is £23,197,968; of the latter 10,064,890 tons, having a recognized value of £3,367,144, in the raw state, or as mineral ore; but when converted into pig-iron 4,767,951 tons, at the value of £11,919,877. After having given an extremely interesting sketch of the history of iron working in the county, from the earliest times of which there is any record, and described the general physical features of the district where it is found, and the geological position and mode of occurrence of the ores, he concluded with the following abstract of the generally received theories of the origin of iron-stone veins:—First, the *contemporaneous* formation of mineral veins with the rocks which enclose them; secondly, the filling in of fissures found in rocks by the *sublimation* of substances, driven by heat from beneath upwards; and thirdly, the filling in of fissures in rocks by chemical deposits, from substances held in solution in the fissures, and by infiltration; such accumulations and deposits being, perhaps, greatly due to electro-chemical agency. It is to this latter in the main, and at the age mentioned, that he believed the iron-lodes and ores of the Tortworth district to have accumulated.

A most enthusiastic vote of thanks was passed to Sir W. and Lady Guise for their kind and hospitable reception.—W. C. L.

Warwickshire Naturalists' and Archæologists' Field-club.—The Annual Winter Meeting of this Club was held in the Warwick Museum on February 26th, 1866.—The President, W. Martin, Esq., M.P., delivered an address chiefly devoted to Archæology; he especially dwelt upon the recent discoveries of flint implements in Post-Tertiary deposits, with an account also of Lake dwellings.

The Rev. P. B. Brodie, M.A., F.G.S., Vice-President, next read a paper "On the Drift of Warwickshire, and on the evidence of glacial action exhibited." He described the gravels and clays along the valley of the Avon, with mammalian remains, and an extensive deposit of drift of all ages largely scattered over a considerable tract of the county around Warwick. His discovery of quartzose pebbles in this drift containing Lower Silurian fossils similar to those discovered in the New Red Sandstone at Budleigh Salterton,[1] was particularly interesting and formed the chief point of the discussion which followed.

Mr. Whittem then read a paper "On the Drift in the neighbourhood of Coventry," and Mr. Startin described the drift in the vicinity of Exhall, both of whom confirmed Mr. Brodie's statement of the evidence which these superficial deposits afford of the action of ice at the period when the gravels were deposited. Mr. Brodie then read a paper "On the Fossils of the New Red Sandstone of Warwickshire," and in illustration drew attention to the fine collection of Labyrinthodont remains in the Warwick Museum. Mr. Startin read a paper on the same formation near Coventry. After which Mr. Brodie gave a *viva voce* explanation of the quartzites in Normandy, with their remarkable fossils, the deposit whence the pebbles in the New Red Sandstone of Budleigh Salterton are supposed to have been derived.—P. B. B.

Warwickshire Natural History Society.—On April 8th the Annual Meeting was held at the Warwick Museum. Officers for the ensuing year were elected. The Rev. P. B. Brodie read a paper "On the Geology of a part of Warwickshire." He described the Drift, Lias, New Red Sandstone, and Permian formations, with their characteristic fossils, illustrated by their extensive local collection. Mr. R. F. Tomes, F.Z.S., communicated a notice of the discovery of human remains at Milcote, near Stratford-on-Avon, which he considered to be of great antiquity, probably Saxons, destroyed by an incursion of the Danes, referred to by Dugdale. Mr. Fetherston briefly described some Roman pottery, found in the same neighbourhood.

After an animated discussion on the several papers, the meeting was adjourned.—P.B.B.

North London Naturalists' Club.—April 12th, 1866.—Mr. W. Hislop, F.R.A.S., Treasurer, in the Chair.—Mr. W. Carruthers, F.L.S., read a paper "On the Vegetation of the Coal Period." He

[1] See paper by Mr. W. Vicary, F.G.S., with descriptions of the fossils by Mr. Salter, Quart. Journ. Geol. Soc., vol. xx., 1864, p. 283; also Geol. Mag., Vol. I. p. 5.

stated that the chief plants forming the Flora of the Coal formation, were not found in the coal itself, but in the clay, called underclay, beneath it; all organic structure having been destroyed in the coal through the subsequent changes which it has undergone. He enumerated the different formations in which coal has been found, and then proceeded to notice the most important plants of the true Coal-period. He explained their relations to living forms, illustrating his remarks by dried specimens of the recent plants most nearly allied to those of the coal. He referred to the many generic names that have been given to different parts of both the *Lepidodendron* and *Sigillaria* before their structure was well determined, and stated that Mr. Binney had even arrived at the conclusion that the two plants were the same. He believed that the *Flemingites*, described by himself,[1] was the fruit of *Sigillaria*, as both were most abundant in the coal strata. He concluded by briefly noticing some of the theories advanced to account for the origin of coal.—H. B. W.

Natural History Society, Montreal.—I.—The usual monthly meeting of this Society was held in their lecture-room on the evening of the 18th December.—Dr. Smallwood, the President, in the chair.

Principal Dawson exhibited a number of specimens of flint implements and fossils from St. Acheul, near Amiens, and made some observations on the mode of their occurrence in the "high-level gravel," in the valley of the Somme. He referred to the investigations of Boucher de Perthes, Lyell, and Prestwich, and quoted a portion of the description of the locality by the latter geologist. He stated the following conclusions derived from an examination of the locality and of the specimens, more especially those in the collection of Mr. Prestwich:

1. The implements cannot be considered so much as characteristic of a particular age as of particular work. They are not spears nor arrows, nor hatchets, but picks and diggers, adapted for digging in the earth or ice, or for hollowing wooden canoes. A consideration of the implements of the American stone age renders it in the highest degree improbable that the makers of these tools did not possess also stone arrows, spears, knives, and other implements. The application of the idea of an older and ruder stone age to such implements is gratuitous, and contradicted by American antiquities.

2. There are some reasons to induce the belief that these implements have been used in driving small horizontal adits into the gravel-beds of St. Acheul, in search of flints. In this case they may not be of great antiquity, though certainly older than the Roman occupation of Gaul.

3. They may have been deposited with the gravel. In this case they belong historically to a very ancient period, though geologically modern; and at the time when they were deposited the climate of France must have been more severe than at present, its level different, its surface covered with dense forests, inhabited by several great

[1] Geological Magazine, Vol. II. p. 433.

quadrupeds now extinct, and the River Somme must have been much larger than at present, and must have spread its waters over a wide plain, in which the St. Acheul gravel constituted a bank or point, inundated in times of flood, and perhaps resorted to by the aborigines as a place for making canoes.

4. Before either of the two theories above stated can be finally accepted, much more thorough investigations must be made, and also careful topographical surveys of the whole district. In the event of the view last mentioned being sustained, the question of absolute time required will still be difficult to determine, since the causes of erosion and deposition in operation at the period in question must have been very dissimilar from those now in action; and other unknown causes, whether sudden or gradual in their operation, must have intervened to produce the present state of the country. In this case, however, there would be a strong probability that the *Rhinoceros tichorhinus* and the Mammoth, had continued to exist in Europe down to the period of the implement-makers.

It is much to be desired that a series of systematic excavations in these gravels, and a geological and topographical survey of the whole basin of the Somme should be undertaken by some scientific body in France or England, as it may require many years to enable individual explorers to obtain the data required to settle the questions that have been raised in connection with these deposits.—*Montreal Gazette,* December 20, 1865.

II.—A meeting of this Society took place at its Rooms, on Monday evening last, January 29th, the President (Dr. Smallwood) in the chair. Among other communications, Mr. H. G. Vennor read a paper on the Manitoulin Islands. He commenced by giving a topographical account of the great Manitoulin Island, and described the best mode of access to the group. He next gave a brief sketch of some of the geological features of the island, and exhibited some of the silicified fossils of the Clinton group from the neighbourhood of Manitou lake, also photographs of glacial groovings and scratchings on rocks on the south shore of the island. Indications of petroleum were met with at Wequemakong, and allusions were made to the boring for oil at this spot by the great Manitoulin Oil Company. The oil from this locality, the lecturer remarked, was of the finest kind. He stated that the bald eagle and fish-hawk were numerous in the interior lakes, that ravens were abundant on the island, that both the spruce partridge and the ruffed grouse were plentiful, and that wild pigeons were often seen there in immense flocks. In conclusion he remarked that two-thirds of the area of the great Manitoulin Island consisted of fertile land plentifully covered with trees, and that the remainder was of a barren and rocky character. A list of the birds observed on the islands accompanied the paper.—*Montreal Gazette,* February 1, 1866.

III.—February 8th.—The first lecture of the Somerville course was delivered before the above Society by Dr. P. P. Carpenter (late of Warrington, near Manchester), "On the Cuttle-fishes and their allies." Dr. Carpenter included in his interesting lecture descriptions of both fossil as well as recent forms, and exhibited illustrations of the several genera. The President (Dr. Smallwood) on behalf of the Society returned thanks to Dr. Philip Carpenter for his valuable and instructive lecture.—*Montreal Gazette*, February 13, 1866.

CORRESPONDENCE.

ATMOSPHERIC *V*. MARINE DENUDATION.

To the Editor of the Geological Magazine.

Sir,—Having publicly advocated atmospheric action as the power by which the present "form of the ground" has been produced, I would wish to say a word or two on the clever articles you are publishing by Mr. D. Mackintosh, in which the sea is treated as the chief agent.

I am glad to see that Mr. Mackintosh does not allude to the action of internal force as having any *direct* effect on the external features of the ground. So long as we were hoodwinked by the *hocus-pocus* of "grand convulsions," and believed it possible for mountain chains to jump out of the interior of the earth like so many "jacks in the box," no advance in real knowledge was possible.

It may be taken for granted, then, that all the external features of the ground (except of course volcanic cones and craters) are the direct result of external agencies (Presidential Address to Section C. British Association, Cambridge, 1862). It may also be taken for granted that as all lands have risen out of the ocean, marine denudation has done something towards the production of their present form, and that during the time they have stood as dry land atmospheric agencies have also done something towards it. The problem is to apportion to the marine and atmospheric agencies the amount of work each has performed.

In reading Mr. Mackintosh's articles I recognise ideas which a few years ago I held as stoutly as he does now, and I believe therefore that he is following the same path which I did towards a fuller appreciation of the precise operation of these natural agencies. I think I was hardly aware of the change which had taken place in my own convictions, as the result of constant observation in the field, till I hit upon the solution of a problem that had long puzzled me, namely, the precise mode of production of the river valleys of the South of Ireland. (See Quart. Jour. Geol. Soc., London, vol. xviii.)

This solution requires that the rivers should never have ceased to run through the ravines, by which they traverse isolated hills between their sources and the sea, during the denudation of the plains by which those hills are surrounded. Had the sea ever marched across the country, and worn it down to form those plains, it must have obliterated all the old features which formerly existed over the areas where the plains are now; and the subsequently formed rivers would never have regained their channels in those ravines, which would have been left as shallow passes through the hills at a greater or less height above the plains. The plains have many broad openings to the sea, without the intervention of any hills, and these would have been the natural outlets of the rivers, if the "form of the ground" had been made for them by the sea.

The reason why the rivers choose to run through the hills by deep ravines, instead of by much easier routes which are now open to them, is that when they began to run these hills did not exist. The hills were then buried, as it were, in much higher ground, by which they were surrounded, and over which the rivers originally ran. The rivers choosing, of course, the lowest ground they could find in their course to the sea, happened here and there to cross the parts where these hills subsequently became disclosed by the waste and erosion of the rock which surrounded them. The rivers, however, having once cut channels for themselves, have ever since kept those channels open, and it is through those channels that the waste of the interior has been carried off. Although, then, the interior was worn down into a plain, while the hill ground resisted that action and was left standing as a hill, the river channel, through that hill, was always cut lower than any part of the plain, for it was only in consequence of the deepening of that channel that the waste could be carried off and the erosion of the surface of the plain continued.

In Ireland the rock that was thus wasted in the interior was Carboniferous Limestone, the ground that stood as a hill was Old Red Sandstone or some other siliceous rock.

The calcareous rock was acted on both by mechanical erosion and chemical solution, the siliceous rock only by mechanical erosion. The siliceous rock therefore resisted the atmospheric action far more than the calcareous rock did, but it would not have thus resisted the sea, which would have cut into Old Red Sandstone just as easily as into Carboniferous Limestone.

This alone is an argument in favour of atmospheric action, but the great argument is the continued running of the rivers during the denudation. Rivers only run over the land, therefore the denudation took place upon the land.

This conclusion, to which I found myself unconsciously and almost reluctantly brought, acted on me like a sudden revelation. It connected together and explained to me all that had been mysterious in the "form of ground" in Wales and England, and other parts of the world, during my observations of the last thirty years, including many of the localities mentioned by Mr. Mackintosh. I saw how it could be applied to the Weald, as my colleagues Professor Ramsay and Dr. Foster and Mr. Topley have since applied it; and, in fact, that its application was universal.

There are, doubtless, several difficulties to be got over in many cases. Some of those instanced by Mr. Mackintosh are easily removable; the rest will yield to patient investigation, if only we do not assume that there is nothing to be investigated.

In the meantime I confidently rely on two conclusions, which in our islands are specially applicable to Palæozoic districts, but apply *mutatis mutandis* to rocks of all ages. These are—

1st. The sea has removed vast masses of rock, and left undulating surfaces, the highest points of which ultimately become the summits of mountains.

2nd. When those undulating surfaces are raised high into the air they are attacked by the atmospheric agencies, and hills, valleys, and plains gradually carved out of the rock-mass below their particular features depending on original varieties in the nature of that mass, and variations in the action of the atmospheric agencies. The latter depend largely on variations of temperature, by which water is made to assume the different forms of vapour, water, snow, and ice.

It must be recollected that the forms of our Palæozoic grounds are of very ancient date, anterior to the period of the New Red Sandstone, and that the great denudation of the Older Palæozoic Rocks took place even before the deposition of the Old Red Sandstone. The time, then, during which the atmospheric agencies have been modelling the minor features is inconceivably great. The recent temporary depression beneath the waters of the glacial sea did little or nothing in the way of denudation, the principal effect then, being the transport of blocks, or the washing about of materials, already loose on the surface.

Much instruction as to the amount of atmospheric action may be gained by comparing volcanic cones with each other. I observed in Java that small volcanic cones of recent origin had their sides quite smooth and even, while others of older date, as was shown by the young trees growing on them, began to show gullies widening and deepening on all sides. The flanks of the great volcanic mountains were a mere series of deep glens, separated by sharp knife-edged crests, radiating like the spokes of a half-shut umbrella, as described by Dr. Junghuhn. (See Lyell's Elements, 6th ed., p. 620.)

Still older volcanos, as those in the South Pacific, described by Dana, have merely narrow vertical walls, radiating from the central mass, between flat-bottomed valleys, which gradually contracting towards the interior where at the head of each may be seen a little rill of water leaping from crag to crag, still going on with the work it has performed, and to which it seems at first so utterly inadequate.

It has sometimes occurred to me to ask how long grass has existed? and especially those grasses which make our matted turf? Conclusions as to the rate of atmospheric erosion drawn from our turf-covered downs would be apt to lead us astray if applied to hills not so covered. In many parts of Australia, for instance, where you come to ride over a hill that looks quite green in the distance you find you can see the ground between the roots of the grass, very much as if you were riding through young wheat. The rain, when it does come down in a torrent, must exert much more effect on such ground than where there is matted turf.

Supposing no grass at all to exist, the rate of erosion will be still more rapid, as on the recent volcanic cones mentioned above, or as may be seen on a new railway embankment or cutting where one or two years' storms produce perfect models of mountain glens and ravines in miniature. J. Beete Jukes.

Dublin, April 6th, 1866.

ORIGIN OF VALLEYS.

To the Editor of the Geological Magazine.

Sir,—As I have commenced a line of investigation among the valleys, gorges, and drifts of Central Wales, which will require for its completion a series of observations on the sea-coast of Cardiganshire, I shall not take up your valuable space with a concluding article on the *Origin of Valleys* for several months to come. Meantime permit me to add a few lines to my last article.[1] The combes behind Malvern Wells are much deeper than they would seem from the woodcut on page 157. The one behind the Holy Well (right side of the woodcut) embraces nearly three-fourths of a circle, and is exceedingly smooth and regular in its outline. All the three combes referred to have been cut back beyond the axial ridge of the Malverns. The rocks in which they have been scooped out would, by Dr. Holl, be classified as Hornblendic and Micaceous Gneiss, with Quartzo-Felspathic and Granitic veins. In reference to the denudation of the Longmynd Valleys, locally called "gutters," Mr. R. Wilding, of Church Stretton, reminds me of a cwm (English combe) to the north of Carding Mill valley, with no regular stream flowing through it; and this cwm must have been excavated by the same cause as that to which the valleys owe their origin. Mr. Wilding is convinced that the streams have only *furrowed* the bottoms of the valleys of the Longmynd.

I now write from the heart of Siluria; and on entering this hallowed region, I was struck with its richness, not only in underground relics of the past, but in the most striking indications of the various modes in which the surface of the earth has been denuded. This is the land, not only of trilobites, but of escarpments, cliffs, cwms, gorges, and all kinds of drifts. Geological tourists, during the coming season, would do well to devote particular attention to the stupendous accumulations of tumultuously-distributed clay, earth, and sand, with enormous rounded boulders, which may now be seen exposed in cuttings on the line of railway running between Hereford and Llanidloes. The successive tiers of inland sea-cliffs, half wrecked by the weather, but still retaining in sheltered situations their smoothed, grooved, pitted, and caverned forms, near Abereddw, are likewise worthy of minute inspection. Neither ought the tourist to pass by the deep and rocky ravines of the "Great Desert" of Central Wales, to the west and south of Rhyader.—Yours truly,

Builth, Breconshire. D. Mackintosh.

[1] Geol. Mag., April, 1866. At page 166, line 25, for "indication," *read* "induction."

P.S.—There is here a small geological class, the members of which take the "Geological Magazine," and read "The Silurian System." I have just re-perused (after a lapse of many years) the chapters on *Drift* at the close of Sir R. I. Murchison's celebrated work; and I cannot help thinking that the accurate descriptions and sound generalizations with which they abound, if re-published separately, would be of great service in moderating the zeal of modern subaërialists. I see Sir Roderick accounts for combes in the same way that I have lately been advocating in your pages. He says "These combes and valleys could have been modelled into their actual forms only by the action of a large body of water overspreading their entire area. . . . The nature of the excavation indicates also the action of water differently propelled at different times, perhaps by tidal currents, the directions of which were determined by local causes."—D.M.

THE ORIGIN OF BITUMEN.

To the Editor of the Geological Magazine.

Sir,—Your issue for March contains an article on "Petroleum and Oilfields," in which my views on the generation of bituminous substances are alluded to and controverted; at the same time a desire is expressed for further information respecting the occurrence of petroleum and bitumen in Trinidad.

If "E. C. H. D.," author of the article in question, had carefully considered the evidence adduced in the "Report on the Geology of Trinidad," he could scarcely have arrived at the conclusion that the direct production of bitumen from vegetable remains is doubtful, or the proofs of the production "defective," since this view is not proposed as a theory, but stated as an evident fact, beyond the range of discussion.

To detail, briefly as possible, the proofs on which this origin of bitumens is founded, viz.:—the existence over the bituminous districts of strata more or less charged with vegetable *débris*, with the woody matter in progress of conversion into bitumen, which conversion is induced entirely by internal chemical action, and independent of any extraneous influence, such as heat. This process is distinguished by the production of a dense, very black petroleum, which oozes out of the vegetable mass and only ceases to be formed on the complete change of the woody substance into bitumen; and is also accompanied by the formation of hydro-carbons. This oily fluid gradually solidifies (probably from the evaporation of a volatile solvent), leaving a black, very pure bitumen, locally known as "glance pitch." The residue of the wood is represented by a brownish black bitumen of impurer nature, in which all trace of vegetable structure has disappeared. The operation of this conversion is so intense, that hand specimens of the wood, when isolated from their earthy matrix and placed in a room, have continued to discharge the oily fluid for two months.[1] The bitumen may be shown to have originated in these strata charged with vegetable remains, by the coast and ravine sections, where such strata are exposed containing wood in various stages of conversion; whilst intervening beds of sand or clay, in which no vegetable matter was ever contained, are entirely free from from all traces of bitumen, though equally adapted for fixing that substance, if it had been produced by distillation and risen from below.

It was not a part of the geological enquiry, respecting the bitumens of Trinidad, to investigate the chemical nature of this change of wood into the former; hence the term "special mineralization" was proposed as a record of the fact, and to distinguish this process from that which produces coal or lignite. It would seem to be due, however, to a reaction of the earthy matter of the containing stratum on the vegetable remains, since, where the latter predominate so as to form a pure mass of woody matter, lignite results; beds of which also exist in the same districts, but are quite distinct from the bituminous strata, which only occur when a large amount of earth is associated with the woody substance. The forest swamp soils on the coast, in progress of formation at the present day, exhibit many analogies with the bituminous beds, viz., by containing up to 75 per cent. of vegetable débris, alternately overflowed by the sea and subjected at low tide to the influence of a powerful sun, an active chemical action, distinguished by the sensible production of sulphuretted hydrogen and other gases, is developed; and subsequent changes of level would reduce these swamp soils to precisely the same conditions as those presented by the bituminous strata.

We know that the mineralization of vegetable substances, whether tending to the production of coal and lignite, or bitumens, is accompanied by the production of gases and especially of hydro-carbons. Over the whole bituminous area in Trinidad and Venezuela, wherever the liquid petroleums are issuing from the surface, they are accompanied with an emission of gas more or less inflammable, and frequently associated with water and mud. It is evident that the pressure of the gases generated in the production of the bitumens, is the active agent in the delivery of the oil and water which arrive at the surface perfectly cool. These oils and pitchy substances rapidly lose their volatile solvent principles and consolidate; where exposed to the solar action a further evaporation takes place and a hard brownish black bitumen remains, possessing a considerable proportion of earthy impurity. Wherever the surface is favourable for the accumulation of the pitchy discharges, the bitumens, still plastic, flow together from various centres of emission and coalesce into a more or less extensive aggregation of the substance. The "Pitch Lake" of Trinidad is merely an instance of this coalescence on a larger scale than usual.

Many specimens of vegetables, undergoing this species of mineralization, were subjected to the late Mr. Stermann Crüger, Colonial

[1] Numerous specimens illustrating the change of wood into bitumen were deposited in the Museums of Jeroneport, and Port of Spain, Trinidad.

Botanist for the Island of Trinidad, and a most skilful observer in vegetable physiology, who, though originally opposed to the view of the direct conversion of wood into bitumen, was obliged to yield to the evidence of his own researches, as detailed in his descriptions of the fossil plants collected during the survey,[1] viz. "In nearly all these specimens, or at least where there is a strong probability of their representing wood in actual state of transformation into asphaltum, an evident parallelism exists with lignite." . . . . . . "As the chemical process, which transforms wood into asphaltum, must be very similar to that which changes it to lignite or coal, we conclude, not too rashly, I think, in considering them to be in a transitory state."

This view of the production of bitumen was never pretended to be new, since Bischof showed, twenty years ago, that bituminous substances are the result of direct conversion from wood and vegetable remains, and adduced the chemical formula involved in the process;[2] but it was proved that the bitumens, so widely distributed in Trinidad, and the adjacent part of South America, are positively due to this cause, which operates under normal conditions of temperature and climate; not, perhaps, to be observed in a northern country with an average temperature of 50°, but fully developed in tropical latitudes with constant temperatures of 80° and upwards. Such being the case, and every phenomenon relating to the bitumens in these countries being easily explained according to this view, and admitting of explanation according to no other view, why hesitate to extend this origin of bitumens to other regions and other conditions, where the mode of production of the oil, petroleum, or pitch, may not be so susceptible of investigation or satisfactory solution?

With respect to distillation—in what instance can it be shown that the bituminous matter of a carbonaceous stratum has been volatilized by the proximity of heat and condensed at a certain distance in other strata? Experience rather teaches us that it would be entirely dissipated or retained in the pores of the parent stratum in the state of gas. The more or less bituminous nature of a coal seam does not depend on its being in the latter case deeper seated, and nearer the influence of heat; since, as an instance in this district (South Yorkshire), the most highly bituminous coal—the "Silkstone"—is situated near the base of the series and 300 yards below the "Barnsley," or "hard coal," distinguished by a very slight bituminous content; showing that the dry nature of a coal does not depend on the separation of its bitumen by heat, but is due to the original nature of the component vegetables, or to the nature of the mineralization experienced. Again, these natural bitumens, viz., pitch and petroleum, do not correspond with the results of distillation, but are precisely the products that would arise in the direct conversion contended for.

The production of bitumen from animal remains is not a part of the question, which it is necessary to illustrate in this communi-

[1] Rep. Geol. Trinidad, Appendix K.

[2] Chem. and Phys. Geol. Cavendish Soc. Trans. vol. i. pp. 288–291.

cation; but since "E. C. H. D." hazards the observation that "bitumen or petroleum having in some instances arisen from a 'special mineralization' of animal remains, is a doctrine by no means generally accepted;" to adduce only one of many well known instances tending to confirm the truth of this view, also, viz., that of the mountain limestone of the adjacent district (Derbyshire), which almost wherever highly fossiliferous contains bitumen in cracks and joints of the rock, evidently derived from the animal substance of the fossil remains, and not due to the influence of heat.

In conclusion it only remains to ask, what necessity for the mystery and difficulty with which the subject is involved in "E. C. H. D.'s" estimation? To our mind the generation of bitumens is easily and simply explained by the operation, at the ordinary terrestrial temperatures, of chemical laws of which we have cognizance, and the phenomena attending the emission of the oils and associated gases, are equally explicable by known physical laws. The facts and circumstances connected with the occurrence of petroleum and bitumen, which induce "E. C. H. D." to accept a "distillation theory," have a directly contrary influence on us, and convince us that these substances are the result of a law of mineralization operating as regularly, and almost as extensively, as that which produces coal and lignite.

Yours respectfully, Geo. P. Wall.

Sheffield, March 26, 1866.

To the Editor of the Geological Magazine.

Dear Sir,—Since I sent you the last communication on the junction of the Chalk and Thanet Sands,[1] Mr. T. McKenny Hughes has read a paper before the Geological Society on the same subject.[2] His theory of the formation of the green-coated flints is that, they are the result of the solution of the chalk by carbonated water after the deposition of the Thanet Sands; the objection to this appears to me, that by such means we should not have that remarkably even surface presented by the Chalk at its junction with the Thanet Sand, nor that marked peculiarity of the green-coated flint, resting on other flints not presenting this peculiarity, moreover where the chalk is worn by the action of carbonated water as in the pipes and furrows of the chalk, we find a most *uneven* surface presenting no appearance like that of the junction of Chalk with the Thanet Sands. The tabular flint, immediately below the green-coated flints, is by no means so continuous as to present an obstacle to the passage of water, sufficient to account for the even undissolved chalk, and wherever pipes do occur beneath the Thanet Sands (which, as far as I can ascertain, is only the case where the latter is near the surface), the green-coated flints sink down into the pipe with the tabular uncoated flint, which is always to be distinguished from the former.

I believe the tabular flint has been formed subsequently to the Thanet Sands, and the green-coated flint resting upon it.

Yours, etc., George Dowker.

Stourmouth, April 18th, 1866.

[1] See *ante*, p. 210. [2] See *ante*, p. 223.

To the Editor of the Geological Magazine.

Dear Sir,—I have two or three new palæontological facts to communicate, and I do not wish to keep my brother palæontologists waiting till I shall have leisure, which like "to-morrow, never comes."

Imprimis.—The earliest trilobite we know in Britain, is not *Paradoxides*, as usually supposed; it is a large and well developed species of *Conocoryphe, C. bufo*, which will be figured by Mr. H. Hicks and myself in our forthcoming work on "The Geology of St. Davids."

2. The Arenig and Skiddaw group of Sedgwick, long known, but only lately defined by its fossils, is disclosing in various ways its fossil contents, and is unequivocally the representative of the Stiper Stones series, which Murchison, in his last edition of Siluria, insisted on considering as the true Lingula flags.

I have every reason to believe too, and shall give you my reasons for so thinking, shortly, that the anomalous fauna of the French Silurians of Angers and Brittany generally, is to be referred to this date; and in all probability the "Budleigh Salterton," excluding its mixture of Devonian forms, is referable to this important period also. My first suggestion is thus refuted: for I thought it, in the paper you did me the honor to print,[1] the equivalent of our Llandeilo, or possibly our Lower Llandovery rock group.

3. The Lower Llandovery, or as I prefer to call it with Prof. Phillips the "Llandovery rocks," are intimately united with the Caradoc, and pass up from them with a great admixture of Lower Silurian, not Upper Silurian forms. The May Hill Sandstone, on the contrary, as Sedgwick showed in 1853, is as unequivocally the base of the Upper Silurian, and contains scarcely any true Lower types.

4. The Downton Sandstone is the natural top of the Ludlow series, and is quite distinct from the "Passage beds," of Murchison, which I have for some time called the "Ledbury shales." In the Downton rock of Kington, Herefordshire, my friend, Richard Banks, Esq., has for more than two years, I think, discovered the tracks of an animal, which, in your June number I hope to show, is the track of *Pteraspis*, our oldest fish. I owe it to Mr. Banks, who gave me the specimens, unique they are at present, to withhold his discovery no longer. The fish had apparently a bony crutch or spine in advance of the pectoral fin, and the tracks are accordingly double, on each side.

I am, Dear Sir, truly yours,

J. W. Salter.

April 16, 1866.

I will only add that, with respect to the Devonian controversy, our excellent field geologist, Prof. Harkness, having lately visited Devon, has returned, convinced that the Devon rocks are all subcarboniferous.—J. W. S.

[1] Geol. Mag., 1864, Vol. I., p. 5.

THE

GEOLOGICAL MAGAZINE.

No. XXIV.—JUNE, 1866.

ORIGINAL ARTICLES.

I.—On the Origin of Hills and Valleys.[1]

By G. Poulett Scrope, Esq., M.P., F.R.S., F.G.S., etc.

WHILE referring the present "form of the ground," in a large degree, to the several agencies of atmospheric and marine denudation, do not let us ignore the, at least, equally efficacious action of subterranean force. This Professor Jukes appears to me to do, to an extent likely to mislead ordinary readers, naturally influenced by his high authority, in the communication from him published in your last number (Vol. III. p. 232). He there speaks of "the action of internal forces," as "having no direct effect on the external features of the ground." In a subsequent sentence, indeed, he makes exception, in a parenthesis, of "volcanic cones and craters," but seems to consider these exceptional cases as of trifling moment, and to deny altogether the influence of other internal forces in producing superficial elevations or depresssions.

Now, in the first place, I would observe that the admitted exceptions compose in the aggregate no trifling proportion of the mountainous excrescences of the globe's surface, including, among others, the bulk of the entire chain of the Andes and Cordilleras of South and North America, the mountain masses of Iceland, Etna, Ararat, Teneriffe, Kamschatka, Java, Sumatra, etc., with all those numerous volcanic islands of the Pacific and Atlantic, which are in fact submarine mountains, stretching their roots to great depths in the ocean valleys around. But besides this enormous amount of elevated surface falling within the Professor's parenthetical exception of volcanic cones, are we to overlook the effects of those other subterranean forces, indicated to external perception in all probability by earthquake-shocks, and quite distinct from the outpouring of matter from volcanic orifices, by which the superficial rocks have evidently been, through all time, in some places elevated, in others depressed? No one, more readily than myself, will join with Professor Jukes in deriding what he calls "the *hocus-pocus* of grand convulsions, by which mountain chains were (and, perhaps, still are, by some geological schools) believed to have jumped (at once) out of the interior

[1] See the May Number, page 193.

of the earth like so many Jacks in the box." And I have assisted, I hope, by adducing arguments and facts in contravention of the theory of "elevation craters," of Von Buch, Humboldt, and Elie de Beaumont, effectively to put down this catastrophal doctrine. But as even Mr. Jukes himself states (loc. cit.) that "all lands have RISEN out of the ocean," and it is clear that the ocean bed itself is but a series of great valleys, he must admit that some superficial portions have been upheaved far above others, and consequently that mountainous or high districts are to a considerable extent the result of elevatory internal movements, the intervening hollows, of depressing ones. What, I may ask, has carried Tertiary marine strata up to heights several thousand feet above the sea in the Alps, Pyrenees, and Himalayas, nay, I would add, in the Andes, Etna, and Ischia,—for elevation *in mass* is by undeniable evidence, in these and many other cases, proved to have affected volcanic cones, no less than metamorphic or palæozoic mountains? What but the action of internal force? And ought it to be declared *ex cathedrâ* by a professor of the Science, that "the action of internal force has had no direct influence on the external features of the ground?" The process has, no doubt, been gradual. The Alps did not jump up like a "Jack in the box." But yet they have risen by many thousand feet from below the sea-level, while the valley-beds of the Adriatic and the Mediterranean either remained stationary or subsided to a lower level. Is it not indeed generally true that the course of mountain ranges and of the intervening valleys has for the most part been determined by the lines of axial upthrust of subterranean matter, the consequent strike of the elevated strata on either side, and anticlinal or synclinal lay of their folds—all the results of internal force? Is not the basin of Switzerland a synclinal valley between the elevated ridges of the Alps and Jura? Is not that of the Po and the Adriatic the same between the upheaved Alps on the one hand and the Apennines on the other?

So far, then, from agreeing with what seems to be the opinion of Professor Jukes, I would maintain that all the grander features of the earth's surface have been fashioned by internal rather than by external forces—the influence of the latter being confined to what may be called the minor details, the planing and chiselling, rather than the moulding, of the subject matter. And in respect even to some of the minor details, such as the transverse valleys, that act as tributaries to these grander depressions of the surface, there seems good ground for believing many of them to owe their *origin*, and consequently the course of the superficial waters or ice-streams that have, since their emergence from the sea, widened and deepened them by erosion, to the transverse cracks and fissures which could not fail to accompany the violent elevation of more or less solid strata, even though effected by gradual throes.

It is well known how liable the followers of any science are to push, for a time, some favored theory to an extreme extent—to the complete neglect of other equally influential causes. It may, therefore, not be inopportune for me at the present moment to recal the votaries of mechanical geology from the exclusive consideration of glacier-action, atmospheric erosion, or marine denudation, to that of the mysterious but vast and indubitable subterranean forces, daily exemplified in the volcano and the earthquake, as by no means the least energetic or efficient among the agencies that have been always operative in modelling the superficial features of our globe. I venture to think that this branch of geology has been of late undervalued, not to say neglected.

II.—Traces of a Group of Permian Volcanos in the South-West of Scotland.

By Archibald Geikie, F.R.S., etc.

Although volcanic rocks of Permian age have long been known to occur abundantly in Germany, their existence in Britain does not appear to have been recognized up to the present time. Trap-dykes, indeed, are far from rare among our Permian strata; there occur likewise many igneous masses penetrating the higher portions of the Carboniferous formation; but the former are evidently later than the Permian period, while the latter may be anterior to it. The history of volcanic action in the British isles, so far as I am aware, embraces as yet no clear evidence of Permian volcanos. In the present communication I propose to fill up this gap by showing that during the formation of the Permian sandstones a series of small but active volcanos was scattered over the south-west of Scotland.

After the labours of Sir R. I. Murchison, Mr. Binney, and Professor Harkness,[1] it is now admitted that the red sandstones which range from Cumberland into Dumfriesshire, and ascending Nithsdale, stretch in interrupted patches or basins as far as the Valley of the Ayr, are of Permian age. In Ayrshire they occupy a well defined area about six miles long by four or five broad, traversed by the river Ayr, which has worn through them a succession of picturesque ravines. The basin which they thus form rests upon the upper red portion of the Carboniferous group. At the eastern edge of the basin to the south of the village of Mauchline the Ayr has laid open a section which has been described by Mr. Binney and Mr. Harkness. The bottom of the brick-red Permian sandstone is there seen to rest conformably upon and pass down into a rock called by both these observers a "breccia," and classed by them with the Permian breccias of Dumfries and the north-west of England. A more extended examination of the district has enabled me to connect this "breccia" with other similar deposits, and with wide sheets of felspathic trap, as parts of a series of volcanic rocks interstratified with the base of the Permian sandstones of Ayrshire.

[1] Murchison, *Siluria*, p. 351, Quart. Journ. Geol. Soc. vii. 163; xii. 267. Binney, *Id.*, vol. xii. (1856) p. 138. Harkness, *Id.*, p. 262. It was not the object of these observers to investigate the igneous rocks of the Ayr, and they treated them simply as intrusive masses, though the singular aspect of the "breccia" led Mr. Binney to remark that "the cementing paste has much the appearance of felspathic ash." In a later paper (Quart. Journ. Geol. Soc. vol. xviii.

The Permian basin of the Ayr is completely encircled by a ring of trappean rocks, from half a mile to a mile broad, and rising for the most part as a conspicuous ridge, separating the brick-red Permian sandstones inside, from the dull red or purple Carboniferous strata outside. It is the nature of this girdling ring which falls to be considered in the present paper. For the sake of clearness and conciseness, it may be of advantage to show—1st, that the ring consists of lava-flows and ashes, and is therefore truly volcanic; and 2nd, that this volcanic series is a part of the Permian formation.

I. The accompanying section (Fig. 1), drawn through the village of Mauchline along the north-eastern margin of the basin, shows the general arrangement of the rocks of the district. The ring of igneous rocks rises on the north-west side into the ridge, on which Burns' farm of Mossgiel lies, and reappears again on the south-west side in the cliffs and ravines of Ballochmyle. It consists of successive sheets of trap, occasionally interstratified with sandstone and sandy ash, and sometimes lying on, sometimes covered by, ash. These trap-sheets have a prevailing dull red, purplish red, or dark brown hue, and are made up of a mixture of labradorite and specular-iron, with sometimes a little augite. They would be called *melaphyres* in Germany, and as our English nomenclature of igneous rocks is so poor, I have found it useful to adopt that term. Their mineralogical structure and changes are full of interest, but need not detain us at present. The melaphyres are bedded masses, now compact and porphyritic, and then passing into a coarse slaggy amygdaloid. Between the beds thin layers of more or less ashy brick-red sandstone are often found, and it sometimes happens, as on the east side of Mauchline Hill, that perpendicular veins of horizontally stratified red sandstone reticulate the upper part of an amygdaloidal bed. In such cases it is clear that these veins represent old cracks in the lava-flow into which sand was washed before the eruption of the next flow. Even where a bed of trap is very compact and close-grained, its upper and under portions are usually cellular and slaggy, the cavities being in most cases filled up with steatite or calc-spar. Hence a section of a series of melaphyre beds presents a succession

(1862) p. 437) he expresses his doubt whether the trap seen near the breccia is interstratified or intrusive. In the course of an excursion into Ayrshire in 1862 I descended the course of the Ayr from Sorn to Stair and recognized the breccia as a true volcanic tuff, or gravelly ash, closely resembling the red trap-tuff of Dunbar. The trap at the same time was found to present all the characters of true lava flows, and I saw it coming again to the surface on the west side of the basin. Though it was clear from these sections, that the Permian sandstones of Ayrshire contained at their base a contemporaneous volcanic series, I was unwilling to publish any paper on the subject until the whole of the ground had been examined. From the results of this excursion, however, the Permian basin was represented to be bounded by igneous rocks, on the east and west sides, on the Geological Map of the British Isles, published in 1864 in their Educational Series by Messrs. W. & A. K. Johnston, and in the Explanatory Handbook to that map (p. 67) I have referred to the true volcanic nature of the breccia and its associated trap. Since that time, the Geological Survey having been extended into Ayrshire, I have had an opportunity of mapping the Permian basin in detail. The full results will properly appear in the Official Memoirs, and I shall here, with the sanction of the Director General of the Survey, offer a brief summary of them.

of compact sheets and rough amygdaloids, as in those wonderful sections of old lava-flows along the coasts of the Western Islands and the north of Ireland. In the railway cutting at the mouth of the Mossgiel Tunnel the melaphyres are found in their lower parts to be interstratified with and to rest upon beds of volcanic ash and brick-red sandstone. These strata are well bedded, and are made up of thin alternations of red gravelly trap-tuff, or peperino, fine ash, and, more or less, ashy sandstone — the whole pointing to a period of intermittent eruption when showers of dust and lapilli fell upon and became interstratified with ordinary sediment. In the river section at Ballochmyle, described by Mr. Binney and Professor Harkness, a similar red angular tuff (the "breccia" of these geologists) forms a bed at least 30 feet thick, passing up into the red sandstones, as will be more fully pointed out in the sequel. It rests upon the melaphyres, which can be traced to within a few yards from it when the river is low, though the actual line of junction is not here seen.

Such are the characters of this group of volcanic rocks round the whole of the ring with which they girdle the Permian basin of the Ayr. From the bedded, slaggy, amygdaloidal character of the melaphyres, from their interstratification with red sandstone and ashy beds, from the tuff which is found both below them and above, it is evident that they are not intrusive masses thrust up among the palæozoic formations, carrying with them little or no clue to their date, but that they have been poured out at the surface, and must be of the same geological age as the strata with which they are associated.

Outside the volcanic ring there occurs a number of small rounded hills or hillocks, consisting of a coarse red volcanic agglomerate (*d* in Fig. 1). This rock is unstratified and presents a very tumultuous appearance. It is made up of fragments of various melaphyres of all sizes, up to masses a yard or more in length, angular, subangular, and rounded, imbedded in a gritty, ferruginous, felspathic paste, in which scattered crystals of augite, melanite, and black mica occur. As a rule,

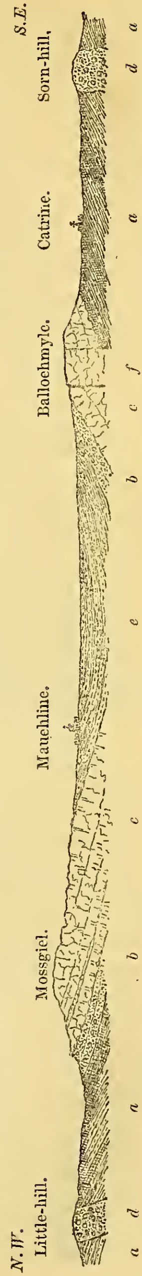


Fig. 1.—Section through the Permian Basin of Ayrshire.

a Carboniferous sandstones and shales. *b* Trap-tuff and brick-red ashy sandstone. *c* Beds of felspathic amygdaloidal Trap (*Melaphyre*), with interbedded brick-red sandstone. *d* "Necks" of volcanic agglomerate. *e* Brick-red Permian sandstones. Intrusive Dolerite (Greenstone).

these hillocks rise conspicuously above the neighbouring ground, and when the geologist has familiarized himself with them in one part of the district, his eye soon detects their form in other localities not before visited. They are not outliers of a deposit once covering here a greater space. Though surrounded by Carboniferous sandstones, and shales, they do not lie upon them; on the contrary, they descend vertically through the coal measures like so many huge pipes, sometimes standing on lines of fault, while the coal near them is altered. They are, in short, true volcanic "necks," each representing a former crater or focus of eruption. In one case, that of Helenton Hill, near Monkton, I found the sides of the neck still partially crusted with a mass of rough scoriaceous melaphyre—the remnant of the slaggy scoria which once coated the walls of the volcanic orifice. These necks vary in size from only a yard or two to 500 or 600 yards in diameter, and though their present conspicuous, blunted, conical outline is due, of course, to much subsequent denudation, one can readily enough imagine them to be cones of tuff, marking the position of volcanos that have only recently become extinct.

II. That these necks come indiscriminately through the faulted Upper Coal-measures, Carboniferous limestone and lower or calciferous sandstones, may be taken as good evidence that they are later than the Carboniferous period. A very brief examination of the ground is enough to raise a suspicion that they may have been connected with the trap-tuff already noticed. And the more they are studied, the more probable does this connexion become, until we are convinced that they can only be the vents through which the ash and trap were ejected. The material of which the necks consist is identical with that forming the gravelly tuff or peperino, save that it is much coarser and unstratified. But this is a distinction which might be expected to exist between the material which consolidated at the actual focus of eruption, and that which was thrown to some distance and was stratified under water along with ordinary sandy sediment. In each case the paste is dull dirty-red, felspathic, gritty or gravelly, derived from the trituration of the fragments imbedded in it, which are all pieces of different melaphyres, having the same characters as those which form the sheets in the ring.

As the bedded volcanic rocks of this part of Ayrshire lie upon Carboniferous strata, and are overlaid with Permian, they must be either of Carboniferous or of Permian age. The mode of occurence of the necks affords a presumption that the whole volcanic series must be later than Carboniferous times, and this inference is fully borne out by the relation of the rocks of the encircling ring to the Permian sandstones of the basin. No feature more speedily arrests the attention of a visitor to the valley of the Ayr than the great contrast between the general aspect of the Permian sandstones and those of the Carboniferous series below. The latter are of dull purplish red or grey colours, thin-bedded, interstratified with endless seams of red purple or grey shales and nodular marls. The former, on the other hand, are marked out at once by the strange brilliance of their colour, ranging from a brick red to bright orange, by their abundant false-bedding, their thick beds, their entire freedom from shale of any kind, and their clear granular quartzose texture. Now, beds of sandstone having this character, and identical in every respect with the recognised Permian sandstones of the basin, lie among the fine ash and peperino below the sheets of trap, similar beds are intercalated between the beds of trap, they occur again in the ashy deposits overlying the trap, and there they can be seen to form part of the ordinary sandstones of the Permian basin. This latter junction is singularly instructive. It is well seen along the banks of the river Ayr at Ballochmyle where bed after bed can be studied from the massive brick-red sandstones down into the tuff that overlies the melaphyres. The subjoined woodcut (Fig. 2) illustrates this section. At the bottom lies the dull-red stratified tuff—a truly volcanic rock consisting of nothing but angular, subangular, and rounded fragments of different felspathic traps, imbedded in a triturated paste of the

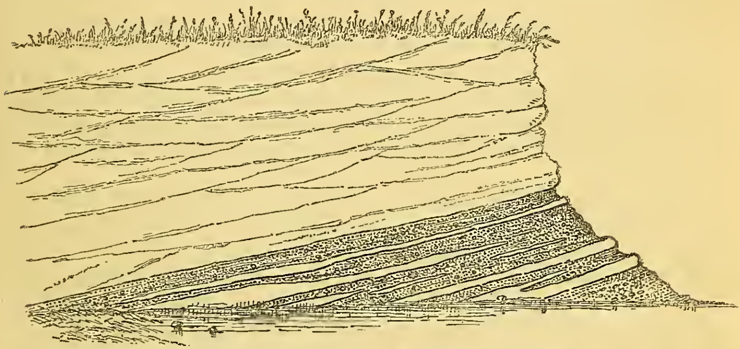


Fig. 2.—Section of Permian Sandstone and Tuff. River Ayr, Ballochmyle.

same materials. Some of the stones are slaggy lumps of rock, like volcanic bombs, and in one case I found the air-cells pulled round the spheroidal surface of the mass—the result perhaps of the whirling of the bit of melted lava through the air at the time of ejection. In the upper part of the tuff, thin lenticular seams of brick-red sandstone, sometimes mingled with ashy material, make their appearance, and these increase in number until they shade up into the main mass of the Permian sandstones. The gradual cessation of the tuff is full of interest, for we find that even after having passed over the highest of its beds we still meet with occasional nests of volcanic lapilli and single stones in the red sandstones. In this section we see how the igneous forces with intermittent and continually decreasing showers of ash and stones, finally died out.

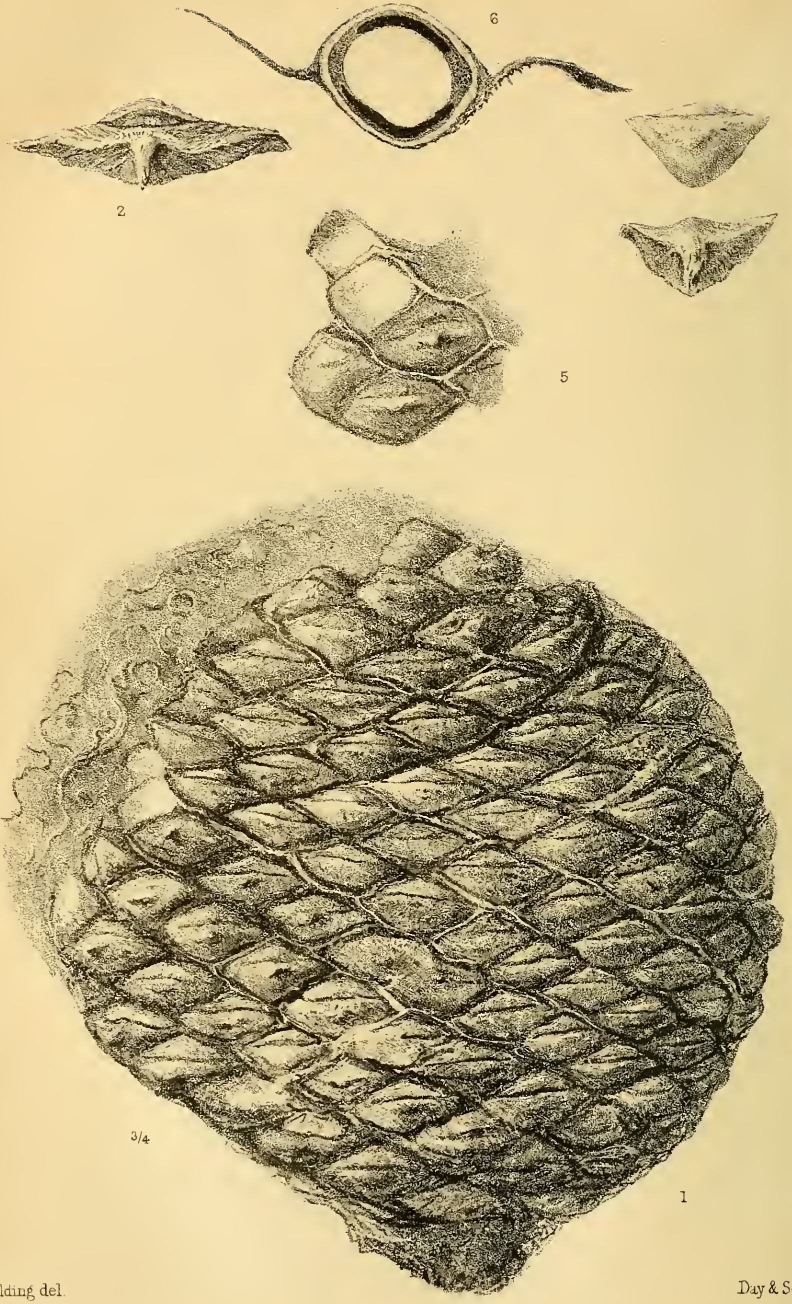
It thus appears that the volcanic rocks of this part of Ayrshire lie upon, are interstratified with, and are covered by red sandstones, which have a distinctive character throughout as parts of one series marked off from the Carboniferous sandstones on which they rest. It is admitted that these red sandstones are Permian; it follows that the volcanic rocks described in this paper and lying near the base of these sandstones afford now the proof of actual volcanic eruptions in Britain during the continuance of the Permian period.

I have spoken only of the Ayrshire basin, but evidence of the contemporaneous intercalation of volcanic rocks is not less clear among the Permian sandstones of Nithsdale. The felspathic trap laid open in the railway cutting at Drumlanrig is identical in its mineralogical characters and general aspect with the Ayrshire melaphyres. Its upper surface has the usual slaggy amygdaloidal character of the higher part of a lava-flow, and it is covered with gently inclined red sandstones containing a few beds of gravelly tuff or breccia like that of Ballochmyle. In the Carron Water there are some excellent sections of these rocks showing the red sandstones, sometimes sprinkled with volcanic bombs and often interlaced with bands of fine ash, angular tuff and even coarse volcanic breccia. Along with these proofs of igneous action occur beds of vesicular and amygdaloidal melaphyre, like those of the Ayr, and showing the same radiating veins of horizontally stratified red sandstone which fill up cracks in the original lava-form mass. The course of the Carron Water furnishes ample proof of the existence of contemporaneous volcanic rocks in the Permian series of the south of Scotland. The same evidence may be traceable southwards towards Dumfries, but I have not yet had an opportunity of examining that part of the district.

Throughout the Carboniferous tracts of the Lowland Valley of Scotland there are many igneous rocks which must be later than even the Upper Coal-measures, but of which the geological date cannot be approximately fixed. Some of these rocks are comparable with parts of the Ayrshire series, and it becomes an interesting question whether they may not belong to the same period. The determination of an actual date among the post Carboniferous igneous rocks is one which may be of great use in working out the geological history of the broad Lowland valley. And it is likewise not without its interest, as it enables us to connect the British type of the Permian system by another link with that of the centre of Europe.

It may be mentioned, in conclusion, that the Permian basins of the south-west of Scotland are traversed by a set of intrusive doleritic traps, sometimes as irregular bosses (*f* in Fig. 1), or as dykes and beds. These rocks have no relation to the Permian volcanic group, further than that they came through it as well as through the sandstones. The dykes belong to that remarkable N.W. or N.N.W. series which runs across Scotland and the north of England. I called attention to these dykes some years ago,[1] and suggested that they might be as late as the Middle Oolite. Since that time additional evidence has been accumulating, and I believe it will be possible to show good grounds for believing that they are not only as late as the Oolitic period, but may even be of Tertiary age.

[1] [Trans. Roy. Soc., Edin., xx, p. 650.]



E. Fielding del. Day & Son, Limit

ARAUCARIA CONE FROM THE INFERIOR OOLITE,

Bruton, Somersetshire

III.—On Araucarian Cones from the Secondary Beds of Britain.

By Wm. Carruthers, F.L.S., of the British Museum.

(PLATE XI.)

THE unsatisfactory condition of palæontological botany arises from the imperfect materials which are obtained from the earth's strata. With the exception of two or three remarkable structures, no histological characters have been found whereby the position of a plant can be determined from an examination of its woody structure; so that silicified or calcified woods, which are far from rare, supply little more information than that they are portions of a vascular cryptogam, a palm, a conifer, or other exogen. Of leaves also it may be said that, while a very few natural families have characteristic forms, yet leaves which are undistinguishable are found belonging to plants widely separated in the vegetable kingdom, so that we have little confidence in determinations made from them; indeed, such determinations must be considered at the best but as guesses at the truth, and these can seldom go further than the natural order, or, perhaps, the genus to which the fossil belongs. To manufacture species on no other characters than those obtained from slight variations in the form of the leaf, is a reckless multiplication of names, condemned not only by the botanist, but by every one who has carefully examined the variety in form and venation that exist among the leaves of a single shrub or tree. The organs employed by systematists in the classification of plants are so delicate, and so easily perish, that they are very rare as fossils. Fruits, however, are more abundant, and after the flower they may be held of next value in determining the affinities of a plant. Even the *separated* seeds of living species, or members of living genera, can be positively determined; but when the affinities are obscure, the more or less imperfect specimens of fossil seeds detached from their fruits are very unsatisfactory materials.

There is, perhaps, no order of plants in which the compound fruit retains its entirety so well as in *Coniferæ*, and consequently perfect cones are not unfrequently found as fossils. The two which we purpose to describe in this paper are not based upon detached seeds, but upon seeds so aggregated as to exhibit the cone arrangement of the genus *Araucaria*. A third specimen has been found, but, unfortunately, I have not been able to discover in whose possession it now is. Dr. Fitton refers to it in a note to his elaborate paper on "The Strata below the Chalk." (Trans. Geol. Soc. 2nd Ser., vol. iv., p. 348.) He says it was found on the shores of the Isle of Portland, and not improbably derived from one of the beds of clay or "dirt," subordinate to the lower part of the Portland strata. Dr. Fitton had the loan of it from the Rev. D. Williams, of Bleadon, Somerset, and submitted it to Mr. Robert Brown, who was satisfied as to its affinities to *Araucaria*. Mr. Brown, unfortunately, did not carry out his intention of describing it. The cone does not exist in his collection of fossils, and the name of its original possessor has disappeared from the "Clergy List" since 1850, so that I do not know where to seek for it.

The two species may be thus characterised :—

1. *Araucaria* (*Eutacta*) *sphærocarpa*, nov. sp. Cone spherical. Scales rhomboidal, with a central ridge produced into a stout, somewhat reflexed spine, and an obvious furrow dividing the scale into an upper and lower portion. Twenty to twenty-four scales in each spiral series in the centre of the cone. (Plate XI., Fig. 1).

Loc. From the Inferior Oolite, Bruton, Somersetshire.

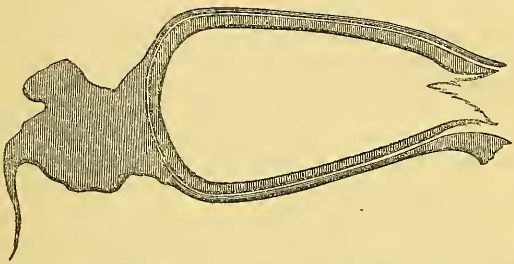
2. *Araucaria* (*Eutacta*) *Pippingfordiensis*, (*Zamiostrobus Pippingfordiensis*, Ung. "Genera et Species Plantarum Fossilium," p. 300.) Cone oblong, gradually decreasing towards the blunt apex. Scales rhomboidal, with a prominent central ridge, and an obvious furrow dividing the scale into an upper and lower portion. Fourteen to sixteen scales in each spiral series in the centre of the cone. Trans. Geol. Soc. 2nd Ser. (Plate xxii., fig. 10.)

Loc. From the Wealden, in a mass of hard greenish grit at Pippingford, in Ashdown Forest, very near the highest point of the ridge of the Hastings Sands.

The only specimen of *A. sphærocarpa* yet found (Plate XI.) was obtained from a bed of marine limestone. It is noticed by Sir Charles Lyell in the last edition of his "Elements," where a woodcut is given, but without any description. The detached cone has been floated out to sea, where, having sunk, it has been partially buried in the calcareous mud among the remains of *Serpulæ* and *Mollusca*. The spaces between the scales have first been filled with calcareous matter, shown in the figure by the irregular white lines separating the scales. The organism having decayed, the upper portion is entirely lost; but calcareous mud having been deposited in the mould of the buried portion a remarkably perfect impression of that half of the cone remains. The base is imperfect; the two or three series of basal scales, which are more or less triangular in outline, are wanting. There is no indication of any stalk. The draughtsman of the woodcut, in Lyell's "Elements," has mistaken a fragment of a shell for the stalk, and has given, in his restoration, an aspect to the cone unlike any known Araucarian. The upper portion of the cone is more perfect, and exhibits the change in form of scales observed in recent cones. (Compare Plate XI., Fig. 5, one of the apical scales, with Fig. 6, a similar scale, from the cone of *A. Bidwilli*, Hook.) The fossil is five inches long, and as many inches broad at its widest part. There are fifteen of the spiral series of scales from left to right, and ten from right to left. The apex of the scale is a rhomboid. It is divided into two unequal portions by a transverse scar; the lower and larger half has been furnished with a strong and somewhat reflexed spine. A fracture in two of the scales on the upper left-hand portion of the fossil, figured of the natural size at Fig. 5, shows that the scar is superficial, and that each scale supports a single seed.

Dr. Fitton figured *A. Pippingfordiensis*, and, without giving it a name, characterised it as a "cone of an unknown species." Unger, in his "Genera," referred it to *Zamiostrobus*, a genus which we hope to show at another time has been made the receptacle for other true coniferous cones besides the one in question. A comparison of Dr. Fitton's figures with *A. sphærocarpa*, and with the recent species of *Araucaria*, belonging to the section *Eutacta*, has convinced me that it belongs to this genus.

Although the Bruton fossil is only a cast of the cone, it is so characteristic that it can be certainly referred to its modern allies. The single seed supported on each scale, along with the general form of the cone, conclusively establish it to be a true *Araucaria*. Sir W. J. Hooker describes *A. Cookii* ("Botanical Magazine," Vol. lxxviii., Tab. 4635) as having "two oblong seeds" in each scale, a structure at variance with the generic character. I have carefully examined a number of scales from different cones, and I find that while the form of the cavity is different from that of the other species, it is truly unilocular, and contains a single seed. In its early stage a transverse section of the hard integument of the seed



Longitudinal Section of Scale of *Araucaria Bidwilli.*

(*From a dried specimen, in which the seed is separated from the scale.*)

gives a dumb-bell-like outline, exhibiting two large open canals on either side, which freely communicate round the base of the seed, while the surfaces of the integument almost approach in the centre, and between these surfaces the single embryo is situated. As the seed grows the contracted central portion enlarges, while the lateral canals retain their original dimensions; and the ripe seed shows the unicellular cavity with its single seed and relatively slender lateral canals. An examination of the early stage of the scale would very readily give the erroneous impression that it contained two seeds, or rather, that the hard integument was bilocular and contained a single seed in each loculament. For comparison I have placed a transverse section of the cone of *A. Bidwilli* on the plate (Fig. 6), and I add here a longitudinal section of another scale, showing the relation that the seed bears to the scale. This genus contains six known species, four of which are natives of Polynesia, and the remaining two of South America. The species thus geographically grouped together have so many peculiarities in common, that Salisbury proposed to establish two genera for them—the one, *Colymbeia*, including the two American species characterised, as regards the cone, by having the scales without wings; and the other, *Eutassa* (*Eutacta*, Link), for the Polynesian species distinguished by the possession of wings to the scale. Although these and the other characters obtained from the number of the anthers and cotyledons, the form of the leaves, and the germination, are of importance, they have not been considered by recent systematists of generic value, but sufficient only for the division of the genus into two natural sections. Another peculiarity is possessed by the majority of the Polynesian species, which is important in connection with our fossils. The Brazilian species never exhibit externally any division of the scale into an upper and under portion. The small upper scale, so evident in *A. Bidwilli* (Plate XI., Fig. 4) and *A. excelsa*, and in the two fossils, is so reduced in them that it is only discoverable on the upper surface of the scale after it has been withdrawn from the cone.[1] This small upper scale is larger in the fossil than in any of the recent species. Three different views are entertained regarding the nature of this portion of the scale. Richard[2] and Endlicher[3] describe it as an appendage to the seed; the late Sir Wm. J. Hooker[4] supposes it to be the dilated "upper base" of the scale-leaf folded down upon its upper surface; and Dr. A. Dickson,[5] holding that the scale of the Araucarian cone corresponds to the membranous bract which subtends the scale of the pine cone, supposes this to be the representative of the true scale in the cone of *Pinus*. But whether a seed appendage, the folded base of the leaf, or the representative of the scale in the pine cone, the matter of importance to us is that it is so largely developed in the Australian and fossil species. The specimen of *A. sphærocarpa* is so preserved that it is difficult to say whether the scales were winged, but there seems to me to be indication of short wings. It is, however, evident that the fossils belong to the *Eutacta* section of the genus, and among the species the cones of *A. excelsa* approach most nearly to them in size and form, and in the structure of the scales.

The affinities of these cones to recent Australian species are the more interesting, because Owen, Phillips, and Lyell have shown that the animals belonging to the same epoch have their nearest allies in that continent.

EXPLANATION OF PLATE XI.

Fig. 1.—Cone of *Araucaria sphærocarpa*, two-thirds the natural size. (The original is preserved in the British Museum, and is from the Inferior Oolite, Bruton, Somersetshire.)
,, 2.—A scale of *A. Bidwilli*, somewhat reduced, showing the upper small scale.
,, 3.—Scale from the apex of the fossil cone.
,, 4.—Scale from the corresponding portion of the cone of *A. Bidwilli*.
,, 5.—A portion of the fossil cone, natural size, showing the single interior seed cavity.
,, 6.—A section of the scale of *A. Bidwilli*.

[1] This character is wanting in *A. Cookii*, R. Br. (*A. columnaris*, Hook.), from New Caledonia. The scale of this species has, perhaps, the most largely developed wings, but the small upper scale is even more reduced than in the American species.

[2] Richard. *Memoires sur les Conifères*, p. 87.

[3] Endlicher. *Synopsis Coniferarum*, p. 184.

[4] London Journ. of Botany, vol. ii., p. 504.

[5] Edinburgh New Phil. Journ., 1861, p. 197.

IV.—On the Occurrence of Extensive Deposits of Tufa in Flintshire.

By George Maw, F.S.A., F.L.S., F.G.S.

Of the various geological evidences inferring a vast duration of the existing contour and conditions of surface since the latest marine submergence, there is, perhaps, none more striking than the accumulation of great masses of Tufa charged with recent organic remains.

Whether the extreme slowness with which limestone is capable of undergoing watery dissolution, or the smallness of the volume of the water, which has generally been the medium of its transfer to a tufacious condition is considered, any great mass of Tufa must of necessity imply an immense lapse of time for its formation.

The Mountain Limestone district of North Wales contains several examples of Tufa deposits, and one, to which my attention has been drawn by my friend the Rev. D. Williams, of Nannerch, seems, from its position and great extent, to be worth a special notice in the Geological Magazine.

At the south side of the great Mountain Limestone range of Flintshire, connecting the plain of Chester, near Mold, with the vale of Clwyd, opposite Denbigh, runs a long, narrow, tortuous valley, from which branch numerous ravines, intersecting the limestone range, forming its northern boundary.

One of these ravines, immediately to the east of Caerwys, and a second, about a mile further to the east, are occupied for a considerable distance with extensive deposits of soft Tufa, commencing against the Mountain Limestone, and expanding downwards through a range of altitude of about 150 feet in broad delta-shaped masses towards the main valley, where the Tufa flow appears to have been arrested on the north bank of the river Wheeler.

The more westerly of the two ravines is occupied from north to south for a distance of three-quarters of a mile, and the total area occupied by both masses cannot be less than 200 acres. I believe that deposits of Tufa at all approaching these in extent are unknown in any other part of the kingdom.

At the embouchure of the eastern ravine, close to the Smell turnpike-gate, a cutting in the new Mold and Denbigh railway has exposed the deposit for a distance of more than a furlong, and in one place to a depth of 12 feet. At the point in digging the foundations for a bridge a further depth of six feet was penetrated, and a bed of peat, one or two feet thick, containing fragments of semi-decayed wood, found to intervene between it and the subjacent drift-gravel. The thickness of the Tufa would therefore be 18 feet. Higher up the lateral valleys it ascends in terrace-like ranges, and appears to be much thicker as the streams have cut channels into it 15 or 20 feet deep without exposing the fundamental drift.

For the most part the Tufa is of a soft marly texture, occasionally containing harder masses, which appear to have accumulated round plant remains; the harder parts are full of tubular perforations, bearing the impressions of Equisetums, Carices, and other marsh plants; also, occasionally, willow leaves. The remains of recent shells are most abundant — *Helix memoralis* occurring in great quantities throughout the deposit.

Mr. Gwyn Jeffreys has also determined the following species:—

Limnæa peregra (Müll.)
Succinea putris (Linn.)
* *Zonites nitidulus* (Drap.)
,, *crystallinus* (Müll.)
,, *fulvus* (Müll.)
,, *radiatulus* (Ald.)
Helix aculeata (Müll.)
* ,, *aspersa* (Müll.
* ,, *nemoralis* var. *hortensis* (Penn.)
* ,, *arbustorum* var. *alpestris* (Zugler.)
* *Helix concinna* (Jeffreys.)
,, *caperata* var. *Gigatii* (Charp.)
,, *rotundata* (Müll.)
,, *pygmæa* (Drap.)
,, *pulchella* (Müll.)
Vertigo antivertigo (Drap.)
Zua (*Conchlicopa*) *lubrica* (Müll. *sp.*)
Carychium minimum (Müll.)
* *Cyclostoma elegans* (Müll.)

The species marked thus * were obtained between Pwll Gwyn and Caerwys; all the others and some of those marked * from the railway-cutting, near the Smell turnpike-gate.

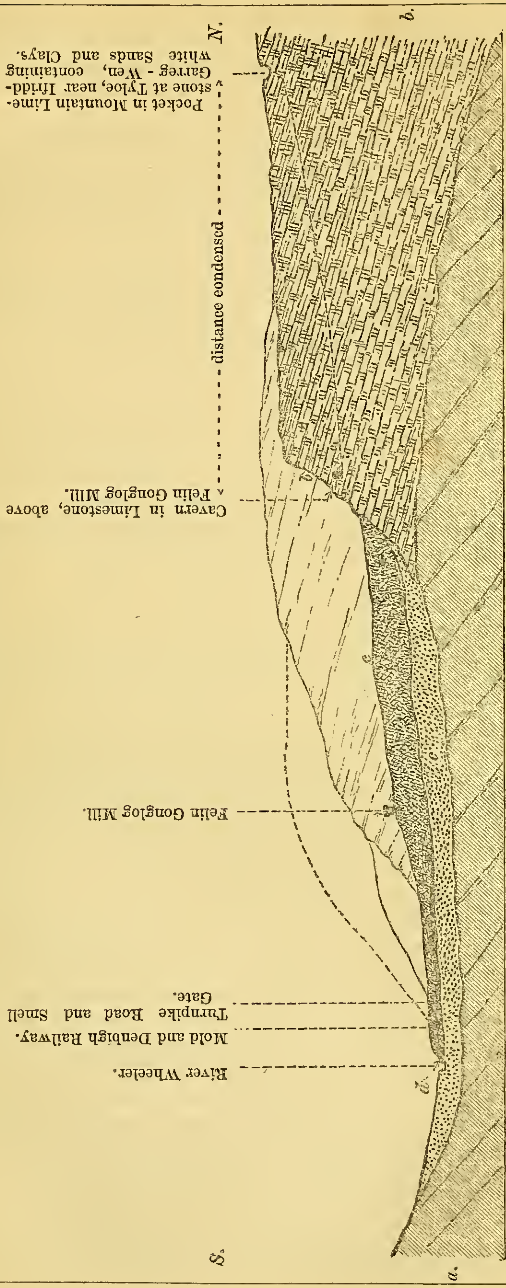
Mr. Jeffreys observes that all the species at present inhabit Wales, and, probably the locality where found; and considers the deposit an extremely modern one. Some of the species indicate a moist situation, others a dry soil.

In a former communication to the Magazine (Vol. II., p. 200), I described the occurrence of curious cavities or pockets in the Mountain Limestone of the same district, which I suggested had been formed through the gradual dissolution of the limestone, by a process similar to that which has been supposed to explain the method of formation of sand-pipes in the chalk. The occurrence of the redeposited lime as Tufa in the immediate neighbourhood affords another point of analogy between the limestone-pockets and the chalk sand-pipes, and further supports the theory suggested to account for their excavation.

The subterranean derivation of the Tufa is here also indicated by the existence of a cavernous opening in the limestone, lined with a stalactitic coating immediately over the upper end of one of the Tufa beds (see Section); and it seems probable that from this cavity the water that deposited the Tufa once flowed. The cavern is now dry, and the deposition of the Tufa appears to have entirely ceased; the only water that flows over it occurs as a stream that has its origin higher up the valley, and instead of adding to the accumulation of the deposit it has cut a channel through it, in some places to a considerable depth. These facts seem to imply a change of circumstances from those which obtained when the Tufa was originally deposited, and the present stream, if it existed at the time, must have occupied a different position.

Assuming that the various cavernous openings in the Mountain Limestone have been similarly formed, it appears probable that these subterranean excavations proceeded during a long geological period; the caves of Cefn, on the opposite side of the vale of Clwyd, appear to have been excavated before the Boulder-clay-drift

CONDENSED SECTION ACROSS THE VALLEY OF THE WHEELER, BETWEEN SMELL TURNPIKE GATE AND YSCEIFIOG, NEAR CAERWYS, FLINTSHIRE.



a. Denbighshire Flags. *b.* Mountain Limestone. *c.* Drift. *d.* Peat, from 1 to 2 feet in thickness, intervening between Drift-Gravel (*e*) and Tufa, *e.*

(*Not drawn to scale.*)

period, with the gravels of which (?) they are partly occupied. On the other hand, the great deposits of soft Tufa near Caerwys could not have resisted the marine submergence, and their deposition subsequently to the drift is also evident from their resting on its eroded surface.

The subterranean dissolution of the limestone commenced, therefore, some time before the submergence of several hundred feet that filled the Cefn caves with gravel, and continued afterwards sufficiently long to provide materials for the great masses of Tufa, near Caerwys.

It is worthy of observation that no evidence is to be found that the calcareous deposition is still proceeding, and that with an apparently similar condition of surface, the causes tending to the formation of a Tufa have entirely ceased.

NOTICES OF MEMOIRS.

I.—On the *Rhinoceros leptorhinus* of Owen.

By W. Boyd Dawkins, M.A., F.G.S.

[Abstract of a Paper read before the Royal Society, April 26th, 1866.]

THE fossil remains of the genus *Rhinoceros*, found in Pleistocene deposits in Great Britain, indicate four well-defined species. Of these the *R. tichorhinus*, or the common fossil species, ranged throughout France, Germany, and Northern Russia, and like its congener, the Mammoth, was defended from the intense winter cold by a thick clothing of hair and wool. Its southern limit in the Europæo-Asiatic Continent was a line passing through the Pyrenees, the Alps, the northern shore of the Caspian, and the Altai mountains. It has not yet been proved to have existed in Europe anterior to the deposit of the Boulder-clay. The second species, the *R. megarhinus*[1] of M. de Christol, characterized by its slender limbs, and the absence of the "cloison," has been determined by the author among remains from the brick-earths occupying the lower part of the Thames Valley, and from the Pre-glacial Forest-bed of Cromer. The species ranged from the Norfolk shore, southwards, through Central France, into Italy. In France and Italy it characterizes the Pliocene deposits, being found in the former country in association with *Mastodon brevirostris*, and *Halitherium Serresii*, in the latter with *M. Arvernensis*. From its southern range we may infer that the megarhine species was fitted to inhabit the warm and temperate zones of Europe, just as the tichorhine was peculiarly fitted for the endurance of an Arctic winter.

The third species is the *R. etruscus* of Dr. Falconer, confined to

[1] For Paper on the *Rhinoceros megarhinus* see Dawkins, Nat. Hist. Review, 1865. p. 399.

the forest-bed of the Norfolk shore, and like the *R. megarhinus*, found in the Pliocene of France and Italy; it ranged across the Pyrenees as far as Malaga, and is the only species known to occur in Spain. The fourth, the *R. leptorhinus* of Professor Owen, is the equivalent of the the *R. hemitœchus* of Dr. Falconer. In common with the other British rhinoceroses, it possessed a molar series of six only on either side, and was two-horned. It ranged through England from the Hyæna-den of Kirkdale, Yorkshire, in the north, as far south as the plains of Somersetshire, and as far to the west as Pembrokeshire. It is very generally found in association with *Elephas antiquus* and *Hippopotamus major*, both of which species lived in Pliocene times.

Its association in Wookey Hole Hyæna-den with *Elephas primigenius*, and *R. tichorhinus* and other characteristic Post-glacial mammals, proves that the leptorhine rhinoceros co-existed with the tichorhine species, to which it probably bore the same geographical relation as the elk does to the reindeer in the high northern latitudes. The sum of the evidence proves that it was coeval with the mammoth and tichorhine rhinoceros, and does not characterize the deposits of an earlier epoch than the Pleistocene. It has not as yet been found in Pre-glacial formations. The *R. leptorhinus* is more closely allied to the bicorn rhinoceros of Sumatra than to any other living species.

II.—An Epitome of the Evidence that Pterodactyles are not Reptiles, but a new Subclass of Vertebrate Animals allied to Birds (*Saurornia*).

By Harry Seeley, F.G.S.

[Ann. and Mag. Nat. Hist. May, 1866.]

After a discussion on the several opinions regarding the zoological relations of the Pterodactyles, Mr. Seeley explains, from his own researches, the anatomical structure of those so-called "flying reptiles," and sums up in the following words :—" From facts, such as these, it seems to me no hard task to determine whether the Pterodactyle has the organization of a reptile or of a bird, I find it in every essential principle to be formed on the avian plan. Yet it differs more from existing birds than they do among themselves, and therefore cannot be included as an order of Aves; for the points of structure in which it differs from birds are those in which all existing birds agree. I therefore regard it as forming a group of equal value with Aves (Sauromia), each as a sub-class, forming together a great class of birds. Its distinctive characters are—in having teeth, in the simple convex or concave articulation of the vertebræ in the separate condition of the tarsal and metatarsal bones, in having three bones in the forearm instead of two, in a peculiar carpal bone, in the sacrum formed of few vertebræ, and in the modification of the wing by the enormous development of the phalanges of one finger. The sub-class so characterized forms a parallel group with the true birds. Whether it may not in some points of organization rise above birds, is a question on which I offer no opinion, further than to state that in none of the typical mammalian characters does it approach the mammals."

III.—Science and Art Lectures at Norwich.

Lecture on the Geology of Norfolk.—This lecture, forming one of the Science and Art series, was delivered at Norwich on April 23rd, 1866, by the Rev. John Gunn, F.G.S., president of the Norwich Geological Society.

As the whole geology of Norfolk was too large a subject for one lecture, Mr. Gunn confined his remarks to the Tertiary strata, more especially those exhibited in the section exposed along the sea-coast. Commencing at Yarmouth, he detailed the circumstances from which the presence there of the Woolwich and Reading beds, and the London clay, was determined, by Mr. Prestwich.[1] He then passed on to the Norwich Crag: it appears north of the jetty at Cromer, whence it gradually rises to an altitude of nearly twelve feet above the level of the Chalk at Weybourne; at the bottom of it is invariably a bed of flints, yielding many interesting mammalian remains. The lecturer referred to the recent paper of Mr. J. E. Taylor[2] on the fossils of the upper part of the Norwich Crag series, which are of a more arctic character than those of the lower part, and which, when brought together, increase the percentage of recent to extinct shells, probably from 65 in the lower to 95 in the upper, so that the Norwich Crag, in reality, is approximated to the Red Crag more closely than was imagined. The Norwich Crag at Horstead has yielded, during the last year, five fine specimens of the teeth of *Mastodon Arvernensis*, and several of the *Elephas meridionalis*. Mr. Gunn next described the Forest bed. He believed that it was "an estuary of a large river which flowed from the west, and that, as all Belgium was covered with crag formations, it was an extension of the great river bed of the Rhine." After directing attention to the laminated bed, so called from the number of laminæ in it, he made some concluding observations on the nature of the soil. Norfolk is overspread for the most part with Boulder-clay, and to this Boulder-clay the county is indebted for its good agricultural soil. Dr. Buckland used to say that he did not want to disturb the soil; he knew what strata he was upon by the appearance of the people. When he saw the rosy cheeks of the lasses in Norfolk he knew that he was upon a rich plain, and they were indebted to the Boulder-clay for the agricultural pre-eminence of the county of Norfolk.

Two Lectures on Coal and Petroleum. By Professor H. D. Rogers, F.R.S., F.G.S., delivered at Norwich, in connection with the Science and Art series, on April 27th, and May 1st, 1866.

In the first lecture Prof. Rogers considered "Coal, its origin, the

[1] Quart. Journ. Geol. Soc., 1860, p. 449.
[2] See reports of Norwich Geological Society, p. 273.

part it played in the active, social world at the present day, and the grand problem of the future supply." After a description of the strata of the Coal-measures, he described the geographical distribution of coal, and contrasted the beds in North America with those of Europe. The area of coal beds in the former continent was 200,000 square miles; one of the largest coal-fields was in Nova Scotia, on the Bay of Fundy; further westward there was a bed with a total area which almost surpassed credence. It was 875 miles in length; it was 185 miles at the widest breadth, and contained more than 51,000 square miles. It was as large as England proper. Beyond that there was another nearly as great, and one still greater—containing 72,000 square miles, an area larger than England and Wales united.

In the second lecture Prof. Rogers discoursed on "Petroleum." For two or three years past there had been an intense excitement about rock-oil and petroleum in Pennsylvania, and the contagion had spread to Great Britain, and in Scotland there was now a very keen and active search for mineral oil. There was great fickleness of duration in these oil-wells,—some ran out in two or three months, while others only in two or three years. The districts which most abounded with the oil were Western Canada, Ohio, Western Virginia, Kentucky, and Western Pennsylvania. He pointed out on a map, the result of his own survey, the extent of the oil bearing rocks in Pennsylvania, in the north-western portion of which the region was called Petrolia, it so abounded in this native mineral oil. The extraction of petroleum as an industrial occupation did not begin till 1859. It assumed no magnitude till 1861, when in the autumn of that year, in North West Pennsylvania alone, the extraction amounted to 2,500 barrels a-day of this rock-oil. Petroleum did not alone constitute the wealth of Pennsylvania: that country was a great centre in the production of coal in the United States, and its coal-mines were wonderfully rich. A great deal of the coal was above the water level, so to speak, and the mines were reached by little tunnels in the hill sides and mountain sides, and were self-ventilated and self-drained.

In conclusion Prof. Rogers made some remarks on the origin of mineral oils. Paraffin came from the shale which was part of the Coal-formation,—it occurred in those great bituminous deposits of fossil remains, black and coaly-like, but not in the coal strata.

REVIEWS.

I.—Monographs of the Palæontographical Society. Vol. XVIII., 1866.

THIS volume or fasciculus of Monographs (or rather parts of Monographs) is issued for 1864, being due for the subscriptions of that year. The energetic efforts of Council and Secretary seem likely to bring up the regular issue of the volumes to the current year before long.—I. The Liassic Ophiuridæ of Britain (comprising several species of *Ophioderma, Ophiolepis, Acroura,* and *Ophiurella*), preceded by a general notice of the Ophiuroidea, form the subject of Dr. Wright's continuation of his Monograph on the Oolitic Echinoderms, and are beautifully illustrated by Mr. C. R. Bone. Sectional lists of the beds of the Upper and Middle Lias, characterized by these Ophiurids, are judiciously introduced in Dr. Wright's descriptions.—II. Mr. Salter continues his Monograph of the British Trilobites, with ten richly-stored plates and numerous woodcuts. What Barrande has done for Central Europe, Salter is accomplishing for the British Isles, with nearly a lifelong knowledge of his favourite fossils and their localities, and of all that has been said and thought about them at home and abroad. Species belonging to *Ogygia, Barrandia, Niobe, Asaphus* (and its subgenera *Basilicus, Isotelus, Brachyaspis,* and *Cryptonymus*), *Stygina,* and *Psilocephalus,* are now fully laid before the student. The numerous additions made to collections of Trilobites now-a-days, chiefly from the neighbourhood of St. David's on one hand, and of Dolgelly on the other, will, without doubt, much augment Mr. Salter's supplementary notes; and the better basis geologists will have for the consideration of the separateness of the Lingula-flags, Tremadoc Slates, etc., as "Cambrian" rocks, distinct from the overlying Silurian group, following the plan adopted by Mr. Salter in this highly important Monograph.—III. Professor Phillips carries on his history and descriptions of the British Belemnites, with an exhaustive notice of former writers on the subject, a brief mention of "Belemnitic Beds," and succinct, well-ordered descriptions of fifteen species of Belemnites (chiefly from the Lias), of which five are new. Numerous woodcuts, and seven very delicate French lithographic plates, on tinted paper, are the illustrations, and will be extremely welcome to those who have many Belemnites in their collections.—IV. No Monograph hitherto published by the Palæontographical Society will, perhaps, interest so many geologists, both those who study the science, and those who take an interest in it as a branch of general knowledge, bearing specially on the history of man, and on the traditional, fanciful, and theoretical histories of the earth, than Messrs. Dawkins and Sanford's "Monograph of the British Pleistocene Mammalia," of which Part I. is now before us. The Introduction will be a full source of information for all the popular geology books for some time to come, when cave-bones are to be talked of, and the mammals with which man has been contemporary have to be enumerated. For real geologists and palæontologists, this Introduction is a very valuable summary of Pre-historic and Pleistocene Mammalology. Five plates, well drawn by Dinkel and others, illustrate some of the bones of *Felis spelæa* (or Cave-lion).—V. Numerous reprints of Indexes, Title-pages, etc., for back volumes of the Monographs, facilitating their being bound separately, show a desire on the part of the officers of the Society to do their work as completely as possible. We notice, also, an improvement on the title pages of the new parts of Monographs, namely, an indication of the pages and plates contained therein; and this, together with the tables of the published Monographs, and their sequence, accompanying the volume, will save the subscribers all trouble in future as to the plan of binding these somewhat complicated fasciculi. Subscribers also can now get the parts of Monographs issued to them in separate covers.

II.—Quarterly Journal of the Geological Society of London. Vol. XXII. Part II. May, 1866.

THE Anniversary Address of the Ex-President, W. J. Hamilton, Esq., F.R.S., and a paper on the Conditions of the Deposition of Coal, by Dr. J. W. Dawson, F.R.S., F.G.S., of Montreal, occupy the greater part of this Number of the Geological Society's Journal.

The Annual Report contains matter bespeaking the very prosperous condition of the Society. Sixty-six new Fellows were elected during the year 1865, amongst whom we notice many Civil and Mining Engineers. The well-being of the Society is also indicated by the satisfactory state of its finances; the income of the past year being stated to have exceeded the expenditure by £268, and the funded property to be £4560, while the long list of Donors shows that the Society is not wanting in supporters.

The President's Address consists chiefly of abstracts and notices of the most important geological works published during the last year, and forms a very useful summary of the progress of geology. Mr. Hamilton reviews the progress of the Government Geological Surveys—of the United Kingdom, of Canada, and of India. He notices the recent publications of the Palæontographical Society; the discussion on the structure of *Eozoön*, the arguments on which, are, "almost against *his* own convictions," in favour of the views of Drs. Carpenter, Dawson, and Sterry Hunt. He gives a long account of the third part of M. Barrande's "Défense des Colonies," and an interesting notice of Mr. Campbell's "Frost and Fire."

Mr. Hamilton suggests that it would be a deserving task for any geologist to get a sufficient number of sections from all parts of the world and endeavour to fill up the breaks in the succession of the sedimentary rocks, for they are only local, and "we should then see by what almost insensible gradations the crust of the earth has been successively formed, and what were the conditions of life, in some places, and their partial extinction in others." He also suggests the inquiry to be made—"whether the plastic condition of the earth to which its oblate spheroidal form has been attributed, be not owing to an aqueous rather than to an igneous origin," and "whether the solidification of the earth began at the circumference, after its formation, as is assumed by the advocates of the central-heat theory, or whether the formation of the earth may not have commenced with a central nucleus consisting of an aqueous paste gradually increasing in size, as matter was deposited around it, from the circumambient fluids and gases which filled the solar space before solid matter was aggregated round those spots which now form the planets in our solar system. For, assuming the possibility of an aqueous origin, and eliminating the theory of central heat, can we not account for all the volcanic and igneous phenomena which we find on the surface of the earth by chemical action taking place at a comparatively moderate distance below the surface? We know that heat and combustion can be thus produced, and we know that all the elements which are necessary for its production must have been contained within the earth's sphere."

The "Proceedings of the Society" contain—1st. A paper on the Rhætic beds of South Wales, by Mr. E. B. Tawney,[1] illustrated with twoplates of the fossils. After giving an account of the lithological character of the beds, Mr. Tawney describes the organic remains found in them; he has determined twenty new species, many of which, however, appear to be founded upon rather obscure specimens. Dr. Duncan adds a very important note on the Madreporaria of the "Sutton Stone," these he has identified with species from the St. Cassian beds, figured by Dr. Gustav Laube.—2nd. Notes on a Section of the Lower Lias and Rhætic Beds near Wells, Somerset, by the Rev. P. B. Brodie.[2]—And 3rd. Dr. Dawson's paper on the Conditions of the Deposition of Coal,[3] more especially as illustrated by the Coal-formations of Nova Scotia and New Brunswick. The author describes at length the physical characters, and the conditions attending the deposition of coal, the remains of animals and plants occuring in it, and gives a descriptive list of the Carboniferous plants found in Nova Scotia and New Brunswick, illustrated with eight beautiful lithographic plates.

In the "Miscellaneous" part of the "Journal," are—(1) An abstract of MM. Cornet and Briart's discovery in Hainaut, below the sands referred by M. Dumont to the Thanet Sands, of a coarse Limestone with a Tertiary fauna.[4]—(2) A report on the geology of the environs of Tokay, Hungary, by Prof. Szabó. All the rocks in this neighbourhood are of Tertiary age, they consist of eruptive rocks, trachyte and rhyolite; and sedimentary rocks, the result of decomposed or disaggregated rhyolite. The soil producing the celebrated Tokay wines is of an argillaceous character, derived from the superficial decomposition of trachyte. Lastly, a notice by Prof. Hochstetter of the discovery of *Eozoön* in the crystalline limestone of Krummau, Austria.

The Council and Fellows of the Society generally, may congratulate themselves that they have the benefit of the services of Mr. Henry M. Jenkins as their Assistant Secretary, whose efficiency, as an Editor, is attested by the manner in which the Journal maintains its high character for scientific value and accuracy of detail, no mean task when such a part as the present quarterly number, occupying 224 pages, and illustrated by 10 excellent plates, has to be issued.

[1] See abstract in Geological Magazine, January, p. 39. [2] *Idem* p. 40.
[3] Geol. Mag., February, p. 79.
[4] Noticed in Geol. Mag., April, p. 174.

REPORTS AND PROCEEDINGS.

Geological Socety of London.—I. April 25, 1866.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair. The following communications were read:—1. "Additional documents relating to the Volcanic Eruptions at the Kaimeni Islands." By Commander Brine, of H.M.S. "Racer." Communicated by the Lords Commissioners of the Admiralty.

In these documents it was stated that the active volcano now forming part of Neo Kaimeni Island continues to increase in size by the addition of volcanic matter ejected from the crater, and that the rate of increase of the new island situated to the south-west, near St. George's Bay, is considerably less than at first. The new island contains the crater of a second volcano, 30 feet in height, with a circular base of 300 yards; and, judging from the soundings obtained at Paleo Kaimeni and St. George's Bay, it is probable that the island will eventually fill up the bay.

2. "Report to the Eparch of Santorino on the Eruptions at the Kaimeni Islands." By M. Fouqué. Communicated by Sir R. I. Murchison, Bart, K.C.B., F.R.S., F.G.S., etc.

Since the eruptions at Santorino, earthquakes have become much less violent in the surrounding country, and the fears of the inhabitants have been unnecessarily great. A new fissure has been opened between George Island and Aphroessa; and lava and torrents of steam have issued from this vent, as well as much gas. The non-existence of a crater was considered by M. Fouqué to be due to the small quantity of ejected matter and the feebleness of the eruption. M. Ste.-Claire Deville has shown that there exists a certain relation between the degree of intensity of a volcano in action and the nature of the volatile elements ejected; and M. Fouqué has been enabled to establish the truth of this law. Thus, in an eruption of maximum intensity, the predominant volatile product is chloride of sodium, accompanied by the salts of soda and potash; an eruption of the second order gives hydrochloric acid and chloride of iron; in the third degree, sulphuric acid and salts of ammonia; and in the fourth, or most feeble phase, steam only, with carbonic acid and combustible gases. The eruption at Neo Kaimeni has never exceeded the third degree of intensity; and when it excited the greatest alarm, it gave off only sulphuric acid, steam, and combustible gases.

3. "Remarks upon the Interval of Time which has passed between the formation of the Upper and Lower Valley-gravels of part of England and France; with notes on the character of the Holes bored in rocks by Mollusca." By A. Tylor, Esq., F.L.S., F.G.S.

The difficulties attending investigations into the relative ages of gravel-deposits having been stated, and a *résumé* given of the steps by which the opinions now current on the subject had been arrived at, Mr. Tylor proceeded to combat the view that the Upper and Lower Valley-gravels are separated from each other by a long interval of time. The conclusion that man had existed on the earth from so distant a date as is required by Mr. Prestwich's interpretation of the phenomena exhibited in the valleys of the Somme and other rivers was also considered untenable, and the author endeavoured to prove that the theory requiring it was erroneous.

Accepting Mr. Godwin-Austen's theory of the Pleistocene age of the English Channel, the author inferred from it that the excavation of the transverse valleys of the south-east of England was similar to that of the valleys of Devonshire, which he considers to have been excavated in remote geological periods, and to have been filled with gravel prior to the period of the valley-gravels, at which time the valleys were re-excavated. He then brought forward evidence to show that, in the case of the small valley in which Kent's Hole (180 feet above the sea-level) is situated, the gravel has been swept away from the valley during an epoch immediately preceding the historic period, and without any appearance of great denudation of the older rocks, leaving what may be called High- and Low-level Valley-gravels on its slopes as remanié deposits; and in support of this view he mentioned the presence of human implements in these gravels, the existence of Pholas-perforations on the face of the rock in which are the two openings of Kent's Hole (showing that little weathering had taken place since), as well as the occurrence of a bed of red clay, or loess, 80 feet thick, and 220 feet at its base above the sea-level.

The age of the Kent's Hole Valley was identified with that of the Valley of the Somme, on account of the similar position of the gravels and of the raised beaches at the coast-line, as well as the similarity of levels, and of the organic contents of the detritus in the two valleys.

In conclusion, Mr. Tylor gave a note on the character of holes bored in rocks by Mollusca, with especial reference to the bored rocks at Kent's Hole and Marychurch, about 200 feet above the present sea-level, coming to the conclusion that they have probably been formed by *Pholas dactylus.*

The following specimens were exhibited:—1. An almost perfect skull of *Rhinoceros leptorhinus,* from the Brick-earth of Ilford; exhibited by Antonio Brady, Esq., F.G.S. 2. Perforated limestone from Devonshire, and Chalk from Brighton, bored by *Pholas dactylus*; exhibited by Alfred Tylor, Esq., F.L.S., F.G.S. 3. Miscellaneous rocks and shells bored by *Pholas, Saxicava, Gastrochæna,* etc.; exhibited by Henry Woodward, Esq., F.G.S., F.Z.S. 4. Specimen of gneiss perforated by *Pholas dactylus*; exhibited by Prof. T. H. Huxley, F.R.S., V.P.G.S.

II.—May 9, 1866.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the chair. The following communications were read:—1. "On a new species of *Acanthodes* from the Coal-shales of Longton," By Sir Philip de M. Grey Egerton, Bart., M.P., F.R.S., V.P.G.S.

Owing to the kindness of Mr. Ward, of Longton, the author had been enabled to examine a considerable collection of specimens of the Acanthodean fishes of the North Staffordshire Coal-field. The specimens were all imperfect, the anterior parts of the fish being rarely preserved, and even when present being in a very mutilated condition; but Sir Philip Egerton had been able to determine the distinctness of at least one species, which he now described as *Acanthodes Wardi.* The species was far less bulky and more elongated than *A. Bronni* from the Saarbrück Coal-field; but it was not so slender as *A. gracilis* from the Permian beds of Klein Neudorf.

2. "A sketch of the Gravels and Drift of the Fenland." By Harry Seeley, Esq., F.G.S.

By the Fenland was understood the flat country west of the Chalk Hills of Norfolk, from Hunstanton to Cambridge, thence to Bedford, and northwards to Peterborough. Three kinds of drift were described as occurring in this region, namely Boulder-clay covering the high land, a coarse gravel which caps the hills, and the fine gravel of the plains. Mr. Seeley gave first a sketch of their distribution over the area under consideration, and then described some of their most important exposures, especially the sections at March, Barnwell, and Hunstanton. He also gave lists of the marine shells found at March, occurring between Boulder-clays, and those found at Hunstanton, which are of much later date; also of the bones and land and fresh-water shells found at Barnwell, including one bone described as having been cut by man previous to deposition in the gravel.

Comparing the drift of the Fenland with that of the Eastern counties, Mr. Seeley inferred that the brown clay of the latter district corresponds with the brown Boulder-clay, which is the oldest drift-deposit in the former; and that the hill-gravel, the blue Boulder-clay, and perhaps the shell-bed of March, correspond to the Contorted Drift.

3. "Additional Observations on the Geology of the Lake-country." By Prof. R. Harkness, F.R.S., F.G.S., and H. Nicholson, Esq. With a Note on the Trilobites. By J. W. Salter, Esq., F.G.S.

The authors having first communicated the following additions to the fauna of the Skiddaw slates, namely, from the lower strata, *Phacops Nicholsoni*, n. sp., *Æglina binodosa,* and *Lingula brevis*; and from the upper beds *Diplograpsus teretiusculus* and *Agnostus morea;* they stated that fossiliferous rocks had been discovered by them among the "ash-beds" of the Lake-country on the same horizon as those associated with the purely igneous rocks of the eastern parts of Cumberland and Westmoreland, which underlie the Coniston Limestone, and are of Caradoc age. This discovery has thus placed the green rocks of the Lake-country in the same position.

The Caradoc formation of the Lake-country was stated to embrace three divisions, namely, the Coniston Flags and Grits, the Coniston Limestone, and the Igneous Rocks and Ash-beds; and the following organic remains were enumerated as having been obtained from the Coniston Flags and Grits, the uppermost division of the formation:—*Graptolithus Ludensis, Diplograpsus pristis, Phacops obtusicordatus,* *Orthis crispa, Cardiola interrupta, Orthoceras filosum, O. tenuistriatum,* and *O. subannulatum.*

4. "On the Lower Silurian Rocks of the Isle of Man." By Prof. R. Harkness, F.R.S., F.G.S., and H. Nicholson, Esq.

The older sedimentary deposits which occupy the greater part of the island, have been regarded by previous observers as Lower Silurian. These slates were described by the authors as forming an anticlinal axis which traverses the island in a north-east and south-west direction, and to be conformably overlain at Douglas Head and Banks How on the south-eastern part of the island, by green ash-beds (slates and porphyries).

The only fossil of the slates is the *Palæochorda major* of the Skiddaw slates; and from the circumstance that the Lower Silurian rocks of the Isle of Man are in the exact line of strike of the Skiddaw slates of the Lake-country, the authors regarded these beds as corresponding with them; and the "green ash-beds" were considered to be the equivalents of the ash-beds and porphyries which succeed the Skiddaw slates.

The following specimens were exhibited:—Silurian Fossils from Cumberland and the Isle of Man; exhibited by Prof. Harkness and H. Nicholson, Esq.—Specimens of *Acanthodes* from the North-Staffordshire Coal-field; exhibited by J. Ward, Esq.—Copper Ores from Lake Superior, and a specimen of Salt from a remarkable deposit 150 feet above the level of the surrounding swamp, near the shores of the Gulf of Mexico, Louisiana; presented by the Hon. J. D. Caton.—Six photographs of ancient sculptures on Reindeer-horn; presented by the Marquis de Vibraye, For. Corr. G.S.

The Edinburgh Geological Society.—April 5th.—R. A. F. A. Coyne, Esq., C.E., V.P., in the chair. The Right Honorable William Chambers, F.G.S., Lord Provost of the City of Edinburgh, was unanimously elected a Fellow.

Mr. Thomas Smyth read the first part of a paper, which was illustrated by diagrams, entitled, "Additional Observations on the Upheaval of the Shores of the Firth of Forth and part of the East Coast of Scotland during the Human Period." In introducing the subject he recapitulated the evidence contained in a former paper read in December, 1864, to show that many upheavals of the land had taken place during the human period. The author's remarks would now extend from the close of the Post-Pliocene period to the time when a Celtic population inhabited the Lowlands of Scotland. During the Post-Pliocene era the land slowly arose, the glaciers left the valleys, and the whole country became of a warmer temperature. The valley-gravels and fine sands, extending from the Water of Leith to Restalrig, must then have been rearranged and deposited. The land continued elevated for a considerable time, and forests of trees covered the greater portion of Britain; a submergence afterwards took place, but to what extent is unknown. This submergence is proved by the peat-deposits which are found under marine strata in various parts, and also by remains of submerged forests and peat which are seen at and below low-water-mark in numerous British estuaries. Mr. Smyth then described the submerged forests of the Firth of Tay, Largo Bay; and various deposits of peat containing remains of trees underlying marine strata, but in which no human remains or works of art have ever been found. At the close of this period of submergence the land was again elevated, and terraces and prominent escarpments near the present shore-lines were formed. These escarpments, the bases of which are from 25 feet to 30 feet above high-water-mark, seem to afford almost direct evidence that the sea once washed against them. Ancient oyster-scalps and remains of other recent shells have likewise been discovered in many places along our shores at considerable heights above high-water-mark, all lying beneath a depth of several feet of stratified sand and gravel. Mr. Smyth then stated that he had traced an ancient oyster-scalp situated between Portobello and Seafield, from the height of 2 feet to 43 feet above high-water-mark, beneath a stratified deposit of sand and gravel, nearly a quarter of a mile from the sea. One writer (Mr. Alexander Bryson, of Hawkhill, Edinburgh, in a paper read before the Geological Society of Glasgow, an abstract of which was reported in the GEOLOGICAL MAGAZINE, Vol. I., 1865, p. 277) had stated that this oyster-scalp, like a similar one, 60 feet above the sea, near Inveravon on the Forth, had been storm-raised, but this was quite impossible. Waves caused by earthquakes rise to a great height, but it had been ascertained by actual measurement that no storm wave, even in the greatest hurricane, ever reached, either in the open sea or along a level coast such as that near Portobello, a greater altitude than 28 feet. Along a rocky coast the waves and the spray reach a much greater altitude, owing simply to the waves acting against a barrier, but, during the greatest storm within the memory of man, the sea-wreck only reached the height of five feet above ordinary high-water mark. It would therefore be absurd to suppose that those shells near Portobello, and at such a quiet place as Inveravon, so far from the fury of the open sea, could be storm-raised. Such a storm would destroy Leith, Portobello, North Berwick, part of Kirkcaldy, and hundreds of towns and villages along the coast. Mr. Smyth stated that beds of shells lying beneath stratified deposits of sand and gravel, &c., had been found near Newbigging, at Drip, four miles west of Stirling, and at Aberlady and Dirleton, at heights varying from 12 feet to 25 feet above high-water-mark, and at considerable distances from the sea. Such beds could only have been deposited when the land was considerably lower than at present. The *Pholas crispata*, a boring mollusk which is very abundant in the Firth of Forth, furnishes conclusive evidence of this upheaval. Its habitat is never higher than half-tides, and it generally bores a hole of from a quarter of an inch to half an inch in diameter, chiefly in shale, fire-clay, and in all rocks that are softer than its own shell. The *Pholas* commences to bore when young, it widens its house as it grows old, and this house becomes its grave. A short time before his death, the late Hugh Miller showed the author *Pholas*-borings at Joppa, in fire-clay, 3 feet above high-water-mark. There had been a mound of rubbish which had been cleared away, and the burrows could be seen in the solid rock in great numbers. Mr. David Milne Home in his work "On the Parallel Roads of Lochaber, with remarks on the change of relative levels of sea and land in Scotland," states that when the place at Joppa was first excavated, a stratum of fire-clay was found extensively perforated by the *Pholas* at a height of from 2½ to 3 feet above high-water-mark. This was possibly the same stratum which Mr. Hugh Miller had pointed out to the author. Mr. Jamieson, in a paper published in the Quarterly Journal of the Geological Society (August, 1865), mentions, on the authority of Mr. R. Walker, that, at St. Andrews in Fife, a mass of sandstone above high-water-mark is riddled with *Pholas* burrows. Mr. Home also states that the perforations of the *Saxicava rugosa* had been found at two places near Dunbar, at heights of about 13 and 14 feet respectively above high-water-mark. Mr. Smyth then gave a description of the six principal caves of Wemyss, in Fife, the floors of which vary from 9 feet to 18 feet above ordinary high-water-mark. These caves must have been formed by the action of the sea at a time when the land was considerably lower than it is at present. The sides of three of those caves are marked with ancient sculpturings, and he exhibited to the society several drawings of those sculpturings which Sir James Y. Simpson, Bart. (who had first called attention to them), had kindly lent him for the occasion. Mr. Smyth then gave a few of the evidences to show that an upheaval of our shores had taken place during the human period. He stated that he had mentioned in his former paper, on the authority of Sir Charles Lyell, Bart., that two pieces of stag's horns, artificially cut, were found at Airthrie, in the neighbourhood of Stirling, near the spot where the skeleton of a whale was disembedded, a mile from the river, and seven miles from the sea. Pointed instruments of deer's-horn were also found at Blair Drummond, near the skeletons of whales; an iron anchor was discovered in the Carse of Falkirk; and many other instruments have been discovered in the neighbourhood of Stirling, and in such positions that there could not be a doubt that since the commencement of the human period, the sea must have covered a large extent of country which is at present dry land. It was known, too, that Inveresk and Cramond were Roman ports. This would give us at Inveresk a considerable amount of elevation, certainly not less than 25 feet since the period of the Roman occupation. Mr. Smyth then showed from the names of such places as Aberdour, Abernethy, Inveravon, Invergowrie, Inveresk, Auchterarder, Auchtermuchty, Inchkeith, Inchcolm, and many other places, all either Gaelic, or derived from the Gaelic, that a Celtic population must have inhabited the Lowlands of Scotland at one time. He objected to the term "Pre-Celtic," which some writers used, as there was not the least vestige of evidence to show that the aborigines of Britain, south of Caithness, were Pre-Celtic, but he considered the term "Pre-historic" to be quite correct. He then referred to the Inches of the Carse of Gowrie as affording undoubted evidence

that a considerable amount of upheaval had taken place since the country was first inhabited by the Celts. "Inch," or "Innis," signifies an island, so when those Inches first got their names they must, as their names imply, have been islands, although they are now elevated above the level of the Carse. Some of them are now more than two miles distant from the Firth of Tay. The author described Inchyra, Inchcoonans, Megginch, East and West Inchmichael, Inchmartine, and Inchture, their heights above the level of the sea varying from 35 to 60 feet. These islands appear to have been first cultivated in a circular shape, and the Rev. Dr. Grierson, of Errol, has suggested that this mode of cultivation is the most probable explanation of the "curved ridges" which are still so characteristic of the Carse agriculture, and which cannot now be altered or obliterated. On looking over the register of Crown charters issued under the Great Seal of Scotland, Mr. Smyth found one by King James IV. in favour of William Earl of Errol, dated 17th June, 1512, of the sixth part of the lands of "Inchmertyn," and it bears internal evidence that even then the boundaries of "Inchmertyn" were considered ancient. It is uncertain at what time those Inches got their names, but the nature of the ground and the amount of elevation of each above the Tay and the Carse showed that there must have been an upheaval of 25 to 30 feet since a Celtic population inhabited the Lowlands of Scotland. In the second part of his subject, Mr. Smyth said he would lay before the society the evidences of upheaval of our shores between the period when a Celtic population occupied the Lowlands of Scotland and the present time.

A discussion followed, in which Mr. George C. Haswell, Mr. D. J. Brown, the Rev. George Bartholomew, the Rev. James Stormonth, Mr. George Lyon, and Mr. James Haswell, M.A., took part, after which the vice-president conveyed the thanks of the society to Mr. Smyth for his paper.

Geological Society of Glasgow.—I. February 8th.—A lecture was delivered at the Andersonian University, by David Page, Esq., F.R.S.E., F.G.S., on "Ice, its Forms and Functions."

II. The fifth monthly meeting of the session was held in the Society's Room, Andersonian University, on March 1st. The Rev. H. W. Crosskey, Vice-President, in the chair.

Mr. John Young exhibited four species of *Foraminifera*, from the limestones and shales of the Lanarkshire coal-field. They belong to three genera, two of which are allied to *Textularia* and *Truncatulina*. Mr. Young stated that, until last year, no remains of *Foraminifera* had been recorded from the Scottish Carboniferous strata.

Mr. R. W. Skipsey read a paper on "The Clyde, as a River and Firth: its Course, Rocks, and Geological Aspects," in which he stated his belief, that since the deposition of the Boulder-drift, the tidal wave had not reached much, if any, higher than its present limits in the river. At and around Carmyle the gravels were almost entirely the remains of the Boulder-drift from the north-west, as they were also from thence across the country, through the Kelvin, Campsie, and Blane valleys, which he believed to have been the ancient course of the Clyde from Carmyle to the eastern portion of Loch Lomond, into which it flowed, and thence by the Leven seawards; the present course of the river from Carmyle downwards having been subsequently formed by the silting up of the former, and its waters, when in flood, forcing a new outlet for it. Mr. Skipsey believed the channel of the Firth, by which the river flowed, after its junction with the Leven, traversed exclusively the north shore, along the Cowal coast, and reached the outer waters through the Kyles of Bute, while the southern shores of the present firth, embracing the whole of the present lowland range, upwards to Paisley, Gowan, and to the centre of Glasgow itself, had probably formed a succession of quiet estuaries—the great profusion of Boreal shells suggesting to the author such a conclusion.

Mr. John Donald Campbell gave a discourse on "Some Difficulties in the Ordinary Theory of the Origin of Species," relating chiefly to the distribution of species in time and space, and the relation of species to each other.

III. March 22nd.—Mr. James Farie exhibited a specimen of "Wulfenite," or Molybdate of Lead, from the Lachantyre mine, near Gatehouse, Kirkcudbrightshire; it is undoubtedly new to Scotland, if not to Britain.[1] Mr. Farie exhibited also, from the same mine, a specimen of Vanadiate of Copper, which is new to Britain, and is in recent works, such as Bristow's and Dana's, recorded as found only in the Ural.

IV. A communication was read from Mr. James Croll, "On the reason why the change of Climate in Canada, since the Glacial Epoch, has been less complete than in Scotland."

Mr. Crosskey, in a paper[2] recently read before the Society, entitled, "The Relationship between the Fossils of the Glacial Beds of Canada and those of the Clyde," has shown that the difference between the shells of the Glacial beds of Canada, and those now existing in the Gulf of St. Lawrence, is far less marked than the differences between the Glacial shells of the Clyde beds and those now existing in the Firth; and therefore infers that the change of climate in Canada, since the probable Glacial epoch, has been far less complete than in Scotland, though the temperature at that period, in both countries, was equally severe. Mr. Croll agrees with Mr. Crosskey that there must have been a deflection of the Gulf Stream from our coast during the Glacial epoch. To the stoppage, or, at least, great reduction of the stream, was due the cold of the Glacial epoch; and the consequent rise of temperature due to its return, was probably the cause why the change of temper-

[1] See Geological Magazine, vol. ii. p. 575.
[2] Geological Magazine, March, 1866, p. 135.

ature has been much greater in this country than in America, for the temperature of the former has never been raised by the influence of the Gulf Stream, owing to the cold Polar stream from Davis Straits.

The excessive cold of the American winters is due to the continental character of the climate, and the absence of any benefit from the Gulf Stream; the summers also are cooled to a great extent by the icebergs from Greenland. It is no wonder then that the shells which flourished in Canada during the Glacial epoch, have not left the Gulf of St. Lawrence and neighbouring seas.

On the whole, it may be concluded that had the Gulf Stream not returned to our shores at the close of the Glacial epoch, and had its place been supplied by a cold stream from polar regions, similar to that which washes the shores of North America, it is highly probable that nearly every species found in our Glacial beds, would have had their representatives flourishing in our British seas at the present day.

Manchester Geological Society.—A meeting of the members of this society was held on the 28th at the Museum, Peter Street; Mr. E. W. Binney, F.R.S. the president, in the chair.

The President exhibited a nodule of ironstone, found by him in the Wigan 4ft. coal, containing a number of small spores or seeds about the size of a pin's head. The outside of the specimen had evident characters of the root of *Sigillaria*, and its inside was full of the spores. These latter were covered by a thick brown cover, one side presenting a rounded appearance, but on the other a triradiate ridge. The inside was composed of beautifully white carbonate of lime. The spores appeared to be more like those of the *Lepidostrobus ornatus* figured and described by Dr. J. D. Hooker in the Memoirs of the Geological Survey of Great Britain, than of any other with which he was acquainted, but he had not as yet found them in a sporangium. In all cases where he had met with them they were loose and detached. Mr. Carruthers had described in the Geological Magazine for October last a singular cone, found by Mr. James Russell, of Airdrie, which he had termed *Flemingites gracilis*, containing many sporangia similar in form, but considerably less in size than those found in the Wigan Specimen. These sporangia of *Flemingites* are found largely in all the splint-coals of Scotland and England, and no doubt had a great deal to do with their good qualities for iron making and steam raising purposes. In the Fifeshire coals he had found these in the 8ft. main, and Princewell seams at Methill, and in the Barnsley main at Handsworth Woodhouse, east of Sheffield. He believed that Professor John Morris, F.G.S., had also found them at Low Moor. So far as his (the president's) knowledge extended, all splint coals contained more or less of these sporangia. It was only in Mr. Russell's specimens that the sporangia were seen *in situ*, and in all the other cases they were found detached like the spores from Wigan coalfield now exhibited. It was singular that the sporangium of the *Flemingites* should be so similar in shape and size to the spores of the *Lepidostrobus ornatus*, and so dissimilar to the sporangium of the

Lepidostrobus Brownii of Carruthers. We required a great deal more evidence of the fructification of coal-plants than we at present possessed to enable us thoroughly to understand the true nature of the vegetables of the Carboniferous epoch. He wished all the members who devoted attention to the collection of coal-plants to assist him by all the means in their power in finding cones united to branches and cones with sporangia and spores *in situ*. These were the most valuable specimens which they could bring before the society; and it was his opinion that they only required to be diligently searched for in order to be found.

Mr. W. R. Barr, F.G.S. read a paper on "A Fossil Shell from the Oil-wells of Canada." He said there were certain indications of large reservoirs of petroleum in certain portions of the earth's surface. He produced specimens of shells which he had received from Mr. W. L. Eskrigge, the ex-Mayor of Stockport, and which that gentleman had collected. The place from which the shells had been brought was the village of Oil-springs, in the township of Enniskillen in Canada. They were picked up from the stiff blue clay by Mr. Eskrigge, having been brought up in his presence by the boring tools. He had come to the conclusion that the fossils themselves were truly Carboniferous, and were the same as our *Spirifera striata*, only found in this country in the Carboniferous limestone. The oil was found in the underlying rocks at different depths, but whatever character the rock might have, it was certain it had nothing to do with the origin of the oil it contained, but rather that it had come from some extraneous source, and was only found in the crevices and cracks with which the rock was permeated. These cracks being better filled, and the yield being more abundant near the surface than deeper, seemed to point to the supply coming from above. He suggested that the origin of the oil was from the now overlying clay which, from its imbedded remains, must have been a member of the Carboniferous series; it most probably was originally a shale similar in character to the bituminous shales so well known in our Coal-measures, or a band of bituminous matter as found in the Mountain Limestone, but he was the more inclined to think that it was originally a shale from the dark blue clay residue in which these shells are deposited—that by a decomposing process, the bituminous matter was distilled into an oil, and filled up the cracks of the underlying rocks, forming the reservoirs from which modern energy and skill are now, for the first time, bringing it to light.

An interesting discussion followed, in the course of which the Chairman said that many years ago he read a paper on the petroleum oil formed from the decomposition of peat going on at Downholland. Unfortunately the supply was not great, but the quality was undeniable. More than 150 years ago there were petroleum springs at Wigan and Coalbrookdale in the pitch and flint coal. There was no difficulty in accounting for it when found in coal, the decomposition distilling it to oil. Petroleum abounded in India and China, where it was used as a cure for rheumatic pains. The Chinese made use of it for burning lamps. The Americans found out its use in the course of a trial that took place in this country in which he was concerned.

A vote of thanks was passed to Mr. Barr and to the President, and the proceedings terminated.—*Manchester Courier*, March 28th, 1866.

Dudley and Midland Geological Society.—The first Field-meeting of this Society was held on the 16th April, in the neighbourhood of Nuneaton. The party first examined the altered Millstone Grit of the Hart's Hill range. This stone is here inclined at a high angle, and passes conformably under the Coal-measures of the district. The line of hills is extensively quarried along its entire length, the material being chiefly used for road purposes. The quarries first visited were those on the estate of Mr. Dewes, who offered every facility to the party. In a tramway leading up to these quarries, the gritstone presents a very coarse appearance, and seems scarcely to have undergone any change. Above this the stone has been fused into a compact quartzite, which is coloured by the oxides of iron and manganese. A considerable mass of igneous rock underlies the gritstone, and has probably been the agent in changing the coarse stone into quartzite. A large quarry has lately been opened on the eastern side of Caldecote Hill, below the ordinary Hart's Hill stone. The igneous rock in this place very much resembles the Basalt of the Rowley Hills, but is much more compact, and of a higher specific gravity. The material is now prepared for paving purposes, for which it seems admirably adapted, and is extensively used. The course of this mass of igneous rock was traced for some distance to the north. At the Hart's Hill quarry, in the gritstone, a very interesting trap-dyke was noticed. The party next visited the Coal-measures in the neighbourhood of Stockingford. The outcrop of the several seams of coal in the Warwickshire field was traced in the valley. In the Neah cutting, approaching Nuneaton, on the Midland Railway, the Lower Coal-shales are seen, with several beds of intrusive igneous rock, which shoot among the shales in a most curious manner, and have baked the coal-shale into a kind of porcellanite. The last point examined was a dyke of trap rock in contact with the Millstone Grit. This occurs near the Nuneaton Railway Station. The party was conducted by Mr. A. Startin, of the Warwickshire Field-club; and the details of the geology of this important district were fully explained. After tea at the Newdegate Arms, Mr. Charles Twamley conveyed the thanks of the club to Mr. Startin for his able guidance, and a vote of thanks was also passed to Mr. Dewes, for his kind hospitality, and for the facilities he had afforded the party.

Norwich Geological Society.—The monthly meeting of this society was held at the Museum on the 3rd April. The following paper, by the secretary (Mr. Taylor), was then read:—"The Relation of the Upper and Lower Crags in Norfolk."

He stated his belief that the apparent great difference between the Red Crag and the Norwich Crag had arisen as follows—At some vertical distance above the *true* Norwich Crag was another bed of shells. This bed varied in height above the lower one from twelve feet to two. Hitherto it has been the custom to take the *mean* of the two beds, and sum up the total of species as belonging to the Norwich Crag, totally ignoring the characters of the upper and lower beds. By limiting the per centage of shells found in each, we arrive at far different conclusions to those commonly received, and he believed the difference between the two beds to be as distinct and as great as it was between any of the other crags. It followed from this that we must either regard the upper bed as a *fourth* crag, or must regard the lower as approximating in age to the Red Crag. He was inclined to the former theory, and believed that, when well worked, the four crags would be found to pass gradually into each other, and to be connected with the Glacial series, more closely than has yet been seen. His own investigations proved that the upper bed was of a far more distinctly Arctic character than the lower. The same shells might be found in each, but the *proportion* was vastly different.

Mr. Taylor then described several localities where he had observed the two separate crag deposits in superposition, at Coltishall, Horstead, Bramerton, Thorpe, Whitlingham, and Postwick.

From these facts he drew *three* conclusions, viz., the total absence of fresh-water shells, and the general predominance of those usually found in deep water, indicated that the upper bed was formed under more distinctly marked marine conditions; secondly, the paucity of littoral shells bore out this supposition; and, thirdly, the distinct Arctic or "Northern" features, which everywhere are found in the upper bed, marked it off definitely from that below it, and indicated a more rigorous climate during its deposition. The paucity of species in the upper bed, when compared to the richness and variety of those found in the lower, was another argument in favour of their distinct character. Doubtless the lower bed contained more "Northern" shells than the Red Crag of Suffolk, and thus showed an increasing cold. The upper bed supplemented this theory, and proved that the cold was increasing, whilst the succession of Glacial clays and foreign boulders carried out still farther the belief in a gradual and increasing rigour of climate. The "Iron Pan," which usually lies five or six feet above the upper bed, was also marked with the impressions of shells, chiefly *Cardium*, *Mytilus*, and *Pectens*, proving the marine character of the entire series, from the Coralline Crag to the latest Boulder-clays and sands. He considered the custom hitherto adopted of taking the mean of the shells from the upper and lower beds, and calling the per centage that of the Norwich Crag, had misled geologists as to their relative ages and character. The various crags seemed to glide into each other, and the upper or *fourth* crag was the connecting link between the true Norwich Crag and the Glacial series.

The thanks of the society were then tendered to the author of the paper, and the President requested Mr. Henry Woodward, F.G.S., who was present, to make a few remarks on the paper.

Mr. Woodward said the subject was most important to geologists, and he thought that Mr. Taylor had treated it in an able manner. He agreed with the author that the establishment of a proper distinction between the upper and lower beds would make a great difference in the per centage of shells. He also thought that the manner in which the lower bed was shown to be a fluvio-marine or littoral deposit, and the upper decidedly marine, was very important, inasmuch as the latter, perhaps, formed a connecting link between the true Crag and the Glacial series. He had mentioned to his brother, Mr. B. B. Woodward, that Mr. Taylor was about to read a paper on this subject, and he, from long experience with his father, the late Mr. Samuel Woodward, in the geology of the county, was able to confirm Mr. Taylor's views respecting the distinct character of the two beds. Mr. Woodward advised the members of the Norwich Geological Society to devote their attention to the solution of this very interesting question.

The President (the Rev. John Gunn, F.G.S.), then said that he thought the bed of shells in the Whitlingham Tramway belonged to the laminated beds, which, in the "Antiquity of Man," were called fluvio-marine. They overlaid the forest bed on the south side of the Cromer Jetty, and the Norwich Crag on the north side. The forest bed must have occupied a long period of time, during which its soil was first raised above the water in which it had been deposited, continued above it while the forest flourished, and then was gradually submerged; and this forest bed intervened between the Norwich Crag and the upper or marine part of the laminated beds, in which Mr. Gunn supposed the shells to be. He pointed out a fine section of them, near Bishop's-gate Bridge, Norwich, where they lie between the Norwich Crag and the Lower Boulder-clay.

CORRESPONDENCE.

NOTES AND QUERIES IN REGARD TO THE VALLEY OF THE SOMME.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—The valley of the Somme, as described by Sir C. Lyell and Mr. Prestwich, is a long shallow trough, thirty miles in length, about one in average width, and from two to three hundred feet in depth. It has been hollowed out of a bed of "Chalk with Flints."

On the sides there are two level terraces, composed of shingle and sand, with occasional beds of clay. The gravel consists of fragments of rocks, the same as those found in the district at present drained by the Somme. In some places, where the terraces have been opened for industrial purposes, implements of flint have been discovered, as well as the bones of some mammalia now extinct.

Sea-shells are found mingled with the gravel as far up as Menchecourt, twenty miles from the mouth of the river.

In the gravel beds there are sometimes found fragments of rock, with their edges unbroken, as if they had been brought down by floating ice; and there are other evidences which show that these frozen masses must have exerted considerable influence in the formation of the level terraces.

The bottom of the valley is occupied by a bed, which Sir Charles Lyell characterizes as peat, and describes as being from ten to thirty feet in thickness.

Sir Charles Lyell speaks of this peat as having grown on the spot where it is found, and as having required an immensely extended period for its production.

Mr. Prestwich, in his paper read before the Royal Society in 1864, does not speak of peat at all, but calls this bed "alluvium."

Query First.—*What is the nature and origin of the bed which occupies the bottom of the valley?*

In England, and more particularly in Scotland, we find extensive accumulations of peat. In some instances, the peat remains in its natural locality. In such cases, the roots and stems of those plants that grow in marshy soil, and by their decay produce peat, are mingled through the whole mass, being of course more abundant in the upper part, which has in consequence a soft and spongy consistence. In other cases the more completely transformed particles of peat, after having been saturated with water, have run down into the hollows, leaving the undecomposed portion of the plants behind. This variety of peat, when condensed and dried, is very tough and hard, and is almost as heavy as coal.

If the peat in the valley of the Somme has grown in the place which it now occupies, we may expect to find a bed of, comparatively speaking, uniform thickness, having but little foreign admixture, the whole mass being intermingled with the remains of the plants that produced it, and these remains retaining the position they occupied when alive. If it is an alluvium, brought down from the higher grounds, we may expect to find beds of solid peat, with very little trace of the plants that produced it, mingled with deposits of sand and mud, and pieces of peaty soil, with vegetable remains lying in various directions. If, as is most likely, some of the peat has grown on the spot, and some has been brought down by the river, we shall find the soil on the banks of the Somme of a very heterogeneous description, containing peat of different kinds, intermixed with mud, and sand, and clay.

A more accurate examination of the bed which fills the bottom of the valley seems to be required before we can determine its nature, or its origin, or the time taken to produce it.

Query Second.—*Are the terraces on the sides of the valley of the Somme to be ascribed to the effect of river-currents or to the action of the sea?*

Along the coasts of Scotland we find in many places level terraces of recent origin, from ten to fifteen feet above high-water-mark. They are formed of the sand and shingle carried up by the advancing billow, and left behind in those places where the debris thrown up by the sea is accumulating, and consequently where the land is advancing. Their height above ordinary high-water-mark depends on the height to which the billows rise at spring tides and in storms.

While the advancing billow throws up gravel and sand above high-water-mark, the retreating billow carries back similar material into the deep water. We might, therefore, expect to find level terraces formed under the water, as well as above its level. This is generally believed to be the case, and in that opinion the writer of these remarks formerly concurred; but farther examination shows that the currents that sweep along the shores of the ocean prevent such level formations, and throw up the debris carried down into the deep in irregular ridges and banks. The level terraces, or "ancient sea margins," from thirty to fifty feet above ordinary high-water-mark, though some speak of them as "ancient sea bottoms," seem all to have been formed by the advancing, and not by the retreating billow.

The terraces on the Somme seem to have been formed in like manner by the action of the sea. They are ancient "sea-margins," thrown up above high-water-mark by the advancing billows.

They cannot be ascribed to the action of river currents.

Mr. Prestwich's idea that the Somme at some former time carried to the sea a vastly larger body of water than it now does, is disproved by the fact that all the pebbles found in the valley appear to have been brought from the rocks which are found in the basin which it drains at the present time.

Even, however, if the volume of the river had been as large as that of the Ganges or Mississippi, the force of the stream would not have been sufficient to have brought down gravel. The Somme at Amiens, fifty miles from the sea, is only fifty feet above sea level, and there is no reason for supposing that it was different at a former time. No river current, with so gentle a declivity, as one foot in a mile, could bring down stones and gravel such as are found in these terraces, or could scoop out the hollow between them, as Sir Charles Lyell supposes.

In order to put the question more fully to the proof, let those, who look on these terraces as having been formed at the bottom of the river or frith, point out an instance of any such level having ever been formed under water, in any place exposed to the action either of river or of tidal currents.

We remark further, that if these terraces are the result of water flowing down to the sea, any large stone that may be found in them will have a bank or "tail" of sand behind it, and these tails will *all* point downwards to the sea. Stones also of a flattened shape will be found having an inclination to the sea. If the gravel has been thrown up by the action of the billows no such uniformity of inclination will be found.

QUERY THIRD.—*How was the valley originally formed?*

If we rightly understand the descriptions that have been given of it, the valley of the Somme may be regarded as a long, shallow, flat-bottomed trough. Its formation seems to be unique. Some valleys have originated in dislocation of the strata, through the action of subterranean forces; but here there is no trace of such dislocation. The valley has been hollowed out of a uniform level bed of chalk. Other valleys have been excavated by torrents from the surrounding hills, but here there is no evidence of any river-current capable of producing the supposed effect. We remark further, that valleys scooped out by river torrents become narrower as they get deeper, and though they may afterwards be filled with gravel or sand, the original channel cut out of the rock has always the character we have ascribed to it. Other valleys are formed by glaciers; but in the neighbourhood of the Somme there is no trace of glacier action, as far, at least, as the accounts given by Sir C. Lyell and Mr. Prestwich show.

If, as we said, we rightly understand the accounts given of the valley, there seems to be but one cause to which its formation can be assigned. That is the action of floating ice, carried backwards and forwards by a tidal current.

If we suppose the Somme, at first, to have flowed into the sea, through some little narrow creek, the ice formed on its surface, at a time when a boreal climate prevailed, must have rapidly worn away the chalk which formed its banks. When the mouth of the river gradually enlarged into a long narrow estuary, that estuary would be filled in a great measure with fresh water, which would be frozen over in winter. The flux and reflux of the tide would be like that which we find in the Solway Firth at the present time. It would produce very powerful currents, and give to the ice on its surface an impetus which a substance so soft as chalk could not resist. If the sides of the depression had been formed of any of the harder rocks, they would not only have been better able to withstand the shock of the floating ice, but the fragments broken off from them would have formed beds of gravel which would have lessened the force of the ice. The abraded chalk would be diffused through the water and carried out into the ocean; the embedded flints only would remain.

Since various considerations have led to the conlusion that a boreal climate prevailed at the time when the valley was formed, it seems no improbable conjecture to suppose that masses of floating ice, with sand and gravel adhering to the bottom and sides, were the means by which the excavation was originally formed.

Yours truly,

James Brodie.

ON THE ORIGIN OF VALLEYS.

To the Editor of the Geological Magazine.

Sir,—My friend Mr. Scrope, in his article "On the Origin of Valleys," published in your last number (p. 193), has rightly represented me as a convert to his opinions on that subject; but by remarking that I had *at last* acknowledged the correctness of his views, he might lead your readers to infer that I had obstinately maintained an opposite theory, until a very recent period.

It may therefore be worth while for me to appeal to the second edition of my "Descriptions of Volcanos," published so long ago as 1848, as showing, that although in my earlier publications I had been led by the authority of Professor Buckland to attribute the formation of valleys to catastrophic action, such as the Noachian Deluge, I had for many years abandoned that hypothesis.

This circumstance might of itself have been considered a tacit acknowledgment on my part of the value of Mr. Scrope's earlier contributions to Geology, but I was glad of the opportunity afforded by the publication of my recent paper "On the Antiquity of the Volcanos of Auvergne," of more distinctly recognizing the claims of the author alluded to, to the merit of having been the first of our countrymen who clearly pointed out the evidence afforded by the valleys of that volcanic district, as to the erosive agency of rivers continued during long periods of time.

CHARLES DAUBENY.

OXFORD, May 5th, 1866.

THE LONGMYND AND ITS VALLEYS.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—I have just read Mr. Mackintosh's paper in the April number, as well as his letter in the May number of the GEOLOGICAL MAGAZINE.

I am well acquainted with the Longmynd and its valleys, and I am still of the same opinion that I formed more than twenty years ago, as to the origin of those deep valleys, locally called "gutters." I feel not the slightest doubt that they were cut by running brooks. I know of no better locality to which I would refer for so good an example, to show the result of long-continued wear by running water, than the Longmynd with its deep valleys. If the brooks that now run in these valleys have the power to furrow even their bottoms, they require only time to cut down a thousand feet. I believe that the action of the sea could in no way excavate those valleys or any similar ones.

I may add, that after many years of constant observation in the field, on a subject I have always been particularly interested in, I feel now convinced that an immense amount of denudation is due to causes subaërial, and not to the action of the sea.

I am, Sir, yours truly,

W. TALBOT AVELINE.

GEOLOGICAL SURVEY OF GREAT BRITAIN,
EDEN MOUNT, KENDAL, 7*th May*, 1866.

A DENUDING AGENT.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—I have all my life been a diligent explorer of little brooks, in search, I must confess, of beauty rather than fossils. I have often been struck with the steady, and by no means unsuccessful, co-operation of roots of trees with the waters of a streamlet, in undermining and removing the banks. If you examine almost any one of the little tumbling rills among the mountains of the Upper Carboniferous formation, you will find it buried in trees. The fibres of the roots insert themselves in the smallest crack, and push themselves between the layers of rocks; and by degrees they thicken and grow strong, and lift huge masses of stone, with a seemingly irresistible force, loosening the earth at the same time above and below and around. The action of the rain easily washes away the earth, the little tree becomes a great tree, and, either because it is undermined beneath, or because the weight above becomes too much for its hold, it is sure to come down with a crash into the brook, carrying with it a large portion of the bank in its fall. The next flood removes all trace of the ruin. The sand and soil and the small stones are swept away, while the larger stones keep their places peaceably in the channel where they fell, to make fantastic waterfalls and still hollows for the minnows. Yours, etc.,

T. Ashe.

Leamington College, May 7th, 1866.

DENUDATION.—REPLY TO Mr. G. POULETT SCROPE AND Mr. J. B. JUKES.

To the Editor of the Geological Magazine.

Sir,—The appearance in your Magazine of two communications on Denudation renders it necessary that I should again trouble you with a few remarks before the completion of the series of observations on which I am now engaged.

Not having visited the localities described in your last number by the eminent author, Mr. G. Poulett Scrope, I can offer no opinion relative to the conclusions at which he has arrived. I should not think of underrating the power of temporary as well as permanent torrents, to excavate channels in the gravels of the Tyrol, Cumberland, Wales, or any country subject to waterspouts and heavy falls of rain; and I could agree with all that Mr. Scrope has advanced concerning the denudation of Auvergne, without requiring to recant any opinions I have advocated. The facts on which Mr. Scrope's reasonings are based, namely, the resistance offered to the atmosphere by the *basaltic cappings* of the mountains of Auvergne during an immense period of time which can scarcely be exaggerated, furnishes, perhaps, *the most convincing proof which can possibly be adduced, of the impotence of rain as a denuding agent on hard rocks,*[1] and ought to prepare our minds for believing that many of the inland sea-cliffs and rocks of England and Wales have retained their wave-worn shapes since the Glacial submergence, if not since a much more

[1] The phrase "impotence of rain," I have applied only to the action of mere rain on compact rocks and grass-covered land, and not to torrents, charged with solid abrading matter, and acting on exposed gravel, loose stones, or soft materials. When using the phrase, I was not alluding to volcanic or alpine districts where conditions are, or have been, *exceptionally favourable* to atmospheric denudation.

ancient occupation of the land by the sea. The same fact furnishes a presumption, in the absence of very strong evidence to the contrary, that those hollows and portions of valleys in Wales and the Lake district, which have been scooped out in rocks as hard, if not harder than the basalt of Auvergne, have not been excavated by any process of atmospheric denudation which is not admitted to involve such an enormous lapse of time as to allow the sea to outstrip it in its march, and take the work out of its hands. The sea has, comparatively, little difficulty with hard rocks. It insinuates itself into joints and crevices, undermines, detaches, and carries away the largest blocks in a wholesale fashion; whilst atmospheric agents, unless very powerfully assisted by gravitation, have to grind down, or break up, before they can effect that *transportation* which constitutes the main part of denudation. I have only farther, in reply to Mr. G. Poulett Scrope, to state that I have not denied the power of rivers to form cliffs, but asserted that there are many inland cliffs which the sea only could have formed.

The letter of Mr. J. B. Jukes displays the modesty of a true philosopher, animated solely by a desire to arrive at truth. Though, apparently, widely differing, I think we are more or less agreed on the following great fundamental points:—First, that in certain areas the sea forms plains and table-lands; that there cannot be plains without surrounding escarpments or acclivities, or table-lands without declivities or cliffs, in both cases more or less indented, and here and there shaped into bays and combes. Second, that in other areas the sea produces smoothly-swelling elevations and depressions, now and then varied by projecting rocks, or rocky knolls. Third, *that if certain* lands continue a long time above the sea, their coasts must be long exposed to the action of waves, tides, and currents, and that in this way great inequalities must be produced. Fourth, that in partially-submerged areas, sounds or straits must be excavated by tides and currents; and that these, on their being elevated, must become mountain gaps or passes (see Mr. Jukes's own admission in Quart. Journ. Geol. Soc., vol. xviii., page 391). I cannot therefore understand why Mr. Jukes should not admit that many escarpments and upland rocky cliffs (which are not the immediate sides of river-valleys); all our smooth curvilinear combes (which rain-torrents only tend to furrow, disfigure, and destroy); and many of our mountain passes, are not the result of marine denudation. Since I commenced making systematic observations in Central Wales, I have gradually been convinced of the necessity for allowing that ravines on the sides of table-lands have been mainly excavated by streams but these ravines are generally of the V form. A continuation of the process would, undoubtedly, wear down very deep valleys; but that wide and flat-bottomed valleys, and connecting gorges or passes, have been excavated by rivers, appears to be contradicted by the fact that, in those I have examined, there is an absence of true river shingle at any great height above the present river level. In many parts of the upper valley of the Wye, especially between Builth and Rhayader, I have found river-shingle running up to heights, varying from a few feet to 150 feet above the river, and either gradually or suddenly succeeded by the angular drift of the neighbouring mountains, and that with little or no change in the inclination of the acclivity.

Mr. Jukes, in attacking the great seeming objection to the fluvial origin of valleys, namely, the necessity for believing that a river must have wandered over, and excavated a large plain during the time that its action, in a contiguous area, was limited to the wearing down of a narrow gorge, endeavours to explain the disparity by reference to the more easily eroded rocks composing the area of the plain. In Ireland he believes that the Carboniferous limestone was the easily denuded rock, and the Old Red Sandstone, or some other silicious formation, the comparatively resisting rock. But, I think, in many districts, this explanation would not hold good. In the case of the plain of Herefordshire, and the narrow gorge of the Wye between Ross and Chepstow, it would require to be reversed; for there the plain is Old Red Sandstone, and the sides of the gorge Carboniferous limestone. Farther up the Wye, I do not think Mr. Jukes' explanation would apply; though on this point I would wish to speak with deference, and with the greatest willingness to be corrected.

The gorges or passes connecting the vales of Central Wales look as if they were more *recently* excavated than the vales themselves. They cut abruptly, and without any warning, through the ridges by which the vales are separated. Their commencement is as sharply defined as if they had been sliced out of the ridges, and I cannot help thinking that they have been widened, and their sides rendered more precipitous, by the action of the sea during the glacial period of submergence. At the same time, probably, the cliffs of Aberedddw (which, in many respects, are perfect fac-similes of cliffs now washed by the sea on the Cardiganshire coast), were formed and upheaved in succession. It is quite true that all this implies the previous existence of the valleys on a smaller scale; but on this subject I cannot enter farther at present. Its elucidation would require a re-examination of the nature and distribution of the various kinds of drift by which a great part of Central Wales is covered from the mountain top to the lowest depression.[1]—I am, Sir, yours truly,

D. MACKINTOSH.

DOLGELLY, 9*th May*, 1866.

LEPIDOSTROBUS BROWNII.[2]

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—In the interesting paper by Mr. Carruthers, which appeared in the October number of your Magazine, I was glad to see that he distinguished the beautiful specimen of Dr. Robert Brown (who had shown it to me during his lifetime,) from the *Lepidostrobus* described

[1] There are several very important points in Mr. Jukes' letter, the consideration of which I must reserve for a future, and more systematic communication.

[2] See *ante*, p. 271. Report of the Manchester Geological Society.—This letter was accidentally omitted from our last number.—EDIT.

by Dr. Hooker in the Memoirs of the Geological Survey. There is evidently a marked difference between the two specimens. Dr. Brown's came from France, and he states that M. Brongniart had in his possession a similar one from Strasbourg. However, nothing was known of the locality or formation from which these specimens were obtained. I had little doubt in my mind that they came from the Coal-measures, but I had no evidence to prove the fact. A short time ago Mr. Wilde, of Oldham Edge, allowed me to slice a *Lepidostrobus* obtained by him from a nodule found in the Upper Foot coal of Oldham, the same seam from which I have for a long time obtained specimens, and I met with evidence which established its identity with *Lepidostrobus Brownii.* The size of the specimen, the form of the sporangia, and their arrangement around the central axis, as well as their contents, a great numbers of spores, showing a triple arrangement of sporules, are the same in both. The central axis of the strobilus affords evidence of similar structure to that found in the stem of *Lepidodendron vasculare* described and figured by me in the "Quarterly Journal of the Geological Society" for 1862, namely, hexagonal tubes having all their sides bound by transverse striæ and by wanting the internal radiating cylinder found in *Sigillaria vascularis.*

I am, yours truly,

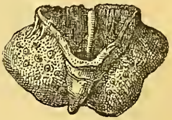
EDWARD W. BINNEY.

MANCHESTER, March 21, 1866.

GONIOPHYLLUM IN THE WENLOCK SHALE.

To the Editor of the GEOLOGICAL MAGAZINE.

DEAR SIR,—It may be interesting to some of your readers to know that Mr. L. P. Capewell of Dudley has found a very perfect example of the *Goniophyllum pyramidale,* His., (and of which I enclose a drawing) in the Upper Wenlock Shale of Dudley. It appears to be the first example of this interesting fossil hitherto discovered in our British Silurian rocks, and is attached to a specimen of *Heliolithes.* It agrees well with a young Swedish example of *Goniophyllum pyramidale,* described and figured by Herr Lindström (pl. xxx., fig. 4) in his excellent memoir on "Zoantharia Rugosa." Having submitted a carefully made drawing of our English specimen to Herr Lindström, he has entirely concurred with the identification here given.



GONIOPHYLLUM PYRAMIDALE, HIS.
UPPER WENLOCK SHALE, DUDLEY.

I am, Dear Sir, yours faithfully,

THOS. DAVIDSON.

REMAINS OF PREHISTORIC MAN IN CENTRAL INDIA.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—I intended to have sent you a notice of my having found, on the bank of the Godavery river, south of Arungabad, traces of worked flint or agate implements. Some uncertainty existed at first, as I had but one specimen. Its transmission to Calcutta for identification, and other things occurring during my subsequent wanderings, prevented my writing until reminded by an allusion to the circumstance in your Magazine for February[1] (p. 93).

After a long march in November last across the steppes of the Deccan I accompanied my colleague, W. T. Blanford, Esq., to the Godavery, in the vicinity of Pyton (or Paitan), to search for further evidence regarding bones of *Elephas* found there several years ago by (then) Major Twemlow. In this we were not very fortunate; but searching the river bed, and its high alluvial banks, resulted in the discovery of several portions of smaller fossil bones and teeth, both of Carnivores and Ruminants, thus proving the similarity between the Godavery alluvium and that of the Nerbudda and Taptee rivers.

While searching in the right bank of the river, just below the houses of Moongie village, where the alluvial cliff has a height of fifty feet or so, I came upon a stratum of uncompacted subcalcareous conglomerate, gravelly, and containing numerous shells of similar species to those now inhabiting the river, in other respects quite similar to the recent conglomerate so frequent in the alluvium of Indian rivers. Imbedded in this I found the specimen referred to, one of the fragments or flakes struck from a flint or agate implement or core, a few inches in length, slightly curved, and somewhat of a knife-like form. I searched in its neighbourhood in vain for other specimens, and kept a sharp look out for more on my way up the river, but could find nothing at all satisfactory amongst the numerous agates and fine blood-stones which crowd the ordinary trappean débris of the river.

The place in which the flake was found is about twenty feet above the base of the alluvial cliff, and it is, perhaps, likely that an extensive search, aided by excavation, might bring to light others, or the implements themselves.

The portion of the river examined did not exceed in length from fifteen to twenty miles, so that an ample field yet remains to be explored. Truly yours, S. B. Wynne,

Geological Survey of India.

Camp Jungles of Central India,
March 20, 1866.

MISCELLANEOUS.

New Minerals.—In the "Comptes Rendus" for March 19th, M. Pisani describes a Cornish mineral to which he gives the name *Chenevixite.* It is an arseniate of copper and iron, the iron being in the state of ferric oxide. M. Pisani gives it hardness as 4·5, and its density as 3·93. The colour is a blackish green, and the fracture conchoidal.

[1] Mr. Wynne's name, we regret to observe, was mis-printed as Bynne in the February number at page 94.—Edit.

According to our analyses of this substance it would appear to be a variable mixture of several minerals. M. Pisani himself finds ten per cent. of intruding silica in it.

Adamite, a new and interesting hydrated arseniate of zinc is also described in the "Comptes Rendus" for March 19th. M. Friedet's analyses of this species points to the formula—

$$\dot{Z}n_3 \, \overset{\cdot\cdot\cdot}{\ddot{A}}s, \, \dot{Z}n \, \dot{H}.$$

In the new notation, with the higher atomic weights adopted by Cannizzaro, this expression may be given—

$$3 \overset{\prime\prime}{Z}nO, \, As_2O_5, \, \overset{\prime\prime}{Z}nH_2O_2.$$

Adamite is similar in crystalline form and in constitution to olivenite. It occurs with native silver, limonite and calcite at Chañarcillo, Chili. The crystallography of adamite has been worked out by M. Des Cloiseaux. Knop has described under the name of *Paclinolite*, a mineral occuring in Greenland with cryolite, and presenting a weathered aspect. It differs from cryolite chiefly by containing calcium.—A. H. C.

Ferrous Chloride in a Mineral Water.—In one of the saline waters of Harrogate, known as the "Cheltenham saline chalybeate," Dr. Hofmann, twelve years ago, ascertained the presence of 4·63 grains of ferrous carbonate (proto-carbonate of iron) per imperial gallon. Dr. Muspratt, of Liverpool, has recently examined the water derived from the same spring, and he now finds it to contain 10.84 grains of ferrous carbonate per gallon, and, in addition to this iron compound, he has detected ferrous chloride to the amount of 16 grains per gallon. The salts contained in the water seem to be almost entirely chlorides; in the gallon there are 454 grains of various chlorides, including 7·72 grains of chloride of barium, a salt of which traces only occur in other strong saline springs.—A.H.C.

Comparative Analyses of the Mediterranean, Red Sea, and Dead Sea, by MM. Robinet and Lefort.—The results give the percentage composition of the solid residue obtained by evaporation:—

	Mediterranean.	Red Sea.	Dead Sea.
Chlorine	52.92	50.33	65.78
Bromine	1.14	1.11	1.25
Sodium	31.15	30·92	11.22
Potassium	7.00	3.33	3.71
Calcium	1.18	1.16	5.67
Magnesium	3.62	3.54	12.59
Sulphuric Acid	6.42	6.35	1.05

—*Chemical News*, May 11, 1866.

Recent Earthquakes.—1. The first shock of an earthquake at Chittagong, Bengal, was felt on December 15th, 1865, at 6.50 p.m., and between that time and 2 a.m. on the 20th of the same month, twelve distinct shocks were felt, of various degrees of intensity. In Thannah Roajan the earth's surface cracked in several places and poured forth jets of water and a fine dark grey-coloured sand. No sand has ever been found in the deepest excavations, either at that spot or within many miles; so that it must have been forced up from a great depth. The heaps of sand thrown out varied from the size of a molehill up to twelve feet in diameter, and three feet deep. At the cessation of the shocks the large sand-heap was still wet and the ground showed signs of having been recently flooded. The water rose some inches from the ground, and so far as could be ascertained, it was cold. It appears that there are in the neighbourhood several "burning wells," which are supposed to be connected with volcanic agency, but none of them exhibited any change during the earthquake.—2. On March 9th, at 2 a.m., an earthquake was felt at Christiania, in many places in Norway, along the west coast at Verblungäs and Drontheim, and the tower of Frauenkirche rocked so violently that the bells began to ring.—3. The earthquake felt in Norway on March 9th appears to have extended as far as the Shetland Isles. The keeper of the lighthouse on the Flugga rock, which is situated about a mile and a half north of Unst, reports that at 1.20 a.m. on the same day, the tower began to shake terribly, and continued doing so for thirty seconds. There was no wind or sea to cause the vibration, and it must, therefore, be attributed to the shock of an earthquake. If the shocks felt at the Shetlands and Norway are in any way connected, they must have proceeded in a north-easterly direction from the former to the latter place, occupying a period of forty minutes—the wave having a velocity of about seven or eight miles per minute.—*Reader.*

Coal in China.—Extensive mines of coal exist in the mountains to the north-west of Pekin. Three varieties of coal are obtained, called dry, smoke, and white coal respectively. The dry coal is a sort of coke, and is admirably adapted for all household purposes. The smoke and white coal are well suited for and employed by steamers.—*Journ. Soc. Arts.*

Geological Map of the Coal District of Westphalia and the Rhine Provinces.—This Map is about to be published by the Directors of the Westphalian Mine Association. In the prospectus it is stated that the annual yield of the district equals about one-eighth of the total annual product of Great Britain, and that Westphalian Coals are superseding those imported by Germany from England and Scotland.

Ornithichnites in the Liassic (?) Formation of Kansas.—Mr. B. F. Mudge, late State Geologist, has recently discovered footprints of birds in sandstone of Liassic (or later) age, on the banks of the Republican River, Kansas. The tracks are referrible to two species of birds, but no names are given to them. No other tracks, no fossils, no imprints of rain-drops, nor any other peculiarities common to the Connecticut deposits were found associated with these tracks.—*Amer. Journ. Science, March,* 1866.

Academy of Sciences, April 23.—M. Berthelot presented a note "On the Origin of Carbides and Combustible Minerals." Starting with the hypothesis of M. Daubrée, that free alkaline metals may possibly exist in the interior of our globe, M. Berthelot supposes that carbonic acid, everywhere infiltrated in the crust of the earth, may come in contact with the alkaline metals, and give rise to the formation of acetylides. The alkaline acetylides acted on by steam, would give free acetylene. But acetylene cannot continue to exist under the conditions supposed, and in its place we obtain the products of its condensation,—bitumens, tars, petroleum, etc. Thus, the author conceives a purely mineral origin for these natural carbides.—*Chemical News,* 5th May.

Oil Well in Russia.—A very rich oil-well has just been discovered in the district of Natuchaitz, on the shore of the Caspian Sea. After boring a depth of 120 feet in solid rock, a stream of oil made its appearance, and flowed for twenty minutes. This was followed by a deafening noise, accompanied, it is stated, by a slight earthquake, after which, a jet of clear water, very saline, burst forth with great violence, and continued running for nearly half an hour. Since then from 1500 to 2000 pailfuls of oil have been drawn out.—*Colliery Guardian, April* 7, 1866.

Siberian Mammoth.—Another specimen of the *Elephas primigenius* has been discovered in the bay of Tazooskaia, in the government of Tomsk. The flesh, skin, and hair are said to be in a perfect state of preservation. A commission has been named by the Academy of St. Petersburg for the purpose of taking measures to disinter the monster and remove it to St. Petersburg. It was discovered accidentally. A native in search of some domestic animals which had strayed, perceived a great horn sticking up in the midst of a marshy moor. In his endeavours to remove it, he broke the horn and perceived a piece of skin from the head, which was covered with reddish hair nearly three inches in length.—*Public Opinion.*

Does the Earth Increase in Size?—M. Dufour, speculating on the cause of the secular acceleration of the moon, calculates that, to account for it, the mass of the earth must be increased in a hundred years by $\frac{1}{114,400,400}$th of its weight. The increase must be occasioned by the accession of meteoric dust, about two cubic metres of which must fall on every hectare of the earth's surface annually. This appears enormous, but it is still more astonishing to read that this meteoric dust lies in parts of England a foot deep. It is derived from the millions of shooting stars which are burnt to dust every day in the earth's atmosphere.—*Chemical News,* May 4, 1866.

The Three Prehistoric Periods of the Stone-age.—Subject to many exceptions, the prehistoric implements may be grouped into three great divisions—namely, those of the Surface, the Cave, and the Drift. In the most recent of these, the Surface-period, where the implements are most commonly found in association with the battle-field or the sepulchre, the work of assigning the relative age lies chiefly with the archæologist, and this is to be determined by their types, the presence of other industrial products, or the circumstances under which they are found, though occasionally the associated animal-remains give some clue to their antiquity. In the next more ancient, or Cave-period, an age prior to the construction of habitations for the living, or of receptacles for the dead, and in which the traces of other and more advanced industries are but rare, the task of indicating their antiquity falls mainly on the palæontologist, and the fauna (sometimes of animals extinct locally prior to either history or tradition, but whose remains are found in indubitable association with those works of man) is his only certain guide—the more so, as sometimes the types of the implements found on the same spot take a wide range, from those until lately supposed peculiar to the Drift, and down to those hitherto assigned to the earlier part of the Surface-period. In the earliest period, that of the Drift, the archæologist finds not the slightest trace of other human industry to guide him; and the work of the palæontologist is less determinate; it rests with the geologist, by indicating the changes which have occurred in the very land itself, to shadow out the period in the dim distance of that far antiquity when these implements, the undoubted work of human hands, were used and left there by primeval man.—*Reliquiæ Aquitanicæ,* Part II.

OBITUARY.

Dr. Nils Nordenskiöld.—We have to record the death of this eminent mineralogist and geologist at Frugard, near Helsingfors, Finland, on the 21st February, in his 73rd year. Dr. Nordenskiöld was a pupil of Berzelius, and from an early age devoted himself to the study of mineralogy. After having made several scientific visits to foreign countries, he was, in 1824, appointed by the Emperor of Russia chief director of the mines of Finland, in which office he continued until 1855. In recognition of his scientific merits, he was elected a fellow of several foreign societies, amongst others the Geological and Geographical Societies of London. One of his last and most important labours is a map of Finland, showing the direction of the flutes and grooves made by the ice on the surface of the rocks. It is accompanied by a memoir "Beitrag zur Kentniss der Schrammen in Finland," Helsingfors, 1863. (See Sir Roderick I. Murchison's Anniversary Address to the Geographical Society, 1864, p. 236). His labours as a mineralogist in Finland are noticed in a paper "On the Rocks and Minerals of Finland," by the late Mr. G. E. Roberts, F.G.S. (see Geological Magazine, Vol. II., p. 534). One of his surviving sons is Professor Adolf Nordenskiöld of Stockholm, the ardent explorer of Spitzbergen and its geology.—G.L.

Dr. C. T. Gaudin, of Lausanne.—Intelligence of the death of this eminent Swiss geologist has just reached us. He was well-known as the author of many original papers, principally relating to the fossil plants of Italy. In 1863 he was elected a foreign correspondent of the Geological Society of London.

THE

GEOLOGICAL MAGAZINE.

No. XXV.—JULY, 1866.

ORIGINAL ARTICLES.

I.—On an Ancient Coast-line in North Wales.

By Miss Eyton.

THE Coast-line which I am about to describe extends from the Vale of Clwyd, in Flintshire, to the Great Orme's-head Mountain at the northern end of the Menai Straits.

The Vale of Clwyd is an ancient bay or estuary some five or six miles in width at the mouth, and narrowing gradually as it winds inland. The hills on either side of the valley are low and rounded at the summit, showing that they were once totally submerged. Immediately above the present beach is a tract of reclaimed land, composed of sea-sand, lightly coated in some parts with vegetable earth, and containing nearly perfect remains of many recent shells. On the neck of land which connects the Great Orme's-head with the mainland of Carnarvonshire, I picked up tolerably perfect specimens of *Mytilus edulis*, *Cardium edule*, *Venus*, and *Patella vulgata*, curiously intermingled with the land shells *Clausilia* and *Bulimus*.

Underlying the sand is a bed of Boulder-clay of uncertain depth, thickly charged with small, round, scratched pebbles. This, so far as I am aware, contains no organic remains. It is, in many parts, closely perforated by *Pholadœ*. On the Conway side of the neck of land before alluded to, some good sections are exposed. I here insert one.

	Ft.	In.
Vegetable earth, ...	1	0
Sea-sand, ...	0	2
Dark vegetable earth, ...	3	0
Sand, ...	2 to 3	0
Boulder-clay, charged with pebbles, about ...	10	0

Thus, after each bed of soil had been formed by the growth and decay of vegetable matter, it was covered by sand which drifted over it from the beach. I may mention that the isthmus, situated as it is between the two bays of Llandudno and Conway, is peculiarly exposed to the influence of high winds.

Rising above the level of the Boulder-clay, and of the superficial deposits which cover it, is a wall of Carboniferous Limestone, continuing from the Vale of Clwyd, round the western circle of Llandrillo bay, until it terminates in the Little Orme's-head Mountain, which separates the bays of Llandrillo and Llandudno. It is broken by many a gorge or rocky valley, evidently scooped out by the former action of the waves. Such is the Vale of Llandulas, which is merely that of Clwyd on a smaller scale, and such the rocky dells above Abergele and Colwyn. They are at present occupied by small mountain streamlets, quite insufficient to have worn such valleys in the Mountain Limestone—one of the hardest of stratified rocks. They were, more probably, originally commenced by the action of water from the land, and then the waves, rushing in at the entrance thus provided for them, scooped out and enlarged the former channel until it became an inland fiord, winding for several miles into the country. The sea, true to its law of always working on the weakest part, turned aside from the more powerful obstructions to seek a place which offered less resistance to its force, thus forming numerous sinuosities.

At the entrance to the Vale of Llandulas, there are several caves, the largest of which (called the Giant's Cave) would seem to have been the course of an underground streamlet, meeting the sea in the manner above described, and forming, what is, in fact, a minute subterranean fiord. The extent of this cave is unknown. It is entered by a lofty Norman arch, supported by rounded buttresses, which, peeping out from amid the foliage, and overgrown with ivy, almost give the idea of the entrance to some ruined fortress.

And now, passing over the headlands of Penmaen rhos, and the Little Orme's-head, we arrive at the larger mountain of that name. This is a huge outlier of Carboniferous Limestone 750 feet in height, nearly six miles in circumference, and three in diameter. The base of the mountain is literally honey-combed with caves, enormous limestone boulders strew the shore, and numerous landslips occur on the sides of the mountain. A finer field for the student of physical geology I can scarcely imagine.

Between 200 and 300 feet above the present sea-level, occurs the old coast line, which has been noticed by the Rev. W. S. Symonds, F.G.S., in a paper published in the "Llandudno Guide," but without specifying particulars. This is well marked throughout the circumference of the mountain by the continuous line of rounded projections and recesses scooped out by the sea. The line is unbroken, save by an occasional landslip, or in one or two places where the hand of man has been at work; but on the south-western side, at the same level, there is a range of caverns, small in size, but clearly produced by the same agencies as those now at work on the cliffs beneath. At the time I visited these caves, they were only accessible by a steep and somewhat dangerous scramble from the shore below, being situated in the most remote part of the mountain, where the foot of man rarely treads; but I was amply rewarded by finding a bed of loose shingle, exactly resembling that which forms the present beach.

At about the same level as these caverns, but nearer to the town of Llandudno, we find several large masses of rock, known as rocking stones, or cromlechs, but which may have been formed by the waves washing away the softer portions of the stone, and leaving only those parts which were hard enough to resist their violence; in the same manner as that by which Mr. Mackintosh describes the Brimham rocks to have been formed.[1]

A much larger cromlech may be seen in the grounds of the Marquis of Anglesea, at Plas Newyd, on the Menai Straits.

Note.—During the last few centuries, the ocean seems to have regained some of its lost dominions. At the base of the Great Orme's-head, on the Conway shore, being that least exposed to storms, a bed has been formed of angular fragments of Mill-stone Grit and earth. Similar beds are found in several parts of the mountain. This bed, which was probably then of considerable extent, was chosen by the ancient Bishops of Bangor as the site of a palace (Gogarth). It has, however, been gradually undermined and carried away by the waves, until the ruins of Gogarth are now situated upon the edge of a precipitous bank, washed by the sea, and in a short time will be themselves carried away. In like manner, what was the old town of Pensarn, in Denbighshire, is now reduced to a few fragments of stone wall, which are daily overflowed by the tide.

II.—On Traces of Glaciers in the English Lakes.

By Rev. T. G. Bonney, M.A., F.G.S.

ALTHOUGH the causes of the configuration of the Lake district have been discussed by Mr. Mackintosh in some interesting communications to this Magazine, and the distribution of the granite blocks from Wastdale Crag formed the subject of an able paper read by Professor Phillips to the British Association at Birmingham, 1865, the glaciation of this region seems scarcely to have attracted the attention which it deserves. In the hopes, then, that some one may be induced to do for Cumberland and Westmoreland what Professor Ramsay has done for North Wales, I venture the following remarks; although, owing to want of time and other causes, they are far less complete than I could wish them to be.

To commence with Windermere; two valleys unite near the head of this lake; the one, that in which lie Grassmere and Rydal Water; the other, that which is drained by the river Brathay, and is also bifurcated. The extremity of the mass which divides these two valleys is called Loughrigg Fell. The general contour of this hill and most of the others near Ambleside and in the neighbourhood of Rydal Water is very suggestive of glacial action, but I sought for some time without finding any satisfactory proofs. At last, however, I fell in with a most unmistakeable boss of ice-worn rock,

[1] Geological Magazine, 1865, Vol. II. p. 154.

on the north side of St. Mary's Churchyard, Ambleside. On following up the right-hand branch of the Brathay Valley (Great Langdale), I found, near Chapel Stile, a mass of debris which very probably is part of an ancient moraine. Near the same village are a considerable number of well-defined roches moutonnées. Throughout all parts of the district at the head of Windermere, which I examined, there appeared to be a remarkable scarcity of both moraines and perched blocks. It is possible, indeed, that these may have been swept away by subsequent denudation, but the very perfect state of the above-mentioned roches moutonnées seems to render this improbable. I am, therefore, inclined to think that the nature of the rock in the neighbourhood must have rendered them always unfrequent; it being a splintering slate, which rarely forms cliffs of any height, or large masses of screes. To the same cause may be attributed the effacing of the glacial marks on the hillsides. The contour, however, of Loughrigg Fell leads me to think that it must have once been almost covered by glaciers. During a short excursion to Patterdale, I observed rounded rocks at the head of it and Ulleswater.

The road from Ambleside to Keswick, as is well known, passes through the gap of Dunmail Raise, and descends by the right bank of Thirlmere. On the left bank of the stream, opposite to the little inn at Wythburn, a very fine rounded rock can be seen from the high road. On each side of Thirlmere traces of ice-action are very distinct, especially on the right bank; first on the right hand, and then on the left of the road. The green slates and porphyries of Borrowdale and the head of Derwent Water, have retained the marks of nature's ice-chisel better than those described in the preceding paragraph.

Following the right bank of Derwent Water we come to the Lodore Fall, where a stream which drains an upland glen some three miles long descends to the lake. This glen appears to have been once occupied by a glacier, perhaps to a height of 300 feet above the present bed. The main outlet of the ice was not by the chasm of the Lodore Fall, but by an opening which leads down to the main valley some distance higher up. This is shown by the extensive tracts of ice-worn rocks in the opening, and by some perched blocks high on its left bank.

At the little hamlet of Grange there is a magnificent smoothed rock, just on the left bank of the stream. Above this a rocky barrier extends nearly across the valley; over it the glaciers which have descended from the Stake and Styhead Passes have forced their way, rounding and scoring its crags in their passage, and leaving their traces high up on the hills on either side. Beyond this barrier the valley opens out into a level plain, which I have little doubt was once, after the retreat of the glacier, occupied by a lake. After crossing the ridge of Borrowdale Haws similar traces of ice-action may be seen near Buttermere.

Returning to Grange in Borrowdale, and taking the road on the left bank of Derwent Water, one meets with constant traces of the glacier, extending, I think, not less than 400 or 500 feet up the hill-sides. Near a farm-house, about half a mile from Grange, are some scratched and rounded blocks, with several *blocs perchés.* On one of the former, a smoothed boss of slate, by the road side, the glacial *striæ* may be seen arranged in parallel flutings pointing down the valley. These are crossed at an angle of about 45° by the cleavage planes, and the whole mass is traversed by two systems of joints, which intersect one another at about the same angle.

The soft slate of Skiddaw is unfavourable to preserving marks of glacial action, and, besides this, its southern face is too steep to have allowed of any great accumulation of snow. The ice-stream from the Derwent Valley would probably sweep under its cliffs, then no doubt streaked with *couloirs* of snow, towards Bassenthwaite. The glacier, indeed, may possibly have divided, and an offshoot have extended some distance up the Greta, where it may have met the ice-stream from the vale of St. John. Near to Threlkeld station I saw, when leaving the district, a number of large blocks scattered over the slopes adjoining the railway, which, I think, could only have been deposited by means of ice. They may, perhaps, denote the position of the terminal moraine of the glacier which, after passing over Thirlmere, descended the vale of St. John.

These are all the notes which I was able to gather during my stay in the Lakes, but I have little doubt that a more careful examination would make it possible to map out approximately the glaciers which once filled the greater part of many valleys in the mountain districts of Cumberland and Westmoreland.

III.—The Terraces of the Chalk Downs.

By G. Poulett Scrope, Esq., M.P., F.R.S., F.G.S., etc.

MR. MACKINTOSH (Vol. III., p. 69, and p. 155, of the Geol. Mag.) adduces the preservation of numerous terraces on the hill-sides in the Cretaceous districts of 'Wilts. and Dorset,' as "evidence of limited subaerial denudation since those terraces were formed," for that they are "raised sea-beaches," he says, admits of no doubt.

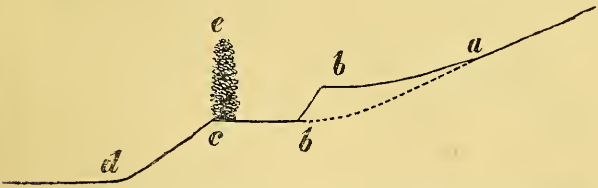
I venture to say that a more preposterous idea has seldom been started for the confusion of geologists.

Being a Wiltshireman I am well acquainted with these terraces, which are not confined to the Chalk-hills, but are found also among the Oolitic Cotswolds, and many other formations, where the hill-slopes and the nature of the subsoil are favorable to their formation. And I have no hesitation in declaring them without exception of artificial origin, worn by the plough, at a time when these slopes were, if they are not still, under arable cultivation.

I had supposed this to be the generally received opinion, and, as such, hardly worth sustaining by argument, until the doctrine of their being sea-worn cliffs, or raised beaches, dating from a time, therefore, when the vales and hills of England lay below the ocean, was put forward as a certain fact by Mr. D. Mackintosh. But since I am not aware that the precise mode of formation of these terraces (locally called Linchets or Balks) has been anywhere clearly explained, it may be worth while to take this opportunity for doing so.

Any one who lives in a neighbourhood where these banks occur may see them, if not in course of formation from their beginning, yet growing yearly before his eyes; that is to say, wherever the slope *above* the bank is under arable cultivation. In this case as the course of the plough almost always follows the more or less horizontal trend of the surface, which is always the direction of the banks, the ridge of soil raised by the mould-board of the plough has everywhere a tendency, through the action of gravity upon it, to fall down-hill, never upwards. This down-hill tendency of the disturbed soil is greatly assisted by the wash of heavy rains upon the sloping surface, and the result is that, year by year, the whole surface soil of the slope, when under continuous arable culture, is, slowly, indeed, but surely, travelling downwards, until it is stopped by some hedge, or wall, or bank, which limits in a downward direction the disturbing action of the plough. Hence it is that wherever a hedge or wall forms the lower limit of any arable surface, with a considerable inclination, an accumulation of mould or made earth will be found, often several feet in depth, and by that much elevated above the surface of the soil on the lower side of the fence. In the meantime the upper parts of the slope, losing their vegetable mould, get poorer and poorer, the plough works nearer the bone (as farmers say), and the soil is there only recruited by contributions levied from the subsoil or triturated rock beneath. The thrifty farmers of Devonshire therefore often employ their idle hands and teams in winter in digging out the soil that has descended to the bottom of their steep fields and carting it up to the top again—thus restoring the balance and maintaining the fertility of the upper portion.

But, it may be said, the ordinary linchets of the chalk-downs have no hedge or wall along their lower boundary, which might act as a material obstacle to the descent of the soil before it reaches the very bottom of the combe or vale. True; but though it might be said in reply that fences may formerly have existed there, it is in no degree necessary to suppose this in order to account for the origin of the banks. We know that in early times the arable lands of the greater part of England were held as in severalty by different tenants or owners. We know, too, that, on the arable Common-field system, nothing was more usual than for the same owner or occupier to possess and cultivate several distinct strips or breadths of land separated from one another by the lands of others. Let us assume that a hill-side in one of these terraced districts was held in three or four strips of land, lying one above the other, by distinct occupiers—the strips being, for the sake of convenience in ploughing, longitudinal in form, that is, having their greatest length in a horizontal or nearly horizontal direction, following the sweep of the hill-side whether curved or straight. The boundary line between these several strips may have been originally only a mathematical one, connecting, say, two mere-stones, and yet a bank will soon have been formed along it. For each *upper* cultivator will naturally have taken care not to allow the soil of his strip to descend to fertilize his neighbour's below. He would draw the lower limit of his strip by a reversed furrow, throwing the last ridge of soil up-hill, and thus leaving a slight trench, sufficient, however, to stop the silt washed down from above, which consequently would accumulate there in a bed perhaps an inch or two only in depth. But the next year, or on the next ploughing, the process is repeated. The cultivator again purposely checks the descent of silt by a double boundary furrow; and by degrees a slight bank of earth is formed, which, in the progress of years, increases into a linchet or balk several feet in height, with a somewhat flattened terrace above. This is not mere theory. I have often watched the growth of such banks, and even witnessed their formation from the beginning. It is notable, indeed, with what rapidity they are produced. For instance, I own a steeply sloping field, which was formerly rough grass-land, having a hedge at its base with the usual bank of earth on the upper side raised some five feet above the level of the surface on the lower side. Along that upper side of the hedge runs a public footpath. I gave leave to my tenant to plough up the grass slope, which he has now done for about ten years past, and the result has been the formation of a new bank, or linchet, as it may be called, from two to three feet high, above the footpath which has remained unchanged at its original level. See the illustration below, where the dotted line represents a section of the surface before the plough had broken it up, the firm line, that of its present form; *a b* is the newly formed terrace,



b b the new balk or linchet, *c d* the older one, *c b* the footpath, *c e* the hedge. The bank and terrace *a b b* are of course composed of soil washed down from the upper slope in the manner above described in the course of ten years ploughing, and the undisturbed position of the footpath shows that the fence has had no influence in producing the bank, which can only have been formed by the gradual accumulation of the soil washed down from above in the lowest furrow turned by the plough above the path. The slight ridge of grass that would naturally grow up on the outward edge of this furrow would alone suffice to check the descent of the silt into the path, and cause it to settle above.

This, I have no hesitation in asserting, is the simple explanation of the origin of the "thousands of *raised sea-beaches*, many of them only a few feet in height, which may be found in Wiltshire, Dorset, and other counties," according to Mr. D. Mackintosh (Geol. Mag. Vol. III., p. 69). Were they raised sea, or, indeed, river-beaches, they would be found composed of shingle or rolled pebbles. If sea or river-worn cliffs, they would consist of chalk, or other rock *in situ*. But on the contrary, they will be found on investigation, I believe invariably, to be composed of made earth, or soil, such as would naturally result from the downward wash of the slopes above annually broken up by the plough through a series of years, and exposed to the influence of subaerial denudation, so that, in fact, these terraces brought forward by Mr. Mackintosh as 'proofs' of the impotence of rain in moulding the earth's surface, afford on the contrary very pregnant and convincing evidence of its power in altering the configuration of our hill-slopes within very recent and limited times.[1]

IV.—Remarks on some "Sarsens," or Erratic Blocks of Stone, found in the Gravel, in the Neighbourhood of Southampton, Hampshire.

By Lieut.-Col. W. T. Nicolls.

(PLATE XIII.)

My knowledge and observation of facts are neither of them sufficient to enable me to determine the mode of deposit of these blocks in their present sites; probably they may have been glacially transported, at the same time with the gravel, to the places where they are now found; or, possibly, they, or some of them, may have been swept away from their original localities in the Tertiary formation, by a flood, or floods, general or partial.

I have taken specimens of only four of these blocks of stone: these are all similar in appearance,being of a small-grained, heavy, and whitey-brown saccharoid sandstone, two of the specimens contain small, partially rounded flint pebbles. There appears to me, to be no evidence of pluvial, or fluviatile action in the deposit of these gravels and stones in the neighbourhood of Southampton, nor have I observed such gravels (high or low level, old or new) to have been laid bare, or denuded, by either of the above now existing causes.

The neighbourhood of Southampton, to the north or north-west, may at one time have been an estuary, but not the bed of a river; and the levels of the country around it, must have at that time stood generally lower relatively to the sea-line, than they now do, or the sea itself must have been, at least temporarily, higher, to admit of gravel having been deposited everywhere about it; and there might

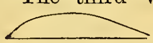
[1] "This is well exemplified where a hill-side has been cultivated. Man, while he cultivated it, acted as the destroyer, and Rain only as a *carrier* to take away part of the soil that man had rooted up. If man ceases to cultivate that mountain side, Rain causes plants to grow," &c. [Extract from Mr. G. H. Kinahan's Letter, Geol. Mag., Vol. III., No. 19, p. 46.—Edit.]

THREE BLOCKS OF TERTIARY SANDSTONE,
FOUND IN A GRAVEL-PIT AT BEVOIS-MOUNT, SOUTHAMPTON.
(preserved in the Hartley Institute, Southampton.)
Engraved from a Photograph in the possession of Lieut. Col. Nicolls.

also be evidence of the upheaval of part of the country during the period when the gravel was deposited, as shown by the presence of similar (?) gravel on both the elevated and low grounds around. The operation of simple denudation to produce the valleys, being excluded from consideration, unless we suppose that the Bracklesham Beds (No. 15 of the Ordnance Survey Geological Map, No. XI.), of which the country hereabouts consists, to be here more than 160 to 180 feet in thickness; and, even then, it would be difficult to explain the recurrence of *similar* gravel on the hills and in the denuded valleys. I do not, in the preceding paragraph, refer to what appears to be an older gravel, consisting of rounded pebbles only, which I have seen in the highest levels, and at an intermediate one, and, if the same (which seems doubtful), at a lower level;—it would also suggest an upheaval of the ground in parts.

And now for the instances of erratic blocks of stone, which have come to my knowledge.

1st.—Some eighteen years ago I was informed by a near relation, who had seen them, of the discovery of such stones in a gravel pit at Freemantle, about a mile west of Southampton. The pit I have seen, but I have not examined the stones. It is on the present coast-line.

2nd.—At Bishopstoke gravel-pit, about five miles north of Southampton. About two years ago I examined three blocks of stone, but did not take specimens of them. They were probably Tertiary sandstone. Two of them were angular, and contained from two to three cubic feet each. The third was somewhat larger, and tortoise-shaped, thus :— 

3rd.—At Bevois valley gravel-pit, in November last, I examined, and took specimens of the three blocks of stone now figured in Plate XIII. They are of Tertiary (?) sandstone, and two of them contained small flint pebbles. Their dimensions are :—

No. 1.—Top block. Long, 43in.; high, 23½in.; thick below, 19in.; thick above, 8in.
No. 2.—Right-hand block. Long, 23in.; broad 19in.; high, 15 inches.
No. 3.—Left-hand block. Long, 23in.; broad, 24in.; thick, 7 inches.

All the stones at Bishopstoke, and Nos. 2 and 3 here, were found at the *bottom* of the gravel. No. 1, however, was found upright, about half-way down the gravel, with about four feet of gravel above, and four below it.[1]

4th.—Red-hill gravel-pit, three miles from Southampton, on the Winchester road, and about 170 feet above the sea. A block of Tertiary sandstone was found at the bottom of the gravel, one foot five inches long, eight inches broad, and about ten inches thick. I have examined this one, and taken a specimen of it, which is quite similar in appearance to the other specimens.

5th.—Hill Head, near Fareham, on the north bank of the Southampton Water. I have not seen this locality, nor read any ac-

[1] These three stones have been placed in the court-yard of the Hartley Institute, at Southampton, where, by the kindness of the Principal of that Institution, they may now be seen.

count of the stones found there. For the knowledge of the fact of their having been found there, as well as for valuable information regarding the numerous "sarsens" in the adjoining county of Wiltshire, I am indebted to Mr. E. T. Stevens, curator of the Museum at Salisbury.

6th.—Between Bishopstoke and Winchester, at about eight miles from Southampton, there is said to be a large "erratic:" the information I have of it is on trustworthy authority.

7th.—A large block of stone near to Winchester, discovered about two years ago. About twelve miles from Southampton, to the north. Authority—a newspaper paragraph.

Whether or not the three last instances (Nos. 5, 6, and 7) are connected with gravel deposits, I am not aware.

None of the seven stones which I have seen and examined, are, in the least degree, scratched, striated, or rounded, and the tortoise-shaped one (No. 2) at Bishopstoke, and the dromedary-hump shaped one (No. 1 of 3rd instance) Plate XIII., at Bevois valley, have been separated from their parent rock by a clean, straight, fresh-looking fracture, in their greatest diameter, so as almost at once to suggest the action of very heavy ice as the disrupting power, by a heavy side blow. The Bishopstoke example affording but a few inches of height for leverage in the fracture, to some two or three feet of length fractured.

In the foregoing communication I may not, perhaps, have written what is substantially new, for I confess myself not "posted" to the latest date in geology. I would, however, with much respect, quote from a little work[1] published three years ago, showing what was then the knowledge, in geological circles, on the subject on which I now write, premising that I am not of opinion that in any of the instances which I have given, were the "sarsens," or erratic blocks, deposited by coast-ice;—with regard to instance No. 5, however, at Hill Head, I cannot speak:—"But England, south of the estuaries of the Severn and Thames, seems all this time to have remained above the waters, for not only is the country in general destitute of drift, but it is only close on the sea near Selsea and Brighton that erratic boulders have been found."—p. 82.

FULHAM, 25*th April*, 1866.

V.—DESCRIPTION OF THREE SPECIES OF POLYZOA FROM THE LONDON CLAY AT HIGHGATE IN THE COLLECTION OF N. T. WETHERELL, ESQ., F.G.S.

BY G. BUSK, F.R.S., ETC.

(PLATE XII.)

THE plate containing the figures of the Polyzoa here described was prepared some years since by Mr. J. De Carle Sowerby, but has never been published, and no description of the fossils them-

[1] The Physical Geology and Geography of Great Britain, by Professor A. C. Ramsay, F.R.S. London, Stanford, Charing Cross.

selves has as yet been given. I have, therefore, been requested by my friend Mr. Woodward to draw one up; and the specimens have been kindly placed in my hands by Mr. N. T. Wetherell for the purpose.

Although the magnified figures are rather small, they are sufficient to afford a very good idea of the structures they are intended to represent.

The species here figured are three in number, but beside these there are one or two more of which very minute specimens are found amongst those forwarded by Mr. Wetherell; but not in such a condition as to admit of any satisfactory description.

The figured species belong to the Families *MEMBRANIPORIDÆ*, *ESCHARIDÆ*, and *GEMELLARIADÆ*, as understood by me and defined in my monograph of the Crag Polyżoa.[1]

1. Fam. *MEMBRANIPORIDÆ*, Busk, Brit. Mus. Cat. p. 55.

1. Gen. *Membranipora*, Johnst.

M. Lacroixii? Pl. XII. Fig. 1.
,, ,, Savigny. Egypt. P. 10., fig. 10.
,, ,, Busk, B. M. Cat., p. 60, pl. 69.
Flustra distans, Hassall, Johnst.
,, *Peachii*, Couch.
Conopeum reticulum, Gray.

As I am unable to perceive any essential difference between the form here represented and the existing species above referred to, I feel justified, though, of course, with some doubt, in placing them together. In general aspect, and mode of growth, usually on the outside of a turreted shell, or of stones, the two agree very closely. The only distinction I am able to draw between the Eocene and recent form, as exemplified in a specimen now before me, collected by the late Mr. W. Thompson, of Belfast, at Portmarnock, consists in the somewhat greater thickness of the septa in the former. The two agree also in the circumstance that in the septa of the more worn cells there is an appearance of minute distant pores, which is quite in accordance with the existence in very perfect specimens, of extremely delicate marginal spines.

It is to be remarked that the existing form is very widely distributed, occurring very abundantly on our own shores, as well as in the Mediterranean and at Madeira. It is curious, however, that it has not occurred to me among the Crag Polyzoa.

2. Fam. *ESCHARIDÆ*, Busk, Brit. Mus. Cat. p. 88.

Under this term I include all those species which have an erect, rigid, compressed, foliaceous, ramose, lobate, or reticulate polyzoary, composed of a single or double layer of cells.

The genera in which the cells are disposed in a double layer are *Eschara* and *Melicerita*, in which the two layers are inseparable, and *Biflustra* in which they are readily separated, when the posterior surface of each layer exhibits a sort of ridge and furrow appearance.

[1] Palæontographical Society's Monographs, 1859.

The species here represented belongs to the latter genus, and it is somewhat remarkable though not difficult of explanation that in all the specimens the posterior furrowed surface is that which is most extensively exposed.

In the Crag Polyzoa I have recorded the existence of a species belonging to the genus *Biflustra* as thus defined, which so closely resembles an existing species abounding in the Eastern seas from China to Australia, and doubtless elsewhere, that I have ventured to describe them as identical under the name of *Biflustra delicatula.* The resemblance between this form and the one I am about now to describe is so close, that in small fragments and in certain conditions, it would be next to impossible to distinguish one from the other. But closer and more extended observation will, I think, show that they are specifically distinct.

In the Eocene species the polyzoary seems to have grown in an irregularly plicated, infundibuliform shape, probably not unlike that of *Biflustra meandrina* of D'Orbigny (Paleont. Franc. p. 257, pl. 695, fig. 7–10), and which may be likened to the mode of growth of *Retepora cellulosa* and *Beaniana,* whilst in the recent form the growth is more like that of *Eschara foliacea*, that is to say in large, foliaceous, contorted expansions. And the Crag species would seem to have had the same habit. Other differences are seen in the rather small size of the cells; in the more rounded form of the opening and more especially in its being bordered below by a distinct thickened margin whilst in *B. delicatula* that border is thin and sharp. From *B. meandrina*, D'Orbigny, it differs in the absence of the regular rhomboidal areolation of the surface as well as in the thickened border of the aperture. In *B. marginata* (Pl. 696, fig. 1–4), D'Orbigny, the openings appear to be oblong and the septa are not doubled as in the London clay species—nor are they represented as granular, but there may, nevertheless, be some reason for doubting whether the two are really distinct; for the present, however, I think, it will be safer so to consider them.

2. Gen. *Biflustra*, D'Orbigny.

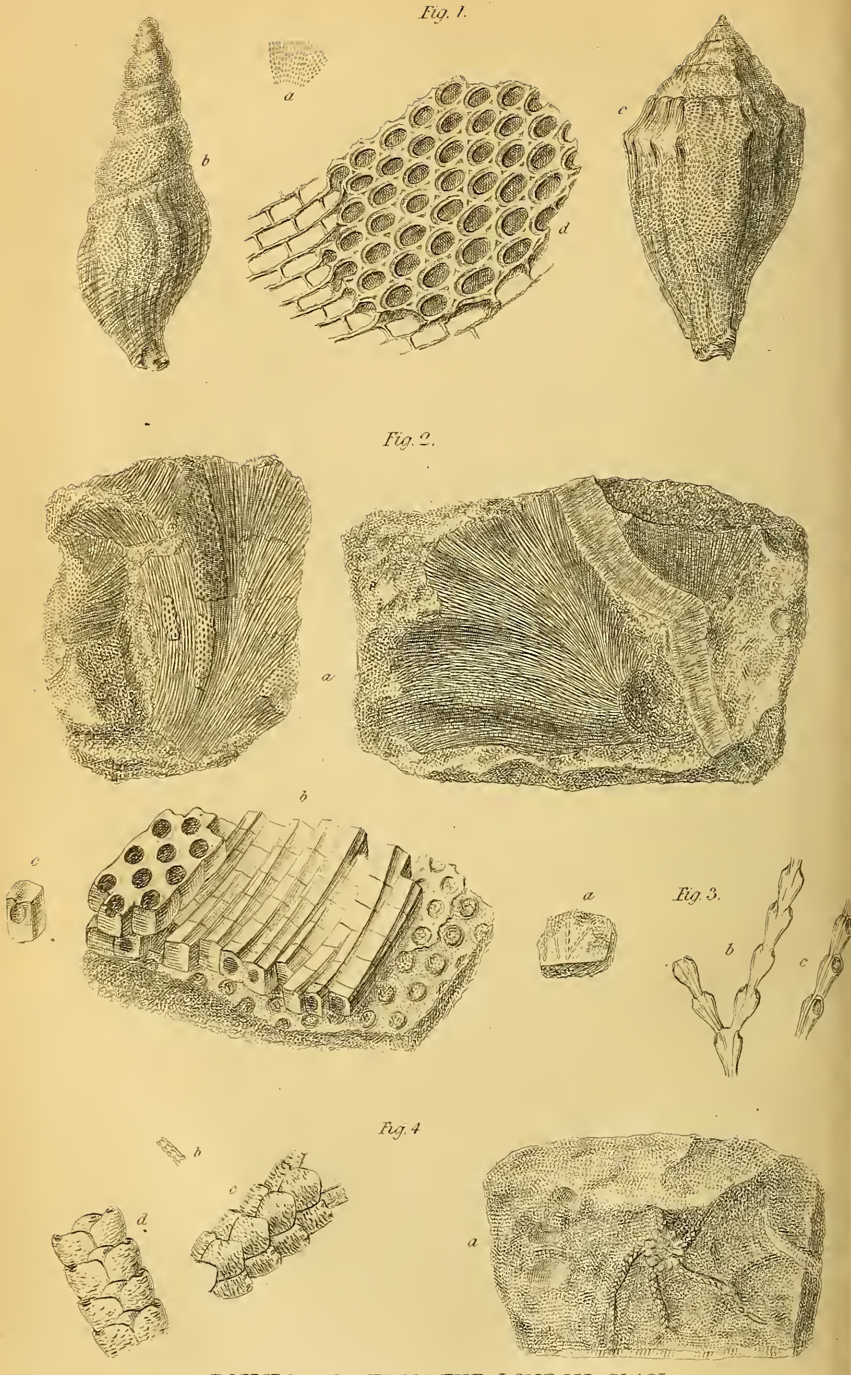
B. eocena, Pl. XII. Fig. 2.

B. cellulis oblongis, supra arcuatis, septis granulosis, duplicibus; apertură subrotundă, margine inferiori, incrassato, granuloso. Polyzoarium subinfundibuliforme.

Cells, oblong arched above; septa, granular double; aperture, sub-oval or rounded, the lower border thickened, granular: polyzoary, irregularly infundibuliform.

3. Fam. *GEMELLARIADÆ*, Busk, Brit. Mus. Cat. p. 93.

The family *Gemellariadæ*, as defined in the above place, comprises all species having the cells in pairs, which do not form distinct internodes separated by flexible joints, but constitute a continuous dichotomously divided polyzoary. As hitherto known to me it contains only forms having a flexible consistence, but the present instance seems to show that that is not to be taken as an essential character.



POLYZOA, &c. FROM THE LONDON CLAY,
Highgate.

J. D. C. Sowerby.

The genera at present included in it are *Gemellaria, Dimetopia, Didymia* and *Notamia.*

In *Gemellaria* and *Dimetopia* the twin cells are placed back to back; in the former the cells on either side all look in the same direction, whilst in the latter, they look in directions at right angles to each other in each alternate pair. In *Didymia* the cells are placed side to side; and in *Notamia* between the pairs of cells are placed two peculiar avicularian organs. The nearest ally therefore of the present species is *Gemellaria,* and at first sight, except in the rigidity of the polyzoary, there would not seem to be sufficient reason to exclude it from that genus. But besides that not unimportant distinction, another is shown in the mode in which the branches arise at each dichotomy.

In *Gemellaria,* whilst the main series appears to be uninteruptedly continued by gemmation from the summit of each cell, a new branch is formed by the pullulation from the side of each cell, a little below the summit, of a second cell, which, applying themselves back to back, constitute the origin of a new branch. In *Dittosaria,* on the other hand, the two branches would seem to be formed by a double cell arising from each of the primary cells.

For this genus I would propose the name *Dittosaria* (διττος, *duplex.*) with the following definition:—

"*Polyzoarium rigidum, calcareum, dichotomum; cellulis, dorsi adnatis, ad singulam bifurcationem cellulam duplicem pullulantibus.*"

(Polyzoarium, rigid, calcareous, dichotomous, cells, adnate by the back; and throwing out a double cell at each dichotomy.)

3. *Dittosaria Wetherellii,* sp. nov.

The orifice is much smaller than in *Gemellaria loricata,* and nearly round; and the wall of the cell is sparsely punctured, so as at first sight to suggest a suspicion that the species may belong to the cyclostomatous suborder, but close examination of the orifice will show, I think, signs of the articulation of an operculum, were not the ventricose form of the cell itself a sufficient indication of the true place of the species.

The two other forms, amongst the specimens submitted to me by Mr. Wetherell, are 1. a very minute *Cellepora,* resembling some of the minute globular specimens of *C. pumicosa*; and a very minute and imperfect fragment of what appears to be a species of *Idmonea.*

EXPLANATION OF PLATE XII.

Figs. 1. *Membranipora Lacroixii?* from the London Clay.
- *a.* Natural aspect.
- *b.* and *c.* do. do. on shells of *Voluta* and *Fusus.*
- *d.* A portion magnified.

2. *Biflustra eocena.*
- *a.* Appearance as seen imbedded in a mass of Septaria; and showing, except in parts of the left hand figure, only the back view of the layer of cells.
- *b.* Detached portion, magnified, showing to the left hand, a part in which both layers are present and towards the right, the exposed back of the adjacent layer.
- *c.* A detached cell.

3. *Dittosaria Wetherellii.*
   a. Natural size.
   b. and *c.* Portions magnified. The puncta on the walls appear to have been overlooked by the draughtsman.
4. *Ophiura Wetherellii*, Forbes "Tertiary Echinoderms," (p. 32, t. 4, fig. 7), from the London Clay, Highgate.

VI.—The Rock of the Cambridge Greensand.

By Harry Seeley, F.G.S., of the Woodwardian Museum, Cambridge.

Examining the Cambridge sands, fresh from a remembrance of the Undercliff and the grand development of the cherty rock of the Upper Greensand in Southern sections, perhaps its most marvellous character is that here it no longer makes a feature in the land, but has dwindled away to barely a foot in thickness, and yet is to be traced through several counties.[1] Blending insensibly into the chalk, resembling in structure beds that sometimes occur in the Gault, it appears but as a parting seam between those deposits. Yet so soon as Dr. Fitton made clear the sequence of the Cretaceous beds, Professor Sedgwick recognised in the film of black nodules, glauconite and chalky marl, the analogue of the sands of the Vale of Wardour and the Isle of Wight.

Although occurring everywhere below the Chalk and often in outliers capping the Gault, there are no good natural sections. But there is no lack of opportunities for seeing the superposition, since contractors pay £100 the acre, or more, for the privilege of making sections to dig out the dark nodules of phosphate of lime.

The plan of working is to sink a trench down to the sands; it may be one foot or twelve feet, but it rarely pays to work deeper; then, when the whole of the deposit has been dug out and one side undermined, a line is cut parallel to the perpendicular face of the trench and about four feet behind it, along which, according to the size of the working, from twenty to forty men appear with iron crowbars, which are used vertically till the whole slice gives way, and goes toppling over. Then digging out recommences, and so the work goes on till the field is turned upside down.

The sections so made, show a layer of nodules imbedded in a soft matrix of marl and glauconite, a stratum varying from six inches to a foot thick, which is all that is left of the Upper Greensand. The nodules rest on a flat irregular surface of clay, into which they do not penetrate; but above the phosphate bed small stragglers usually extend up into the flaggy Chalk. Sometimes, however, another bed is introduced as in Coton, where a dark unfossiliferous clay, nearly black when wet, comes under the flaggy Chalk and over the layer of phosphatic nodules.

[1] See Ann. and Mag. Nat. Hist., March, 1866, on Torynorvinus, etc.; Quart. Journ. Geol. Soc., Nov. 1864, on Hunstanton Red Rock; Geol. Mag., Vol. II., p. 262, Sequence of Rocks and Fossils; Ann. and Mag. Nat. Hist., Oct. 1864, Fossils of Red Rock.

When the workable bed is washed for commerce, water carries away the fine chalky mud; and then, all that remain are phosphatic nodules, glauconite, and sometimes a few large stones; so that the name Green *sand* is a misnomer when this marl is compared with the silicious rock which first gained the name. This variable character of the sea-bottom in different areas must certainly have influenced the fauna of the region; and therefore in the comparison of sandstone and limestone, whether of this series or other beds, it will generally be desirable to compare the fossils of the several districts separately rather than those of one area with remains from all the others; both because the physical conditions will rarely be uniform over a large sea, and because we may in this way track the relation of province to province, and the migration of species consequent on an altering sea-bed, or uplifting or sinking of land.

There is nothing in the character of the stratum to suggest the time required for its deposition; or whether it occupied the beginning, the close, or the whole of the Greensand age; for too much stress must not be laid on its conformability with the Chalk and unconformability with the Gault, for these terms are only true when used relatively. Yet, from its relations to Upper Greensand, north and south, I regard it as representing the entire period. And while the green colour in a certain way connects the Cambridge bed with its southern extension, its calcareous and phosphatic features connect it with its northern extension, the Red Rock of Norfolk and the Wolds.[1]

In the bed are large stones; included erratics. They appear to have rarely been much worn, since the angles are often sharp; and must have laid quietly on the bottom, since they are usually overgrown with *Plicatula sigillina* and *Ostreæ.* We have been careful only to preserve specimens with these seals of genuineness on them, as the Greensand is often capped with gravel. None of the indubitably genuine specimens show a trace of fossils.

The blocks vary in size from an inch to a foot; and include several of granite, some quite rotten; micaceous sandstone with numerous small garnets is not rare; hornstones and quartzites of various colours and qualities are common; various metamorphic rocks occur, which have undergone different degrees of change and sometimes show cleavage. There are traps and rolled sandstone. The slaty metamorphic rocks are less worn than the granites.

The Portland rock may owe its extraneous specimens to the Carboniferous, and other strata to a like cause.

Now these blocks are the only representatives of the silicious part of the Greensand. They seem to me to be fragments of the parent crystalline rocks whence the mass of the Greensand of thicker sections came. If the Cambridge Greensand is so thin, it can only be because no material for forming a rock was drifted here; and this appears to have resulted from the whole of this county, and certain parts of Bedfordshire, and the district S.W., having been a stationary sea-shore. Here, then, would naturally be stranded or thrown up

[1] See Geol. Mag., Vol. II., p. 529.

any fragments from the country of ancient rocks which was then being worn away. This probability becomes almost certainty when a comparison is made of the thickness of the Upper Greensand in different sections. Stated in feet, this is: Ely 1, Cambridge 1, Ashwell 1, Totternhoe 7 to 10, Merstham 25, Folkstone 30, Man o' War Cove 35, Wroughton 40, Woolstone 60, Swindon 70, Lulworth 76, Hampshire 80, Ridge 100, Culham 100, Didcot 120, Devizes 138, Isle of Wight 150. Everywhere it has been noticed to get thinner to the East and North-East; thicker to the West and South-West. And this I suppose to be owing partly to a bottom gradually shelving deeper to the South, partly to a slight prevailing current piling the sand in the hollow, but chiefly to the Southern area being nearer to the old Palæozoic and Plutonic Rocks whence the sand came;—to such rocks in fact as actually occur on the opposite region of France, and probably form the adjacent floor of the Channel, which the Shanklin Sands prove were denuded in a previous age, and which were probably the origin of the sand of the Portland Rock. Other granitic centres may have furnished quartz grains as well. But this French plutonic country could have every winter sent out a freight of boulders, such as those sharp angular blocks which ice, or trees, or a continuous shore could have landed where now found.

Hence the Cambridge area was a long, low coast where few *Foraminifera* lived, and only stray boulders were occasionally carried, while the finely comminuted material was moved away into more open seas to the South; while to the North, in the Hunston Rock, scarcely a boulder ever found its way; and the deposit, becoming eminently calcareous, gradually thickens.

The next feature, noteworthy in the rock, is the green mineral grains colouring the marl, and sometimes also the phosphatic nodules. One very important thing about the glauconite, as the green mineral is named, is its vast geographical range over Europe, and through much of America. And scarcely less remarkable is the association in which it occurs. In England the oldest bed, in which it is characteristic, is the *Sand* of the Portland Rock; then it occurs in amazing quantities in the Shanklin *Sands*, and again in the Upper Green *Sand*, dying away in the Chalk, to reappear in the same locality with the *Sands* of Bracklesham, and other Tertiary strata. Thus, while the wide-spread geographical range suggestively points to an origin as wide-spread as the sea, the geological range, limited for the most part to an association with sands, all derived from the same parent rocks, seems more decidedly to indicate an origin from local causes. Professor Rogers would have attributed it to a former Gulf-stream; but, unfortunately, there are not sufficient data to tell what causes are producing the glauconite which is now forming along the American Coast.

But it is to be questioned whether the different analyses of glauconite given by Turner, Berthier, Dana, Rogers, Van der Marck, etc., do not really indicate different minerals. All the grains are amorphous, and on being powdered, yield a bright green colour. And it deserves note that some analyses of glauconite are singularly similar to some of seladonite, the green earth occurring in the cavities of certain traps.

An analysis of the Cambridge glauconite, kindly placed at my service by Professor Liveing, is as follows :—

Water	10·80
Silica	51·09
Alumina	9·00
Iron (protoxide)	19·54
Magnesia	3·37
Lime	0·30
Soda	3·56
Potash	2·47
	100·13

I cannot concur with Ehrenberg in regarding these grains as chiefly made up of the silicified shells of *Polythalamiæ*, or with the American Professor Bailey, who also found many grains to resemble casts of the cells of *Foraminifera*, and therefore concludes that these were the great agents in forming the green particles. No decaying organic matter could furnish the grains with alumina of which they contain from 5 to 13 per cent.; and until detected by the recent investigations of Professor Forchhammer it was a substance not knwon to occur in the sea. I have many sections of the glauconite grains. The larger ones have a few Foraminifera scattered through them, the cells of which are often filled with a more transparent substance, probably the Red Silicate. Smaller grains sometimes only just invest one polythalamous shell ; while the smaller fragments are often shapeless. In many grains there is no trace of structure.

Now if, as I have suggested, the mass of the greensand is derived from plutonic rocks, its formation, disintegrating the felspars and micas, would set free all the ingredients of glauconite; and in the process the new substance might be formed. Or the Silica would be extracted by *Diatoms*, *Polycystinæ*, etc. Decomposing sea-weeds, etc., would set free the necessary alkali to render them gelatinous, while the particles of alumina falling through the shallow water would serve as nuclei round which these and the other constituents would aggregate.

The dark phosphatic nodules are usually named coprolites. No name could be more unfortunate, for there is no evidence of their coprolitic origin; and the only coprolites found, those of small fishes, are among the rarest fossils of the bed. The nodules vary much in size up to a diameter of three or four inches. Most often they are irregular concretions without any definite shape, but frequently occur as tubes, or halves of tubes, sometimes more than a foot long, and which are made up of successive layers. These seem to have been rolled about the shore, around the stems of sea plants; and one specimen, collected by the Duke of St. Alban's, appeared to have been formed about a stem where it branched dichotomously. When broken, they are dark brown, having a dull fracture, and sometimes contain scales of fishes and small shells.

An analysis by Dr. Augustus Voelker, F.C.S., gives :—

Moisture and organic matter......	4·68
Lime	43·21
Magnesia	1·12
Oxide of iron	2·46
Alumina	1·36
Phosphoric acid	25·29
Carbonic acid	6·66
Sulphuric acid	0·76
Chloride of sodium	0·09
Potash	0·32
Soda	0·50
Insoluble silicious matter	8·64
Fluorine and loss	4·96
	100·05

Now, as many of the concretions are rolled, there must have been gelatinous phosphate of lime on the shore. Sea-weeds contain in their ashes about 2 per cent. of phosphoric acid, these growing on a shore where no sediment was brought, must, during a whole geological period, have accumulated and set free by decomposition a prodigious quantity of phosphoric acid. An additional quantity would have been furnished from decaying animals, which, combining with lime, would be in a gelatinous state, and insoluble in water; this has been rolled into nodules with carbonate of lime and materials on the strand. The phosphatic nodules of the Crag appear to have had a similar and concretionary origin. But it is not impossible that denudation of deposits in the Palæozoic Rocks, as of Estramadura, may have assisted in furnishing the material for the nodules of phosphate of lime which abound in all our Cretaceous rocks.

And now of the components of the rock there only remain to be noticed the chalky mud, consisting chiefly of Foraminifera, similar to those of the Chalk, and the other fossils.

These scattered through the bed are all badly preserved. Bones are mineralized with phosphate of lime, almost invariably broken, and rarely occur in a series referable to one animal; and when this does happen the associated bones are generally washed into pockets of the Gault. They include birds, saurornia, two ichthyosaurs, numerous plesiosaurs, polyptychodon, if such a genus exist, several genera of chelonia, crocodiles, lizards, dinosaurs, and numerous sharks, chimeroids, and bony-scaled and soft-scaled fishes. Some of the reptiles are certainly land animals, others are as unquestionably marine, though nearly all could travel on the shore.[1]

The mollusca are all well represented, but there are no examples that can be considered as land shells. Nearly all the shells having been formed of arragonite are recognised only by their moulds in phosphate

[1] Notes on some some of the Mollusca and Echinoderms of the Upper Greensand will be found in the Annals of Natural History for February, April, and July, 1861, and October, 1865. And on the Pterodactyles, for February, 1865, and May. 1866.

of lime, while a few with calcite shells, such as *Ostrea*, *Nerita*, etc., are well preserved. Many of the casts are worn and often have oysters and *Plicatulæ* growing upon them, showing that the shells were removed while the specimens rolled on the shore.

Echinoderms, crustacea, polyzoa, corals and sponges, all have a fair proportion of species. But nearly everything is mineralized and infiltrated with the phosphate, though small brachiopods, serpulæ, polyzoa and cirripedes have escaped.

The only evidence of vegetable life on land is found in balls of resin, of four or five different kinds, which burn with pungent fumes, some of them having a plum-like smell.

Such is the Cambridge Greensand in its aspect as a rock, a consideration of which may pave the way for explaining how it came to have its peculiar fauna; for a knowledge of the origin of rocks is the very hornbook of biology, both recent and fossil.

NOTICES OF MEMOIRS.

I.—Phosphatic Nodules.

At a recent meeting of the "Bath Natural History and Antiquarian Field-club," the President, the Rev. L. Jenyns, M.A., F.L.S., F.G.S., delivered a lecture on the Phosphatic Nodules obtained in the eastern counties for agricultural purposes. He treated the subject both in its geological and economic points of view. Phosphatic nodules, erroneously called "coprolites," are worked most extensively in the counties of Cambridge and Suffolk. The application of them to Agricultural purposes is due to the scientific acumen of the late Professor Henslow, who, while on a visit at Felixtow, in 1842, noticed the occurrence of certain nodules or concretions in the Red Crag (which is largely developed there), and in a communication, read before the British Association in 1845, he suggested the uses to which they might be put in agriculture.

The phosphatic nodules of Cambridgeshire occur in the Upper Greensand, forming a stratum generally from six to nine inches in thickness, and extending over many miles in the vicinity of Cambridge, they sometimes form an even layer on the Gault, but are not unfrequently found in cavities hollowed out here and there on its surface.

The Suffolk nodules, obtained from the Red Crag, are of rather less value than those of Cambridgeshire, as they contain a smaller percentage of phosphate of lime. They are similar to nodules occurring in the London clay, from which deposit they have been derived. The Eocene nodules contain from 50 to 60 per cent. of lime, while those from the Crag average about 53 per cent. of it, with 13 per cent. of phosphate of iron as well as carbonate of lime and volatile matter.

With regard to the nodules from strata in other counties, Mr.

Jenyns stated, on the authority of Mr. Charles Moore, F.G.S., that phosphatic nodules are found in the Upper Greensand, which is very continuous at the base of the Chalk escarpment throughout the counties of Wilts, Dorset, Somerset, and Devon, it is, however, seldom opened, and when opened the phosphatic nodules, though present, are not so abundant as at Cambridge, and together with the fact that they are more silicious and consequently contain less phosphatic matter, Mr. Moore thought it doubtful whether the beds in the south-west of England would ever repay the cost of working.

II.—Eozoön in Bohemia and in Bavaria.

By Messrs Hochstetter and Gümbel,

[Ueber das Vorkommen von Eozoön im krystallinischen Kalke von Krummau in südlichen Böhmen. Von Prof. Dr. Ferdinand von Hochstetter. 8vo. 1866. Ueber das Vorkommen von Eozoön im ostbayerischen Urgebirge; mit 3 Tafelen. Von C. Gümbel. 8vo. 1866.]

I.

After noticing the discovery of *Eozoön* in Canada and Ireland, and its geological importance, Dr. Hochstetter, in his paper (read before the Vienna Academy of Sciences), briefly explains the relations of the gneiss of Southern Bohemia. This consists of two great series of gneissose and granitic rocks, great infoldings of which form the mountain-range of the Böhmerwald. The lower (1) is Gümbel's "Gojic Gneiss," and the upper series (2) is his "Hercynian Gneiss;" this latter contains (like the Laurentian Gneiss of Canada) beds of graphite and of serpentinous marble. Pebbles of quartz in it, and its bituminous odour when struck with a hammer, had already satisfied Dr. Hochstetter of the sedimentary character of the marble; and he sent some of the green variety (from Krummau) to Dr. Carpenter, who determined the presence of *Eozoön* in it.

The upper gneiss is succeeded unconformably by (3) mica-schist, here referred to the Upper Laurentian; this by (4) clay-slates; and (5) the "Przibram schists" (with Annelid-marks,—*Fritsch*), which are tabulated together as equal to the Lower Cambrian or Longmynd rocks of Britain, and the Huronian of Canada. In the diagram, however, No. 4 is comformable to No. 3; but there is a violent unconformity between No. 4 and No. 5. The Przibram grauwacke follows next, and, with the "Ginetz beds,' (or "Primordial beds" of Barrande), is grouped as the Upper Cambrian of Britain, and the Taconic beds, or Potsdam sandstone, of North America.

II. Herr Gümbel commences his more elaborate memoir (read before the Munich Academy of Sciences) with well-considered remarks on the importance of the discovery of anything like organic remains in metamorphic rocks, especially in those of oldest date;—such discoveries, he says truly, give a new dawn-light to geologists searching out the earth's primæval history. He then proceeds to sketch the chief geological characters of the so-called "primitive rocks" of Eastern Bavaria, and to compare them with Logan's

Laurentian and Huronian systems of Canada, and Murchison's "fundamental gneiss" of Scotland. In Eastern Bavaria Herr Gümbel distinguishes (1) the Hercynian clay-slate; (2) the Hercynian mica-schist (Upper Laurentian); (3) the Hercynian gneiss of Bavaria and Bohemia (comprehending the Donau gneiss, or gneiss of the Danube); (4) the Bojic gneiss (3 and 4 together constituting the "primitive gneiss,'" equivalent to the Laurentian system).

The *Eozoön* and the serpentinous marble, or ophicalcite, of which it forms part, are then carefully described,—both the Canadian *Eozoön*, after Dawson, Carpenter, and Hunt, and the Bavarian, from Herr Gümbel's own careful researches, assisted by Herrn Reber and Schwager. The gneiss and its associated rocks and minerals are described, especially the limestone and its Eozoönal structure, together with some obscure organic remains, possibly Bryozoan. This marble is equivalent to that of Krummau, treated of by Dr. Hochstetter. There are also bands of marble higher up, in the Hercynian clay-slate, on the south and south-east of the Fichtelgebirge, near Wunsiedel, answering to the Cambrian or Huronian zone; and this marble contains traces of *Eozoön* sufficiently distinct to be termed *Eozoön Bavaricum* by Herr Gümbel. Dr. A. Fritsch has found Annelid-marks in this grauwacke at Przibram; and Dr. Reuss has detected Crinoidal and Foraminiferal remains in a limestone equivalent to the above near Reichenstein.

Herr Gümbel finds *Eozoön Canadense* also in the famous pargasite of Finland; traces of *Eozoön* in a piece of coccolite-limestone from New York; in the serpentinous marble of Tunsberg; in the chondroditic marble of Boden, Saxony; in a serpentinous blackish marble from Hodrisch, Hungary; and in a serpentine-marble from Reichenbach, Silesia.

Characteristic Eozoönal structures, and some obscure organisms, are very well figured in plate i.; and two specimens of the Eozoön-rock itself, prepared with acid, are nature-printed with colour in plates ii. and iii. T. R. J.

III.—On the Jöstedal-bræ Glaciers in Norway.

By C. M. Doughty, B.A.

[8vo. London, Stanford, 1866, pp. 14, with a coloured chart.]

The author describes the chief ice-streams which form the outlets of the southern slope of the great Jöstedal-bræ.[1] Glaciers, he says, may be divided into two kinds—one consisting of a stream and reservoir, like those common in the Alps; and the other forming, as it were, a crust to a large tract of land, and having several streams or outflows, like that at present covering Greenland. The Norwegian Glaciers, for the most part, are certainly of this nature, from the peculiar character of the country—a great Alpine boss, as

[1] The Jöstedal-bræ lies between the parallels of 61° and 62°. It is a ridge of irregular shape, some sixty miles long, but of inconsiderable breadth.

it were, cut up into immense plateaux by the intersecting valleys. On as many of these plateaux as reach the snow line, the snow, which is constantly accumulating, becomes transformed into a compact icy mass, traversed by crevasses, and by its weight the entire mass gradually finds its way to lower levels, both squeezing out its surplus down the valleys as ordinary glacier-streams, and discharging from the cliffs in shoots of ice-blocks.

Mr. Doughty gives accounts of the several glaciers marked on the small plan of Jöstedal, with measurements made by him with a theodolite, in July and August, 1864; and his observations tend to prove the identity of the glacier streams of Norway with those of the Alps. He makes some remarks on the nature of the channels of the ice-streams, and on the moraines, and states that, as specimens of the contemporaneous fauna and flora are being entombed every day in the glacial accumulations, and man occasionally among the rest, very early traces of the human race may be looked for in the deposits of the older glaciers, if man were then in existence and inhabited those parts of the globe. H. B. W.

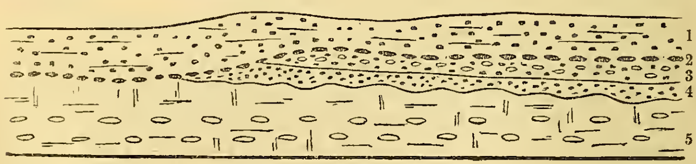
IV.—The Flint Implements of Spiennes in Hainaut.

By Professor C. Malaise, Docteur en sciences naturelles, etc.

[Bullet. de l'Acad. Roy. de Belgiquf, 2me. série, tome xxi., 1866.]

In this communication Prof. Malaise records the discovery of a number of worked flints, below the loess (the 'Hesbayan mud' of M. Dumont), near the village of Spiennes, south-east of Mons; they are very rudely shaped, and belong to the "Stone age."

The loess caps two plateaux between which the river Trouille flows before passing Spiennes; it has a varied composition, often argillaceous and of a brownish-yellow colour in the upper part, and calcareous, of a greyer colour, with calcareous concretions containing fresh-water shells, deeper down. Worked flints were obtained *in situ*, just below this deposit of loess, but they were also found scattered over the surface of the plateaux; their position, and the geological structure of the country will be seen from the accompanying section by Prof. Malaise.



Section of the left Bank of the Trouille.

1. Loess. 2 Flint Implements. 3. Pebbly-bed. 4. Glauconitic-bed. 5. Chalk, with Flints.

The flint implements vary both in shape, and in the degree of finish; those found in place differ from those found on the surface of the country, inasmuch as the latter possess a peculiar superficial alteration, accompanied with traces of oxide of iron, which bespeak their antiquity. The implements are made from the black flints of the chalk. H. B. W.

V.—Mineralogical, Geological, and Palæontological Account of the "Meule" (Grindstone) of Bracquegnies.

By MM. Briart and Cornet, Civil Engineers.

The rock, to which the miners of the neighbourhood of Mons have given the name *Meule,* is one of the most interesting of the Cretaceous strata of Hainaut. It is a glauconitic and opaliferous sandstone, attaining sometimes 180 metres in thickness. The hydrated and soluble silica, which it yields abundantly, distinguishes it from all the other Cretaceous rocks. It is placed by Dumont in the upper part of his Hervien system, and is therefore the equivalent of the Gault. Few fossils have hitherto been obtained from it, but the authors now record, from two well-borings at Bracquegnies, 93 species, namely:—41 Gasteropods, 51 Lamellibranchs, and 1 Serpula. There is a remarkable absence of Brachiopods and Cephalopods, and this fact, together with the mineralogical character of the rock, (?) point to its formation in deep water, and at a considerable distance from the land.

Fifty-one of the species noticed are well-known forms, and afford material for the comparison of the *Meule* bed with other deposits 5 of these species are found only in the *Tourtia* of Tournay and Montignies-sur-Roc; 8 in the Cenomanian strata of Rouen; 13 in that of Sarthe; and 42 in the Blackdown Beds.

The memoir is illustrated with seven quarto plates of the fossils, drawn by M. Briart, and accompanied with carefully prepared descriptions.—*L'Institut,* May 16, 1866.

VI.—Trans-Caucasian Researches by H. Abich.

[Apercu de mes Voyages an Transcaucasie en 1864. Par H. Abich. 8vo. Moscow, 1865.]

In communicating to the Imperial Academy at Moscow the results of his travels in 1864, in the regions south of the Caucasus, M. Abich mentioned that the points he had in view during his last five excursions from Tiflis were chiefly to define the limits and characters of the Tertiary and Secondary Strata of the Southern flanks of the Caucasus,—to study the relationships of the schistose and granitic rocks of the chain, and the trachytes of the extinct volcanos, Elbourouz and Kasbek; also to examine the Tertiary and Quarternary formations of the plain of Colchis, and to finish his special geological map of the canton of Sazéretlo. As a point of geological interest and of practical importance, M. Abich refers to the great extent of the Oxfordian Rocks in the mountains between the Kour and the

Araxes. In the "Carboniferous" rocks, overlying the "Devonian" of Armenia, there appears to be no coal; but it is found in the Jurassic strata there. In the Caucasian isthmus there are Oxfordian grit-beds containing plant-remains and coal, and these are related to the coal-beds of the southern flank of the Caucasus (at Tqirbouly) and to analogous deposits in the Elbourouz of Persia,—constituting, in fact, a grand formation of the Oxfordian period, which stretches, probably, beneath the basin of the Caspian. M. Abich has proof of the Oxfordian strata being well developed also in the mountains crossing the Araxes, between Ordoubad and Migri, where coal of considerable thickness and of Oxfordian age occurs near the village of Bénamptschapour, up the Migri Valley, nearly 3,000 feet above the level of the Araxes. Similar plant-bearing Oxfordian grits M. Abich discovered, in 1862, in the mountains, north of the Lake of Gohtschai, near Daschkesan, and in the valley of Bojan, near Elisabéthpol; and in 1864, besides the indications above-mentioned, he found them also on the left bank of the valley of the Terter at the foot of the Mourovdagh. T. R. J.

VII.—The Dublin Quarterly Journal of Science. No. XXII. April, 1866.

Some very interesting papers on Zoology, Meteorology, Comparative Anatomy, and Archæology, form the bulk of this part. There is also an account by the Rev. Dr. S. Haughton of some Meteoric Stones that have fallen in Ireland. One fell at Dundrum, Tipperary, in August, 1865; it consists of Iron, Iron-oxide, Pyrites, Chrysolite, and some other silicate of Magnesia, &c., with Nickel and Chrome. Some aërolites that fell at Killeter, in Tyrone, April, 1864, consist of Iron, Iron-oxide, Pyrites, some Silicates, including hornblendic mineral, near to Anthophyllite, in composition, with a little Nickel and Chrome, and a trace of Cobalt. T. R. J.

REVIEWS.

I.—Memoirs of the Geological Survey of Great Britain and of the Museum of Practical Geology. The Geology of the Country around Stockport, Macclesfield, Congleton, and Leek.—(Sheets 81, N.W., and 81, S.W., of the Map of the Geological Survey of Great Britain.) By E. Hull, B.A., F.G.S., and A. H. Green, M.A., F.G.S. List of Fossils revised by R. Etheridge, F.R.S.E., F.G.S. Published by order of the Lords-Commissioners of Her Majesty's Treasury. 8vo. London, 1866.

The district here described comprises, on the north, the south-eastern prolongation of the Lancashire Coal-field,—on the south, the northern apex of the Coal-field of the Potteries, one of the

Coal-basins of North Staffordshire. Both of these coal-tracts are abruptly bounded on the west by the great "Red-rock Fault;" and on the east, from beneath them, come out the barren Millstone-grit, and underlying Yoredale shales and Mountain-limestone. These, broken by great faults, undulate in broad troughs and arches over the High Peak district, and then pass beneath the great coal-fields of Western Yorkshire. In the country under notice, some other patches of Coal-measures have been preserved in the great synclinal of Millstone-grit, called the Goyt Trough. To point out the exact definition of all these coal-areas, and the real position and out-crop of their several coal-seams, has been, of course, one of the main objects of the Geological Surveyors,—these points having direct practical bearings on the commerce and welfare of this important manufacturing district. With the aid of the many proprietors, managers, and others, who are duly mentioned in the Preface, the details of the numerous coal-workings have been got together, and scientifically collated, and now plainly illustrated for the benefit of all. Great good must arise from this; for those now working the coal can learn with certainty the relationship of the strata in their several properties to those in the neighbourhood, and may be spared uncertainty and expense in further operations. Moreover, in the immediate vicinity of Stockport, some square-miles of "red-ground" along the great fault are shown to consist of Permian strata, close upon the Coal-measures, and allowing these latter to be reached, and not of the red strata of the Triassic series high up, overlying both Permian-beds and Coal-measures, and too thick to allow of profitable sinking.

Other points of interest and, indeed, results of much value, are to be found in the admirable delineation and description of the geological structure of the district, formed (beneath its coating of Boulder-clay, sand, and gravel,) simply of a succession of Carboniferous, Permian, and Triassic strata, broken, however, by innumerable faults, mainly with a N.S. direction, but often transverse and oblique. The general geological structure and its relation to the hills and rivers, the nature of faults, landslips, the causes and results of denudation, and other allied subjects, are here treated of by really good observers, and clear and cautious thinkers. The illustrative sketches and diagrams, as well as the reduced map, are admirable; and, whilst the coal-owners and "practical men" will have these explanations of the Macclesfield map at their elbow for constant reference, pure geologists will scarcely find a page but must interest them, either by descriptions, elucidations, or suggestions relating to the various deposits treated of (Palæozoic, Mesozoic, and Post-Tertiary), as to their origin, modifications, and actual condition. The Appendix, enumerating the Fossils found in the several sets of strata of the district, is, in itself, an important addition to palæontology. Recurring to the Memoir itself, we must remark that Messrs. Hull and Green have taken much pains to explain the relationship of the "Yoredale Series" in Yorkshire, Derbyshire, and Staffordshire; and they have with great care worked out the different members of the "Millstone-grit

Series," which they prove to be nearly 2,800 feet thick in Yorkshire, with five thick beds of gritstone,—about half of the thickness in Derbyshire,—and only about 300 feet thick, with two gritstone beds, in North Staffordshire. They point out that the topmost of these grits (the "Rough-rock"), and the third, are continuous throughout; and that each great grit-bed had a coal-seam on its surface, indicating that, in the intervals, during which the changes, resulting in difference of deposits, were being brought about, each grit-bed became for a time a land-surface.

II.—Geological Sketches. By L. Agassiz. London, 1866. Trübner & Co. 8vo., pp. 311.

THIS volume contains a series of articles by the well-known Naturalist and Geologist, Professor L. Agassiz, and first appeared in an American periodical, but has since been revised and collected into one volume.

The contents, originally delivered as popular lectures, embrace some of the leading and more interesting facts of geological science, and are to some extent illustrative of American geology, combined, however, with similar as well as additional phenomena presented by the Old World, with which the author is thoroughly cognizant.

The varied nature of the lectures will be seen from the following subjects,—America, the Old World,—the Silurian Beach,—the Fern Forests of the Carboniferous Period,—Mountains and their Origin,—the Growth of Continents,—the Secondary and Tertiary Ages, and their characteristic animals; which are followed by three chapters on a favourite study of the author,—viz.: the formation, internal structure, external appearance, and progression of Glaciers. The subject of Glaciers, with which Professor Agassiz is so well acquainted, occupies one-third of the volume, and is treated with special reference to their geological significance, and is to some extent introductory to a future work, in which the former extension of glaciers in America and Europe—the history of their retreat, and the changes which the climate of our globe has undergone, will be explained.

The style of the work is familiar, and fulfils the intention for which the original lectures were published, of placing before the reader some pictures of the Old World, with the animals and plants that have inhabited it at various times, avoiding as far as possible, all debateable ground, embodying those parts of the subject which are best known, and can therefore be more clearly presented.

Leaving out the *Eozoön* of the Laurentian rocks, the author has the following suggestive passage in the chapter on the Silurian beach:—"To look on the first land that was ever lifted above the waste of waters, to follow the shore where the earliest animals and plants were created when the thought of God first expressed itself in organic forms, to hold in one's hand a bit of stone from an old sea-beach, hardened into rock thousands of centuries ago, and studded with the beings that once crept upon its surface, or were stranded there by some retreating wave, is even of deeper interest to men than the relics of their own race, for these things tell more directly of the thoughts and creative acts of God."

Professor Agassiz considers that traces of birds in the Secondary deposits are of doubtful character, and is of the opinion that the remains of the feathered animals found in the Solenhofen Limestone do not belong to a genuine bird, but to one of those synthetic types, in which reptilian structure is combined with certain bird-like features. Many other interesting points of Palæontology are noticed; and the author's objections to the development theory, and the facts upon which they are based, are discussed when alluding to the fishes and Cephalopods of the Jurassic and Cretaceous strata, in the chapter on the Geological Middle Age.

The work would have been rendered still more instructive had the illustrations been either omitted altogether, or been of a somewhat better style of execution, and, in some instances, more correctly drawn: thus, at page 177, the Turrilite is represented as a dextral shell, instead of sinistral, which is the general form of that genus of Cephalopods. Still, however, the volume is an acceptable addition to our geological literature, as conveying in a pleasing manner the leading principles of the science.

III.—The Age of Man Geologically Considered in its Bearings on the Truths of the Bible. By the Rev. John Kirk. "Christian News" Office, Glasgow. 18mo. pp. 264, cloth, 2*s*. 1866.

We have had our attention directed to the little book whose title is given above, by a fly-leaf advertisement reprinted from Professor Kirk's *own organ*, the "Christian News," of May 26th, and headed "Letter from Sir Chas. Lyell, Bart., to the Rev. Prof. Kirk." (Dated 17th May, 1866.)

Sir Charles Lyell will probably be as astonished as we were, to see his private letter to Mr. Kirk converted by that enterprising gentleman into an advertisement, and it will *no doubt*, as Mr. Kirk naively observes, "tend to promote the perusal of the little volume to which it refers."

Sir Charles will doubtless (after reading the book) be more cautious, for the future, in sending autograph letters to authors of doubtful scientific books. As this letter is now before the public, we will quote one sentence from it. "I am sorry to say that the works in general published by theologians on geology, although in number, I believe, they have, in the course of the last thirty years, equalled all those written by adepts in the science, show such want of acquaintance with the elements of the subject, that my friends are in the habit of neglecting them entirely; but no doubt I shall profit by your objections." . . . . . Led by the same hope, we have carefully perused Mr. Kirk's book, and can only say, that so far from finding any exception to the above description, we are compelled to include its author in the same class, and are sorry to add that he is not only deficient in geological knowledge, but also in good manners towards his opponent,—a grave fault in a minister, and still worse in one who is a "Professor of *practical* Theology in the Evangelical Union Academy."

It needs no practised eye to detect the leading features in this mild essay at book-making, in which our author is familiar.

First we observe the endless repetition of Sir C. Lyell's name, of whom, however, he speaks in the most contemptuous terms throughout his book.

In Chapter I., entitled "Ignorance and Error," he compares him with an ignorant school-girl, who, seeing steam-boats with "wheels," wondered what they would do when they came to deep water! "We could stake a good deal," adds the reverend gentleman, "that she would have beat Sir Charles Lyell himself, if called to speak on the subject of the growth of peat" (pp. 11 and 12)!

Again, p. 73. "This spirit of carelessness follows Sir Charles, even in the reading of the proofs of his volume ('The Antiquity of Man'). For example, he says, regarding the peat-formation at Abbeville:—"This vegetable matter is all of submarine—(yes, 'sub-marine')—or fresh water origin" (p. 111). Mr. Kirk adds:—"We are perfectly well aware of the difficulty of keeping the printer right, and this blunder is no doubt the result of a mere slip of the pen or of the press; but it is in thorough keeping with everything else in the book."

Had the Rev. Prof. Kirk turned to the list of *errata* and *corrigenda* at the end of the "Antiquity of Man," he would have found "for submarine read *supra*marine." It would be well if spelling formed one of the qualifications necessary for the post of Professor in the Evangelical Union Academy, as in that case we might find "Abbeyville" spelt without a *y* (p. 72); *fluminalis*, not "*flumenalis*" (more than twenty times, pp. 201-210); *plutonic*, not "*platonic*" (p. 143); *unio*, not "*unis*" (p. 203); *primigenius*, not "*primogenius*" (pp. 220-221); *tichorhinus*, not "*tichorinus*" (p. 221); *impennis*, not "*impennius*" (p. 185); we notice typographical blunders of common words at pp. 109, 133, 135, 205, 229, but there is no table of errata given.

In another place, speaking of Sir Charles Lyell's reasonings on River-gravels, etc. (p. 113) he says:—"A man who has devoted a life and a fortune to the collection of geological facts is necessarily, in the language of ordinary life, 'an eminent geologist.' He may be trusted as a man of the highest honour, who would not for anything state that as a fact which he only knows as a probability. . . . Yet he has, perhaps, never spent a serious half hour in endeavouring to master the most essential laws of true reasoning."

To speak familiarly or contemptuously of men of science is no proof of wisdom, but the contrary, and we shrewdly suspect Prof. Kirk's boasted frequent visits into geological territory (see p. 4) have been made by night, which may account for his ignorance as a guide both of the country and the language made use of.

As a "Professor of Practical Theology," we would recommend

Mr. Kirk first to remove the beam out of his own eye, and then he will be able to see clearly to correct his own blunders; and in the new edition, which such a work is sure to reach, we shall hope to find not only the gross mis-spellings corrected, but the insolent language adopted towards so eminent a philosopher, geologist, and gentleman, as Sir Charles Lyell, deleted.

The attempt to supersede the reasonings of sound philosophy founded on well-ascertained geological data, by dogmas of his own,[1] for which he furnishes us no proof whatever, suggests to us the applicability of Mr. Kirk's *own* language, that "*he*" (not Sir Charles Lyell) "is manifestly incompetent for the task he has undertaken, and that he is as eminently illogical as (no doubt) in a sense he is eminently" *theological* (*not* "geological"), "and hence he is incompetent" (see p. 114).

IV.—Transactions of the Manchester Geological Society. Vol. V. No. 14. 1866.

1.

SOME of the very interesting specimens of Coal-plants, found by Mr. Wünsch, of Glasgow, in beds of volcanic ash in the lower part of the Scotch Coal-measures, in the North-east part of the Isle of Arran, were alluded to (on their exhibition, February 27th) by Mr. Binney, as offering good proofs of the combined agency of fire and water in producing stratified deposits. 2. Messrs. J. Plant and E. Williamson described the geology and fossils of the Lingula-flags, or Primordial Zone, of the Gold-districts of North Wales in a paper resulting from the joint researches of Messrs. Readwin, Salter, Williamson, and Plant, on the structure of the Dolgelly country, and the fossils found there.[2]

The sectional list of strata seems to be as follows:—No. 9 (uppermost). Tremadoc slates, not examined. No. 8. Moel Gron slates and shales, 750 feet; equivalent to the "Black Shales of Malvern," with *Olenus scarabœoides*, *O. bisulcatus*, *O. humilis*, *Sphærophthalmus pecten*, *Conocoryphe*, *Angelina Sedgwicki*, *Agnostus rex*, *A. princeps*, *A. trisectus*, etc. No. 7, Rhyw Ffely (or Rhyw-feln) slates and shales; 750 feet. *Orthis*, *Orthonota* (?), *Lingula*, *Olenus spinulosus*, *O. bisulcatus*, *O. humilis*, *O. pecten*, *O. alatus*, *Agnostus*, etc. Nos. 9, 8, and 7 form the Upper Lingula-flags.

No. 6. Hafod Owen sandstones and traps; 4,000 feet. *Lingulella Davisii*, *Olenus*, *Conocoryphe*, *Buthotrepis*, Annelid-marks, etc. This great group of felspathic sandstones forms the Middle Lingula-flags, and is chiefly fossiliferous in its upper divisions.

No. 5. Cwmheisian flags, traprocks, and felspathic grits; 1500 feet. *Olenus cataractes*, *Agnostus princeps*, *Sao hirsuta*, *Petraia*, Crustacean tracks, etc. The lowest portion is not fossiliferous.

[1] See Mr. Kirk's Vision of Creation, chap. v., p. 46. See also Mr. Kirk's Interpretation of the Bible view of Time, chap. vi., p. 63.

[2] See Mr. Plant's paper, Report Geol. Soc. Lond., at page 320.

Nos. 4 to 1. Tyddyngwladis slates and traprocks; 1136 feet. No. 4 has the large *Paradoxides Davidis* and *Theca.* No. 3 contains *Obolella, Obolus, Theca, Lingula, Protospongia, Agnostus rex, A. princeps, A. pisiformis, A. trisectus, Microdiscus,* and *Anopolenus.* No. 2 yields at Tyddyngwladis and elsewhere, *Paradoxides Forchhammeri, Anopolenus Henrici, Agnostus, Protospongia, Theca, Lingula, Obolus, Obolella,* and *Leperditia.* No. 1 has not been worked. Nos. 4 to 1 are the Lower Lingula-flags. The Lingula-flags are regarded by Mr. Salter as the Upper Cambrian beds, and the same as the "Primordial zone" of M. Barrande. The Harlech Grit, or Lower Cambrian, lies below the Tyddyngwladis schists.

This improved classification of the "Lingula-flags" is due to the well-directed labours of Messrs. Salter and Williamson, backed by the energetic support of Mr. Readwin, who is warmly interested in the progress of geology as well as in the furtherance and improvement of gold-mining in Merioneth; and it adds considerably to the known structural details of that region as shown by the map-sheets of the Geological Survey, good as they are.

V.—Geological Survey of the Austrian Empire.

[Jahrbuch der kais.-kön. geologischen Reichsanstalt. 1865. Vol. xv. No. 2. April—June.]

THE results of earnest, conscientious, clear-sighted geological work, well managed and carefully recorded, are to be found in the Jahrbuch of the Imperial-Royal Geological Institute of Austria. The Transctions and the Maps published by the same scientific body, and the fine Museum they have collected for the State, are good evidences of their work,—of their enthusiastic labours, well directed by the veteran Haidinger, and supported by the enthusiasm of good Austrian geologists, rewarded with little more than the satisfaction of skilfully deciphering the earth's history, explaining the structure of their country, indicating its mineral resources, and adding hard-won fact to fact, and generalization to generalization, for truth's sake. Communications from geologists, miners, mineralogists, and others not on the Survey, are also received and published by the Institute.

In the number before us, H. Wolf describes the subdivisions of the Cretaceous Series in Bohemia: namely 1. (uppermost), The Senonian Group, consisting of the Baculite-marl and the Calianassa-sandstone. 2. The Taronian Group,—or the Scaphite-marl, and the Hippurite-limestone with conglomerate. 3. The Cenomanian Group, comprising the Rhotomagensis bed, and the "Lower Quader." Their synonyms, characters, and fossils are carefully noticed and tabulated. Dr. Ferdinand von Hochstetter gives an account of the petroleum and asphalt of Western Galicia, which may possibly come from Tertiary lignites, or quite as probably from deep-seated coal-bearing strata, by means of the great cracks traversing that region. Dr. A. Madelung treats of the eruptive rocks, called

"Teschenite" by Hohenegger, that range in a narrow band along the northern edge of the Carpathians; and assigns to them an Upper Eocene age Franz Posepny gives a short note on the occurrence of some Jurassic rocks in Eastern Galicia. Ferdinand Ambroz communicates some observations on the rocks and minerals of the neighbourhood of Padert. The Barometrical Heights observed in Bohemia by the Geological Surveyors during 1861 and 1862, are recorded by H. Wolf. The rocks and minerals of the Stübing-graben, to the north of Gratz, in Steyermark, are noticed by Michael Simettinger. The periodical account of analyses made in the chemical laboratory of the Institute next follows—lignites, coals, limestones, and mineral waters, sent for examination, are reported on by Karl Ritter von Hemer. Lists of presents to the Institute, and reports of the proceedings of its meetings, complete this Part of the Jahrbuch. T. R. J.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. May 23, 1866.—Professor A. C. Ramsay, F.R.S., Vice-president, in the chair. The following communications were read:—1. "Notes on the Geology of Mount Sinai." By the Rev. F. W. Holland. Communicated by Sir R. I. Murchison, Bart., K.C.B., F.R.S., F.G.S.

The physical features of the peninsula were described as exhibiting in the north an extensive table-land of limestone of Cretaceous age, supported and enclosed on the south by a long range of mountains composed of syenite, porphyries, and schistose rocks. Near Jebal Serbal is a mountain of Nummulitic limestone; and a limestone, apparently of more recent date, occurs near Tor and Ras Mohammed. The author further stated that in some parts of the peninsula the syenite mountains are capped by a considerable thickness of horizontal beds of sandstone, which are unaltered at their contact with the syenite. This sandstone formed the great mining district of the Egyptians in Sinai, and is now worked for *turquoises*, which appear to occur more or less in veins. Raised beaches were discovered by the author on the western side of the peninsula, at elevations of from 20 to 30 feet.

2. "On a new genus of Phyllopodous Crustacea from the Moffat Shales (Lower Silurian), Dumfriesshire." By Henry Woodward, Esq., F.G.S., F.Z.S.

The fossil described consisted of the disk-shaped shield, or carapace, of an Apus-like Crustacean, the nearest known form to it being *Peltocaris aptychoides*, Salter, from which, however, it is at once distinguished by the absence of a dorsal furrow.

A line of suture divides the wedge-shaped rostral portion of the shield from the rest of the carapace, the two parts being seldom found together. From their strong resemblance to *Discina*, the author proposed for them the generic name *Discinocaris*, and named the species *Browniana,* after Mr. D. J. Brown, who first drew his attention to it.

3. "On the oldest known British Crab (*Protocarcinus longipes,* Bell, MS.) from the Forest Marble (Great Oolite) of Malmesbury, Wilts." By Henry Woodward, Esq., F.G.S., F.Z.S.

The author stated that three genera and twenty-five species of Brachyurous Crustacea had already been described by Professor Reuss and H. von Meyer from the Upper White Jura of Germany; but as no limbs or abdominal segments had been met with, it was more doubtful where to place them than the species now described, which had nearly all its limbs *in situ,* and a portion of the abdomen united to its carapace. *Protocarcinus* closely resembled the common spider-crabs—the *Maidæ* and *Leptopodidæ* living on our own coasts at the present day.

4. "On the species of the genus *Eryon,* Desm., from the Lias and Oolite of England and Bavaria." By Henry Woodward, Esq., F.G.S., F.Z.S.

The genus *Eryon* of Desmarest was established for certain extremely broad and flat forms of *Astacidæ* found in the Solenhofen limestone, near Munich, and first described in 1757. The late Dr. Oppel has recorded fourteen species, two of which, *E. Barrovensis,* and *E.* (*Coleia*) *antiquus,* are from the Lias of England. Mr. Woodward gave descriptions and figures of *E. Barrovensis,* M'Coy, and five other species, namely, *E. crassichelis, E. Wilmcotensis,* and *E. Brodiei,* from the Lower Lias; *E. Moorei,* from the Upper Lias of Ilminster; and *E. Oppeli,* from the Lithographic stone of Solenhofen.

5. "Notes relating to the Discovery of Primordial Fossils in the Lingula flags in the neighbourhood of Tyddyngwladis Silver-lead Mine." By J. Plant, Esq., F.G.S.[1]

The discoveries described in this paper included the finding of *Paradoxides* near the second adit of the Tyddyngwladis mine, in the Lower Lingula-beds, and subsequently of further specimens in the neighbourhood, associated with fragments of *Anopolenus* and *Theca.* A detailed examination of the district, undertaken by the author and Mr. E. Williamson, had proved the correctness of their opinion, that the strata at Tyddyngwladis belong to the Primordial zone, and that within a limited area, extending east from the boundary line of the Lower Cambrian grits, the rocks ought to yield a series of fossils of Primordial types. This examination had also enabled them to draw a section extending from the junction of the Lower and Upper Cambrians at Cefn Ddiddw to the base of Craig-y-Dinas, which was described in detail by the author, who adopted the following division of the beds :—

			feet.
Lower Cambrians or Harlech Grits.			
Upper Cambrians.	Lower Lingula-beds	Tyddyngwladis slates	1,136
		Cwmheisian slates	2,500
	Middle Lingula-beds	Hafod Owen sandstones	5,000
	Upper Lingula-beds	Rhywffely slates / Moel Gron slates	1,500
			10,136

[1] See Trans. Manchester Geol. Soc., *ante,* p. 317.

The following specimens were exhibited:—1. A collection of Rocks and Fossils from the neighbourhood of Mount Sinai; exhibited by the Rev. F. W. Holland. 2. A series of Crustacea, illustrating Mr. Woodward's papers; exhibited by D. J. Brown, Esq., W. Carruthers, Esq., F.L.S., R. F. Tomes, Esq., F.Z.S., Charles Moore, Esq., F.G.S., the Rev. P. B. Brodie, M.A., F.G.S., and Captain Hussey.

II.—June 6, 1866.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair. The following communications were read:— 1. "On the Metamorphic and Fossiliferous Rocks of Co. Galway." By Prof. R. Harkness, F.R.S., F.G.S.

A great portion of the area under consideration was described as being occupied by contorted gneissose rocks, striking east and west, with a prevailing southerly dip towards the granitic area of Galway Bay. Quartzose rocks, exhibiting great folds, give rise to the bold mountainous scenery of Connemara; and reposing on these, and passing underneath the gneissic strata, is a band of serpentinous limestone, the structure of which is not of animal origin, but results solely from mineral association. The gneissose rocks on the north are covered unconformably by sandstones, the fossils of which indicate the horizon of the Upper Llandovery rocks. These metamorphic rocks correspond with those of the Highlands of Scotland, representing the Upper Quartz rocks, Upper Limestone, and Upper Gneiss, the positions of which are known in consequence of the Lower Limestones at Durness having been determined to be not lower than the Llandeilo Flags.

2. "On the Metamorphic Lower Silurian Rocks of Carrick, Ayrshire." By J. Geikie, Esq. Communicated by A. Geikie, Esq., F.R.S., F.G.S.

In surveying the southern district of Ayrshire, the author and his colleagues recognized the metamorphic character of certain Diorites, Serpentines, and crystalline felspathic rocks independently of each other; and Mr. J. Geikie had also been enabled to trace passages between the various altered rocks, which seemed to him to throw light upon the obscure process of metamorphic action. In this paper he first gave a generalized description of the metamorphic strata, dividing them into four groups, namely, (1) Felspathic Rocks, (2) Diorites, (3) Serpentines, and (4) Altered Limestone and Calcareous Greywacke, and again subdividing the Felspathic rocks into Amygdaloid, Porphyry, Brecciæform rocks, and finely crystalline Felstones, and the Serpentine into Schistose and Compact. He also described the association of serpentine with diorite, and stated that the only igneous rocks of the district, consisting of a few dykes of felstone and greenstone, are of much later date than the metamorphism, and have not altered the strata in contact with them. These and other facts described in the paper had enabled him to arrive at the following conclusions:—(1) That the strata owe their metamorphism to hydrothermal action. (2) That the varying mineralogical character of the rocks is due principally to original differences of chemical composition, and not to infiltration of foreign matter at the time of metamorphism. (3) That the highly alkaline portions of the strata have been most susceptible to change. (4) That in beds having the same composition, but exhibiting various degrees of alteration, the intensity of the metamorphism has been in direct proportion to the amount of water present in the strata. (5) That in some places the rocks have been reduced to a pasty condition.

3. "On a Cheirotherian Footprint from the base of the Keuper Sandstone of Daresbury, Cheshire." By W. C. Williamson, Esq., F.R.S., Professor of Natural History, Anatomy, and Physiology in Owens College, Manchester. Communicated by the Assistant Secretary.

The specimen in question was discovered by Mr. J. W. Kirkham, in the Lower Keuper Sandstone at Daresbury Quarry. It differs from all footprints hitherto obtained from this district, in being more quadrate, and distinctly that of a scaly animal; the separated toe is also less recurved, and approaches nearer to the other toes. The arrangement of the scales corresponds very closely with that seen in the foot of the living Alligator; many of them run across the foot in oblique lines, as is common amongst living Crocodilians, leaving no room to doubt that they represent true scales, and not irregular tubercles, such as are seen on the skin of some Batrachians. Traces of other impressions of feet occur on the slab, particularly an imperfect one with much larger and more oblong scales, especially under the heel; and this difference is so very similar to what is seen in the fore and hind feet of many Saurians, that Prof. Williamson believed that they did not belong to a Batrachian animal at all, but that they were Saurian, if not Crocodilian, in every feature.

4. "A description of some remarkable 'Heaves' or Throws in Penhalls Mine." By J. W. Pike, Esq. Communicated by Dr. C. Le Neve Foster, B.A., F.G.S.

This mine is situated in the parish of St. Agnes, in Cornwall, and is, from the extraordinary dislocations and heaves of the lodes and veins, without a parallel in any other part of the county. In the immediate neighbourhood of the workings, taking the well-known law that a lode or vein traversed is older than the one traversing it, there are in the order of formation, (1) four or five tin lodes, (2) three or four "Downright" lodes, (3) innumerable "gossans," (4) a great number of slides or faults, dipping at various angles, (5) four cross courses, and (6) certain caunting slides. The mineral productiveness of the tin lodes is increased by the proximity of the gossans, but not by that of the slides; and although the dislocations are most perplexing to the miner, the district has yielded great riches, and has been worked from time immemorial.

The following specimens were exhibited:—1. A Cheirotherian Footprint from the base of the Keuper at Daresbury, Cheshire; exhibited by J. W. Kirkham, Esq. 2. Specimens of Gold from Nova Scotia, and Silver Ores from South America; exhibited by Prof. J. Tennant, F.G.S.

Geological Society of Edinburgh.—May 3rd, 1866.—R. A. F. A. Coyne, Esq., C.E., Vice-President, in the Chair.—Mr. George Lyon read a paper "On the occurrence of two Trap-dykes, one on the North, the other on the South side of Edinburgh." The one situated opposite the Archer's Hall, had all the character of an intrusive rock; the other on the side of the City of Glasgow Bank in Hanover Street, had caused a considerable disturbance and contortion of the strata, which dipped at the point in question at a considerable angle to the north.

Mr. D. J. Brown read a paper entitled, "Have we had recent upheavals of the shores of the Firth of Forth?" In his introduction, he mentioned that numerous papers had been written on the subject, two of the authors—Mr. Archibald Geikie and Mr. Thomas Smyth—contended that there had been an upheaval of the land since the Roman invasion. This had induced him last summer to make an examination of the south coast from South Queensferry to near Fast Castle. Beginning at the Ferry, he first mentioned Barnbougle Castle, which, he considered, overthrew Mr. Smyth's assertion that the land is at present rising at the rate of five feet in the century; because the Castle is more than one hundred years old and the windows of it are nearly reached by the tide, and sixty years ago, when it was still inhabited, the lower appartments must have been filled by the sea. He mentioned the "Roman Eagle," carved on a rock, a little to the West of Cramond village, which Mr. Geikie terms the work of some "idle peasant or truant school-boy." Mr. Brown asked why the idle peasant or truant school-boy should choose for his subject a "Roman Eagle," and how account for its weathered appearance but by its great age. Of the old Roman port at Cramond no vestige now remains, hence it was useless as evidence. Besides, the mouths of rivers have a great tendency to silt up, and are, in the opinion of the author, the worst places to seek evidence on this subject. He then mentioned the bed of shells found at the old quarry near Granton—a bed which must have lain undisturbed for many ages; but although this bed had been minutely searched, no traces of man had yet been found in it. Mr. Brown next referred to the tide-register at Leith Docks, an old church and burying-ground at North Berwick, and some old graves near Dunbar, to show that there is no rising of the land taking place at present. A portion of the graveyard at North Berwick has been washed away by the sea in consequence of its being near the level of high tides. The church was built in the middle of the twelfth century, and there could have been no material rise since that time. The graves near Dunbar are just about the ordinary high-tide level, and according to antiquaries are about one thousand years old; hence there can have been no rise of the land since that period—a period which would carry us back to within a few centuries of the Roman occupation. Mr. Brown concluded by stating that in the other parts of the coast which he had visited, he could see no evidence that the land had risen since man inhabited the country, and that geologists should suspend their judgment regarding the upheaval of our shores during the human period until further evidence be adduced.

Glasgow Geological Society.—The last monthly meeting of the winter session of this Society was held in the Society's Room, Andersonian University, on the 12th April—Dr. John Scouler, F.L.S., Vice-president, in the chair.

Mr. James Bennie exhibited two specimens of remains belonging to the ancient, but now extinct, cattle of Clydesdale, and which Dr. Scouler had identified—the first as a small specimen of part of the forehead and horns of the *Bos longifrons*, which he (Mr. Bennie) had got from an excavation in Rutherglen Loan, and the other as a horn of the *Bos primigenius*, which he had got from an excavation in Greendyke Street. The excavation in Rutherglen Loan was for a sewer, and was from 7 to 8 feet deep. The remains of the *Bos longifrons* he had obtained from it, was found near to Rose Street, in a deposit of unmistakeable river drift, consisting of sand, gravel, drift wood and bark, hazel and oak nuts, leaf beds, and other vegetable débris. The hollows in the specimen were filled with the grey sand, and Mr. Bennie called attention to two oval holes which had evidently been made by some implement, for what purpose he could not say, but he had little doubt of their having been bored by one of the old canoemen of the Clyde, with whom there were not wanting proofs that these extinct Clydesdale cattle had been contemporaneous, one of which he produced in the shape of a perforated stone sinker, got from the same bed, and which was similar to some of those he had got from Windmillcroft Dock. The cutting in Greendyke Street was also for a sewer ; it was about 10 or 11 feet deep, and although the section of it from which he had obtained the horn of the *Bos primigenius* was composed of a black earthy silt, without any trace of sand, gravel, drift-wood, or nuts, numerous leaf beds occurred in it, with innumerable roots and stems of water plants traversing them, marking it unmistakeably as a deposit of river silt.

A paper was then read "on the Occurrence of Coal Strata under the Traps of the Bowling Hills," by Mr. Alexander Currie, of Bowling, in which he said that with the view of corroborating the opinions held by various members of the society, in opposition to those put forth by the officers of the Government Geological Survey, he wished to direct their attention to the occurrence of certain coal seams which had come under his observation, in his own neighbourhood, and which, being overlaid by the traps of the Bowling Hills, might help to throw some light on the age of these igneous rocks which form the western termination of the Kilpatrick range. The physical aspect of this beautiful range of hills must be familiar to all who have sailed up and down the Clyde, or who have had the pleasure of rambling among them and examining their structure. From near Old Kilpatrick to Dumbarton they impinge on the shores of the Clyde, forming in some parts of the foreground a series of abrupt conical heights, such as Dunglas, Dumbuck, and Dumbarton rock ; while in the background there are the lofty terraced fronts of the Long Craigs and other eminences, the whole presenting a scene only to be witnessed among the trap-hills of Scotland. It is evident that the Bowling Hills form part of the great chain of trappean heights that extend across Scotland in a north-east and south-west direction from Androssan on the Clyde to near Montrose on the north-east coast; they are continuous, although now only under the Clyde, with the trap-hills of Renfrewshire. The age of these great igneous outbursts—always a subject of interest to those engaged in their investigation—can only be satisfactorily determined by the age of any sedimentary strata, which they overlie, erupt, or otherwise disturb. The officers of the Geological Survey, in their new sketch map, have coloured this great chain of trap-hills as of Old Red Sandstone age, holding that they were erupted before our Carboniferous strata were deposited. If such were the case, they ought not to be found overlying or altering the beds along their margins, as it has been clearly shown they unquestionably do in many sections along their course through our western coalfield, and as the section which he now brought under their notice not less clearly proves. The section he referred to may be seen in Auchentorlie Glen, an interesting ravine on the hillside, immediately to the west of the village of Bowling. On entering the glen a little to the north of the Dumbarton Road, the stream is seen to have cut its way through an overlying bed of greenstone containing crystals of glassy felspar, which rock forms the sides of the glen in its lower reaches, and dips southwards towards the Clyde. A little way up on the left-hand side, there is a cave-like recess under the trap, partly filled with water, which has been formed by the scooping out of a bed of coal and shale which crop out near the level of the stream. The trap is here seen resting on the coal, which dips to the south-west at an angle of 26 degrees, and is about two and a half feet in thickness. It is considerably burnt in its upper part, but some of it gives off a little flame. Between the coal and the trap there is a thin bed of clay shale, and another shale underlies the coal; but its thickness cannot be ascertained, owing to its position on the level of the stream. The trap, where in contact with the coal, has been changed into a lightish coloured rock, but a little higher in the bed it resumes its normal tinge of a dark blueish grey. A few yards higher up the glen, there is a small waterfall, where the stream tumbles over a ledge of the trap which overlies the coal. The strata here dip to the south-east at an angle of 24 degrees. The coal-bed stretches right across the stream, and is overlaid by, and rests on, clay shale as in the former section; but without boring it is impossible to say what thickness of coal strata may exist here, nor, in the absence of organic remains, can the relationship of this bed to our other Coal strata be satisfactorily ascertained. That it belonged to the coal Measures proper he had little doubt, although occurring nearly two and a half miles within the trappean border; but whether its position was above or below the Hurlet or Campsie series he could not say. However, the fact that the lowest bedded traps of this part of the Kilpatrick range rest directly on Carboniferous strata, which they have also burnt on the upper side, cannot be gainsaid, and they cannot, therefore, be of Old Red Sandstone age, as assumed by the Government surveyors.

Dr. Scouler next gave an account of the various remains of extinct quadrupeds found in the valley of the Clyde. They include the elephant, the *Bos primigenius*, the reindeer, and the red deer. The remains of the red deer are by far the most common. They occur in bogs, in the alluvial soil, and in the river alluvium. The reindeer is more rare; but a fine specimen was found near the Endrick several years ago; and Dr. Scouler exhibited a fragment of the horn of this species dredged from the Clyde, near Renfrew. A fine specimen of the head and horns of *Bos primigenius*, exhibited by Dr. Scouler, was also found in the Clyde, near Renfrew, in digging the foundations for a house. Kilmaurs, near Kilmarnock, must have been a great resort of the Mammoth, as no fewer than nine tusks of it had been found there, which would indicate at least five elephants, and it is somewhat remarkable that none of their bones have been traced, with the exception of a portion of a molar found by himself. The horns of the reindeer were found associated with these remains of the elephant.

28th April, 1866.—The first excursion of the season was a visit to Corrieburn, on the Campsie Fells. The Corrie is situated on the hillside, about a mile and a half to the north of the road leading to Kilsyth, and about two miles north-west from that town. From the variety of phenomena exhibited in the sections of both its east and west burns, and its easy access from Glasgow, it is perhaps one of the very best of the many localities for geological field study in the immediate neighbourhood of the city. The hillside sections of Corrie exhibit in their lowest divisions beds of trappean (volcanic) ash and greenstone, overlaid by strata of sandstone, limestone, shale, coal, and ironstone. The geological position of the Corrie beds is in the lower division of the Carboniferous Limestone series, and the limestones and shales are characterised by an abundance of the peculiar marine organisms of that period. The members then proceeded up the west burn, examining the numerous boulders in its bed, which have been washed out of a great deposit of Boulder Clay, which forms the western bank of the stream. Many of these boulders are of great size—one of them, in particular, being estimated as upwards of 50 tons in weight; some of them present very distinct traces of glacial striæ, and are, indeed, among the finest examples of large striated boulders in the district around Glasgow. After examining the altered strata of sandstone, limestone, and shale in contact with the trap rock above the lofty waterfall in the western burn, the party proceeded along the hill-side to the eastward, where a thin vein of sulphate of Barytes in the trap crops out. It contains traces of silver and copper, which were once unsuccessfully attempted to be worked. Specimens of the heavy spar, as it is called, having been procured, the party reached the eastern burn in the Corrie, where a very fine section of shale, with nodules of clay ironstone, is seen. In passing along the hill-side the sandstones and shales are seen to be very much indurated near their junction with the trap rocks, proving clearly that the various sedimentary beds of the Corrie had been elevated, disturbed, and altered since the period of their original deposition.

The various points of geological interest were pointed out and explained by Mr. John Young to the members of the society; and as they rested on the hill-side they were favoured, under a clear atmosphere, with a most varied and extensive view:—spread out before them, like a map, lay the great coal basin of central Scotland, with its undulating heights and cultivated fields—to the south-west, dimly seen in the distance, was Goatfell, and one or two more of the Arran mountains, towering over the trappean hills of Ayrshire, which, with the hills of Renfrewshire and Lanarkshire, bounded the view to the south and south-west—Tinto soaring over all in front, and the Pentlands closing in the view on the extreme east, while the more elevated range of the Campsie Fells closed in the view on the north.

Cotteswold Naturalists' Field-club.—The members assembled for the first Field-day of the season, at Haresfield Station, on May 16th.

The Haresfield section was first examined; and from thence the members proceeded to the small quarry on Broadbarrow-green, where there is a wonderful display of the Gryphite grit. The quarry above White's Hill was examined, where the Trigonia-beds and Oolite marl received due attention; some of the *Trigoniæ* being almost as sharp and well-defined as recent shells.

At Scot's Quar, Captain Dickinson, of Brown's Hill, provided an excellent luncheon, to which the club did ample justice.

Under the guidance of Messrs. Pullen and Witchell, both well acquainted with the geology of the district, the club proceeded to investigate the Coral-beds of the Inferior Oolite. Crossing the Painswick Valley, to Juniper Hill, they examined a coral-bed twenty feet thick, which has been ascertained to extend for several miles. This hill is capped with strata charged with the characteristic *Terebratula globosa.*

The club dined at the Imperial Hotel at Stroud, after which they proceeded to discuss various subjects of interest. A good specimen of a bird, now somewhat rare in Great Britain, viz., the Dartford Warbler (*Melizophilus provincialis*), obtained by Mr. Jenner Fust, in Kent, was exhibited; also some relics of a Roman villa by the hon. secretary, Dr. Paine. These were obtained on the site of a house now being erected by Mr. Wethered, at Stroud. Dr. Wright then gave an interesting address on the palæontological evidence afforded by the sands of the Upper Lias of the Haresfield and other Cotteswold sections, illustrating his remarks by the exhibition of several beautiful and typical fossils. He mentioned that more than twenty years ago he had detected the peculiar and distinctive Ammonite, the *Am. opalinus* of Reineker, in the Upper Lias sands at Haresfield. This form of Ammonite marks this zone of deposits, between the Lias and the Inferior Oolite, at Braun Jura, at Gmünd, and at Gündershofen, Lower Rhine. The form of Ammonite which may be said to replace it in the Inferior Oolite is the *Am. Murchisoniæ.* Dr. Wright declared that the sands possess an entirely different fauna from the Inferior Oolite, and ought to be classed as Upper Lias beds, to which they palæontologically belong.

Mr. Symonds, of Pendock, requested the attention of the geologists of the Cotteswold Club to a matter which he considered of importance to the public in general. He alluded to the miserable building materials which, under the very indefinite cognomen of "Bath stone," are used by architects and builders in so many houses and churches erected far away from the Cotteswold Hills, even among the hills and vales of Wales. Much of this so-called "Bath stone," when used for external purposes, is utter rubbish, and weathers and shivers with the first winter's frost. He mentioned examples of the window sills and plinths of several churches and houses which had fallen under his observation, the weathering of the building stone of Eastnor obelisk, of various railway bridges, of exterior ornamental work at many churches, and declared that he strongly suspected the capability of the stone of which Sir Cornewall Lewis's monument is erected, at New Radnor, to resist the effect even of a few years' frost. What, then, was Bath stone? It appeared to him that it was a most indefinite, misleading, and unsatisfactory term, and was applied alike to the truly good building stones of certain beds in the Oolitic deposits, and the wretched stuff sent down by builders and architects to their misled and ill-fated employers in the vales. A friend, who was building an expensive house in Hampshire, was to have the window facings, &c., of "Bath stone," from the Box Tunnel. Would any Cotteswold geologist inform him whether this Box Tunnel "Bath stone" would stand the weather, or shiver in two winters into atoms? Would the Cotteswold Club unite in giving the public information on the proper localities where really good weather stone might be obtained, and endeavour to stir up architects, builders, and engineers, to educate themselves in the elements of lithology and geology, and thus to make themselves acquainted with the beds of rock proper to be used for external purposes, and save their employers from much future annoyance and expense?

Mr. Symonds's speech caused considerable discussion, and the subject was taken up and replied to by Dr. Wright, Mr. Witchell, and Mr. Stanton.

Dr. Wright said that it was an almost painful question, and still more painful to see money thrown away in consequence of the use of improper materials. The subject was too large and too intricate for the Cotteswold Club to take up, and proper men, paid for their services, should be appointed to select beds that would resist the action of the weather, who understood what they were about, and were not utterly ignorant of the first principles of lithology and mineralogy. No gentleman building a house should trust an architect or a builder in the selection of stone for external purposes, as architects and builders were at present educated. It was most desirable that the question be thoroughly ventilated and investigated. In this progressive and scientific age it would become necessary that architects, engineers, and builders should make such subjects a part of their education, instead of going to work, as was too often the case now-a-days, in utter ignorance of the elements of those economic sciences which were so really useful and necessary to their profession.

Both Dr. Wright and Mr. Witchell agreed that the true Bath Stone of the Box Tunnel, from the beds of the Great Oolite, was excellent building stone for exterior as well as interior purposes.

The Severn Valley Field-club.—The first meeting for the year was held at Dudley, on May 31st. The members on arriving at Dudley proceeded to the Museum of the Dudley and Midland Geological Society, where they were met by several members of that society, and spent some time in examining the very fine loan collection of the fossils of the district. The trilobites exhibited by Mr. Hollier, including the well-known *Homalonotus* belonging to Mr. Blackwell, attracted great attention, as did the fossils from the band of shale passed through in the new sinkings at the Old Park. It has been disputed whether this shale, overlying the Wenlock Limestone of the Wren's Nest, should be classed as Wenlock or Lower Ludlow; but the general verdict of the geologists present appeared to be in favour of the latter. The whole party then proceeded to the Wren's Nest, where the outer workings in the upper band of limestone on the western face of the hill, were first inspected. These were followed to the northern end of the hill, where the anticlinal fault, which throws off the limestone to the east and west, was noticed; and the upper line of caverns was traversed on returning. Here a very able and lucid address on the geology of the district was delivered by Mr. J. Jones, secretary of the Dudley Club, in the absence of the Vice-President, F. Smith, Esq., who was unable to attend. After admiring the long perspective of the caverns with its varied effects of light and shade, and collecting some of the characteristic fossils in the outer workings on the eastern flank of the hill, the fault at the southern end, which throws down the Upper Limestone on the west to a level with the lower band on the east, was examined. The sinkings at the Old Park were next inspected, and, on the way back to the town, the Ruins of the Priory were passed and visited.

The members of both clubs sat down together to a cold luncheon at the Dudley Arms Hotel, after which some exceedingly beautiful and perfect specimens from the collection of Mr. E. Hollier were handed round by him for inspection. Amongst them were the original of the Ceratiocaris tail-spines (figured in the Geological Magazine for May last), and a new and undescribed star-fish. A visit to the Castle, under the guidance of Mr. Hollier, and some others of the Dudley Club, concluded the day's proceedings.—C. J. C.

Malvern Field-club.—The members of this club held a field day in the neighbourhood of Tewkesbury, on Wednesday, the 9th May. They were met at the Abbey Church by the Rev. Canon Davies, who courteously conducted them over that fine old building.

and explained the leading points of its noble architecture. From thence the club proceeded to the "Bloody Meadow," where the President, the Rev. W. S. Symonds, M.A., F.G.S., of Pendock, read a paper on the events that led to the Field of Tewkesbury, and the chief details of the battle. The club then proceeded to the woods, where a rare plant, the "Smooth-leaved Hound's Tongue," (*Cynoglossum sylvaticum*) was gathered by Major Barnard and Mr. Lees. Passing on through greensward, and surrounded by the beautiful blossoms of the orchards of Deerhurst, Mr. Symonds led the party to Apperley Court, the residence of Miss Strickland, who had hospitably provided refreshments for the members and their friends. The collection of mammalian remains which were obtained by the late Hugh Strickland, Esq., the well remembered geologist and naturalist, from the low level drifts of the Avon valley near Pershore, were examined, and the naturalists looked upon the fossil relics of elephants, hippopotami, rhinoceri, deer, and gigantic wild cattle that lived and died on the shores of an ancient Avon and Severn many a long year ago. W. S. S.

Warwickshire Naturalists' and Archæologists' Field-club.—The first summer meeting of this club took place at Nuneaton, on Wednesday, May 16th, 1866. The members assembled at the Coton Railway Station, and first examined the interesting sections of the Lower Coal-measures with intrusive trap, exposed along the line. The succession of the beds raised a good deal of discussion, for it presents some difficult questions as to the circumstances which caused the influx of the igneous rock in connection with the coal-shales, which, in some cases, though in close proximity, remain little changed, and in others have undergone much alteration. After a pleasant walk the party reached Haunch-Wood Colliery, where, although it was stated that no fossils were to be found, the Rev. Mr. Brodie and other geologists soon discovered abundant evidence of the life of the period, namely, ferns, reeds, *Lepidodendron*, and *Sigillaria*, the estuarine shells *Anthracoptera* and *Anthracomya*, and the teeth and jaws of Sauroid fish. In fact, the whole of the Warwickshire Coal-field abounds in fossils. Proceeding thence to Hart's Hill, a careful examination was made of the altered Millstone-grit of which this anticlinal axis is mainly composed, the trap rocks, which vary much in character, appearing at each end of the ridge. The summit affords a fine view over the country—Charnwood Forest is seen in the extreme distance. The party consisting entirely of geologists, the day was exclusively devoted to the sections which are of special interest in this district, few places indeed present within a small area such an instructive lesson in physical geology.—P. B. B.

Bath Naturalists' Field-club.—The second excursion of the season took place on 15th May.—As this meeting was especially devoted to Geology, Mr. Charles Moore, F.G.S., undertook the guidance of the members, who mustered in good numbers at the Bath station. The route taken, was from Bath to Shepton Mallet by train and thence across the Mendips to Wells and Frome.

After leaving Shepton Mallet, on the right hand side of the Bath road, an interesting section was seen, where on the upturned edges of the Carboniferous Limestone are horizontally deposited beds of Rhætic and Liassic age. This succession is due to one or more faults which have brought the Liassic beds on a level with the Carboniferous limestone, against which the former rest at a slight angle. These Liassic beds, which are unmistakeably the same in geological age as the Weston beds near Bath, and contain the usual Lower Lias fossils, assume a precisely similar appearance to the "Sutton stone" beds at Southerndown,[1] and both lithologically, and as regards their fossil contents, at once presented to those members who had joined the Southerndown excursion, a striking resemblance, if not perfect identity,—the first few blows of the hammer revealed the usual fossils, *Lima gigantea*, *L. punctata*, etc., of the Lower Lias, and many specimens of *Ostrea liassica*. The same bed was traced on rising ground the other side of the road. The chief peculiarity noticeable in this, as compared with the "Sutton stone" series, was the absence of corals, of which during this short visit no traces could be found. Even the very flinty conglomerates, which form so conspicuous a feature in the beds at Southerndown, are traceable here. The members then mounted the axis of the Mendips, and followed the Romano-British Road, called the "Ridgway," till they arrived at the Beacon, one of the highest points. Whilst passing along the Ridgway, several indications of Trap were noticed, especially one in an adjoining field, where Mr. Moore pointed out this rock cropping out in the form of a boss, thus giving evidence of a mighty volcanic movement which took place at a remote period, the limestone, before horizontal, being then upheaved by this great protuding mass, and thrown off on either side with considerable force; the lava at the same time bursting forth wherever a vent could be found. The approximate time of this upheaval must have been after the deposition of the Coal-measures. For in the Valley to the north, the older rock overlies the more recent strata, and coal is worked beneath the Carboniferous limestone, which Mr. Moore accounted for by the great force of the upheaval doubling the strata thus back upon itself. The recent discovery of the Trap rock in this neighbourhood adds weight to the theory. H. H. W.

CORRESPONDENCE.

PROF. J. BEETE JUKES' REPLY TO MR. G. POULETT SCROPE'S ARTICLE.

To the Editor of the Geological Magazine.

Sir,—I am unwilling to allow Mr. Poulett Scrope's article in your last number to pass *sub silentio*, and therefore seize the first halt that occurs to me, since receiving it, to pen a few words in reply to it.

[1] See paper by Mr. E. B. Tawney—Geol. Mag., January, 1866, p. 39.

First let me acknowledge my own debt of gratitude to Mr. Poulett Scrope, whose clear exposition, more than thirty years ago, of the purely subaerial origin of the valleys of Central France has had, perhaps, even more influence on my mind than I was altogether conscious of, in leading me to correct views of the amount of the action of atmospheric forces. I used, indeed, to suppose that this was an exceptional case, or one applicable only to soft Tertiary rocks and thin lava streams, till my investigations into the origin of the river valleys of the South of Ireland showed me that it was only a normal example of a universal rule.

The subject of the production of the "external form of the ground" is one which has been so little discussed, that it is difficult to write on it without being misunderstood.

By the "form of ground" I would mean, not its altitude above or below the level of the sea, still less the position, (horizontal, inclined, bent or broken) of the rocks composing it,—but simply the *form of its external surface:* and I think Mr. Poulett Scrope will agree with me that internal forces have never any direct effect upon that, except to a slight extent and only for a brief period of time.

Even a volcanic cone could not stand ten years without having its sides more or less washed or gullied by rains, abraded by winds, or modified in some way and to some extent, however slight.

The direct effects of earthquakes in cracking, or bending *the surface,* are surely very insignificant, and the features thus produced are externally modified almost as soon as they are made.

Great elevation and depression of land might occur, and apparently has occurred, without any alteration of "the form of the ground," though of course some change of slope about the boundaries of areas thus acted on must be produced even at the surface.

I hope Mr. Poulett Scrope will pardon me if I say that I do not know whether "the basin of Switzerland" be "a synclinal valley between the elevated ridges of the Alps and Jura" or not. Still more ignorant am I of the Italian side of the Alps, a region I can never hope to visit till the Geological Survey of Ireland is finished, and long before that time I shall probably myself be passing into the inorganic condition.

The hills in the central valley of Switzerland are, I believe, "hills of circumdenudation:" that is, are hills solely because of the removal of the matter which once surrounded them.

The hills of the Jura and the Alps are, doubtless, "hills of uptilting," that is, the rocks composing them are at that altitude and in that position in consequence of having been thrust up by forces acting from the interior. But the rocks which we now see at the surface were not at, or near, the surface at the time they were thus thrust up.

The present surface cuts across the edges of beds having an aggregate thickness of many thousand feet. If that surface was formed before the rocks were disturbed and while they were still horizontal, there must have been an excavation in order to form it, sufficient to show a section of that depth, and the subsequent elevation must have been confined to that previous hollow.

No one would uphold such an idea.

It follows then that while the beds were being tilted up, or since they have been tilted, a sufficient mass of rock has been removed to allow of the edges of some beds appearing at the surface that were once buried many thousand feet below it.

In other words, the present surface of the ground has been gradually arrived at by the external removal of vast masses of rock that previously covered it.

It makes no difference whether the surface be a perfect plane or a corrugated mountain chain, wherever beds crop to the surface, it can only be the effect of denudation.

A plain formed across the edges of a great series of beds, shows that either from length of time or other circumstances the external denuding force has completely obliterated the effect of the action of elevation.

A mountain chain shows that along a certain band of country the action of elevation has been so great, or so long continued, that the forces of denudation have not been able to overcome it.

The mountains still stand in spite of the denudation, although probably it has been much greater there than in the surrounding regions, and therefore the most deeply-seated rocks have succeeded in reaching the surface there.

In every case the "form of the ground," whether in mountains, hills, valleys, or plains (except those so recently made that there has been no time to modify it), is the result of external action upon materials variously prepared and placed for it by internal force.

I should suppose that the Alps must have concealed in them one or two or more old surfaces, on which the superior formations repose uncomformably. Whether it will ever be possible to distinguish these I do not know, but it must be done before the structure of the mountains can be understood, or their history be unravelled. Careful sections, on a true scale, with nothing inserted that cannot be actually seen, must also be constructed before we can be said to be in possession of even sufficient data to state the problem of Alpine geological history.

Lastly, allow me to say that I feel sure there is no real difference between Mr. Poulett Scrope and myself in our opinions on this subject, and that any apparent difference arises from the want of a precise settlement of the meaning of terms.

J. Beete Jukes.

P.S. There is one passage in Mr. Mackintosh's letter on which I may usefully make a remark, and that is at page 282, where he speaks of the Old Red Sandstone of Herefordshire as more easily eroded than the Carboniferous Limestone. The Old Red Sandstone of Cork and Kerry, however, is much harder than that of Siluria, the shales being all converted into hard clay-slates by true slaty cleavage. Many parts of the Old Red of the south-west of Ireland indeed are lithologically very like parts of the Cambrian rocks of North Wales and Wicklow.

Kilronan, Arran Island, Galway Bay, *June* 11*th*, 1866.

THE DENUDATION CONTROVERSY.

To the Editor of the Geological Magazine.

Sir,—Believing that an amicably-conducted controversy creates a desire to re-examine old, and pursue new lines of investigation, I am glad that my articles on "Denudation" have excited interest among eminent men of science.[1] I should be grateful to Mr. Aveline if, to his avowal of opinion, expressed in your last number, he would add his *reasons* for supposing that the Longmynd valleys have been excavated by streams. I have just read Professor Jukes' testimony to marine denudation in his "Student's Manual of Geology," published in the same year (1862) in which his paper on the River-Valleys of the South of Ireland was read before the Geological Society. The following is a brief extract:—"The passes leading across the crests of great mountain-chains could have been produced by no other cause than by the eroding action of tides and currents, as the mountains rose through the sea. . . . . Isolated crags and precipices, or long lines of cliff, and of steep slopes, looking down upon broad plains, must have in like manner been formed by the sweeping power of the sea. Broad open valleys attest a similar origin, and speaking generally, the principal features in the form of the ground in all lands have been produced by this wide-spread action. . . . . The results of this erosive action are exhibited to us often in the most striking manner in the gorges and ravines of mountain slopes" (page 101). The great reason why Professor Jukes so suddenly modified the above declaration of belief, would appear to have been the "revelation" that, during the *denudation*, our lands have not been a sufficiently long time submerged to enable the sea to accomplish it. I hope soon to be able to prove that the drift deposits of Siluria furnish undeniable indications of long, if not repeated, submergences, during comparatively recent periods.

Yours truly,

D. Mackintosh.

DISCOVERY OF FLINT IMPLEMENTS IN KENT.

To the Editor of the Geological Magazine.

Dear Sir,—It may be of interest to record the fact, that a number of flint implements have been found by Mr. J. Brent, jun., of Canterbury, between the Old Haven Gap and Reculvers. These implements, seventeen in number, are mostly of large size, of the Amiens type, very perfect. They were found strewn on the beach. One is a very interesting specimen, being extremely flat and sharp, of the figure represented in Sir Charles Lyell's "Antiquity of Man," page 114, fig. 8, and about the same size. It is remarkably weathered, and of an opaque white colour. The other specimens showed little or no

[1] In the last number at page 281, line 21, read *are the result* instead of "are not the result."

discolouration. Kent has also lately yielded a number of specimens to the careful search of Mr. W. Whitaker, F.G.S.; some of these are from the neighbourhood of Dover and Sandwich.

Yours truly,
GEORGE DOWKER.

STOURMOUTH HOUSE, *June* 11*th*, 1866.

QUARTZ CONGLOMERATE BED.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—There is at present on the shore at Cushendun in the County of Antrim, a mass of extremely hard Conglomerate, some scores of yards in length and breadth, and from thirty to fifty feet above the sea. This is composed of round pebbles of quartz rock, from two to four inches in diameter; and they occur so closely packed, that every one is in contact with another, and no room left, except for the sand which cements them, and which fills the openings between the pebbles, when originally heaped together.

These pebbles, as just stated, are of quartz rock and therefore all of one kind. There is no actual rock of the same kind, on the shore, nearer than—1. Malin Head, or Culdaff, in Donegal; 2. Belderg, east of Belmullet in Mayo, where it occupies the shore for fourteen miles; and 3. in the twelve bins, near Clifden, in Connemara, where it forms bands interstratified with Mica Slate.

This mass is backed by a hill of brown Devonian grits and shales interstratified, which extends from Cushendun to Cushindall. In both those rocks are a few round pebbles of quartz rock, similar to those in the mass on the shore, but in the rocks of the hill they are thinly disseminated, perhaps six or ten of them to a cubic yard.

Perhaps some of your numerous correspondents would have the kindness to explain how the pebbles of this mass were brought together, unmixed with pieces of rock of any other kind.

I am, Sir, Yours, etc., very truly,
JOHN KELLY.

38, MOUNT PLEASANT SQUARE, DUBLIN, 22th May, 1866.

Probably all the other pebbles were of softer materials than quartz and were consequently converted into mud and sand by the grinding motion imparted to the mass by the sea, when the Conglomerate formed the shingle-bank of the ancient coast.—*Edit.*

OBITUARY.

HENRY DARWIN ROGERS, LL.D., F.R.S.L. & E., F.G.S., Professor of Natural History in the University of Glasgow, died on Tuesday, May 29th, 1866. Though a native of the United States, he was of Scotch extraction, and the member of a family traditionally devoted to the culture of the exact sciences. At the early age of twenty-one he was appointed Professor of Chemistry and

Natural Philosophy in Dickinson College, Pennsylvania, which post he held for three years, when he came to Europe, chiefly for the prosecution of scientific researches. During this visit he turned his attention more especially to the study of geology, and on his return to the United States almost immediately entered upon his great undertaking,—the geological survey of the States of New Jersey and Pennsylvania. This work, the result of twenty-two years of unintermittent industry, consists of three large quarto volumes, illustrated with numerous engravings, and geological maps and sections of Pennsylvania and its Coal-fields. It at once established Professor Rogers' claim to a high position in the scientific world. Besides the local geology, it contains a general view of the geology of the United States, essays on the Coal-formation and its fossils, and a description of the Coal-fields of North America and Great Britain. It was published in 1858, but Professor Rogers, in his official capacity of State Geologist, had previously brought out five annual reports on the geology of Pennsylvania, and two on New Jersey, published between the years 1836–1841. Professor Rogers contributed a sketch of the Geology of the United States to Keith Johnston's Physical Atlas (1856). He has published many original papers in the American Journal of Science, the Proceedings of the Boston Society of Natural History, the Transactions of the American Philosophical Society, the Reports of the British Association, and the Proceedings of the Geological Society of London. He also delivered a lecture on the origin of the Parallel Roads of Lochaber (Glen Roy), before the Royal Institution, on March 22nd, 1861. In the last number of the GEOLOGICAL MAGAZINE (p. 258), we reported two papers on Coal and Petroleum which Professor Rogers read at Norwich in April last, notwithstanding that he was so unwell as to be obliged to sit the whole time, and to a great part of the assembly his discourse was inaudible.

PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF GLASGOW. —We have very great pleasure in announcing that Dr. John Young, F.R.S.E., F.G.S., is the successful candidate for the chair of Natural History in the University of Glasgow, rendered vacant by the death of Prof. H. D. Rogers. Dr. Young is an able Comparative Anatomist and Physiologist, and is well versed in general Zoology; his Natural History studies began under Professor Goodsir, and the late Professor E. Forbes, in the University of Edinburgh, of which he is a Doctor of Medicine. For the last five years he has been engaged, as a field geologist, on the Geological Survey of Great Britain, and during that time he has done much detailed work in Geology and Palæontology. In June 1864, he communicated to the Geological Society of London a paper on the former extension of glaciers in the high-grounds of the south of Scotland,[1] and he has recently read, before the same Society, several important papers on Fossil Ichthyology.

[1] Published in Quart. Journal. Vol. xx., p. 452.

THE

GEOLOGICAL MAGAZINE.

No. XXVI.—AUGUST, 1866.

ORIGINAL ARTICLES.

I.—Ancient Sea Margins in the Counties Clare and Galway.

By G. Henry Kinahan, F.R.G.S.I.

In a paper that appeared in the "Geologist" for May, 1863, the author, Professor King, has noticed the remarkable escarpments that occur in the Burren Hills, on the south side of the Bay of Galway. He is of opinion that they have been formed by sea action during the slow upheaval of the British area after its submergence during what he calls the "subaqueous" or "middle division" of the Glacial period, and that "every escarpment indicates a stoppage in the upheaval." These escarpments, or ancient sea-margins are not confined to the Burren Hills, as I have observed them in various other localities, but never so continuous, nor so well developed.

In this paper it is proposed calling attention to those in counties Clare and Galway. I shall first notice the conspicuous escarpments in the Burren Hills, but before doing so I may be allowed to refer to similar phenomena in course of formation at the present day.

During a short visit to the largest of the Arran Islands (Inishmore), at the mouth of Galway Bay, I remarked that on its south-western shore the Atlantic seems now to be cutting an escarpment in the nearly horizontal beds of the Carboniferous Limestone of which the cliffs are composed. The general section of this escarpment is as represented in Fig. 1. There are from four to seven terraces cut out by the action of the sea; one terrace by the high spring tides, another by the high neap tides, another by the low neap tides, another by the low spring tides, often with from one to three intermediate terraces, according to the thickness of the beds of limestone, and above them all is a "Blockbeach," formed of huge boulders hurled up during the winter gales. The above action is what seems generally to be taking place; but in some parts where master-joints occur, two or more of the above-mentioned terraces are merged into one, and when the master-joints are perpendicular or oblique to the

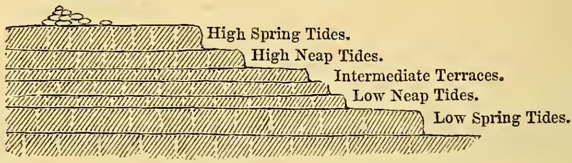


FIG. 1.—DIAGRAMMATICAL SECTION OF CLIFFS ON THE WEST COAST OF INISHMORE.

direction of the force of the waves, the destruction is much more rapid, giving rise to high, unbroken, precipitous cliffs.

The Burren Mountains display very similar results. In numerous places there are escarpments formed of from four to seven terraces cut out of the nearly horizontal beds of the Carboniferous Limestone. These continue for miles, but in places they appear to have been affected by the varying conditions found on the west coast of Inishmore. This is exhibited in the accompanying sketch of the

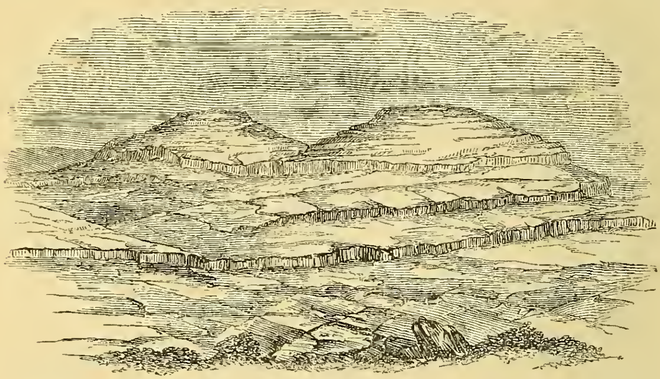


FIG. 2.—HILLS EAST OF GLENCOLUMBEKILLE, LOOKING NORTH-EAST.

hills on the east margin of Glencolumbekille, taken by my old friend and colleague, A. B. Wynne, F.G.S., now of the Geological Survey of India (see Fig. 2).

In the neighbourhood of Black Head, the north-west point of the Burren, the ancient sea-margins are very apparent when viewed from Yar-connaught, which lies immediately north of Galway Bay. Here an observer will remark three sets of terraces forming conspicuous escarpments as shown in Fig. 3.[1]

[1] The wood-engraver has not succeeded in this sketch; he has given the idea of three hills, instead of a mountain with three peaks, and has not continued the terrace to Cappanawalla.

The highest of these escarpments is near the summit of the three most western hills (Doughbraneen, 1,041 feet, Knockaghaglinna, 1,044 feet, and Cappanawalla, 1,028 feet), and is found to be at an altitude of about 975 feet. On Doughbraneen, the most western summit, its height on the Ordnance Map is 975 feet, and on Knockaghaglinna 985 feet; on Cappanawalla, the height nearest to the escarpment, which is south-east of the summit, is 968 feet. In places there is a steep rocky talus from this set of terraces.

The next conspicuous escarpment is about 650 feet in altitude. It forms the north-west shoulder of Doughbraneen, called Caherdoonfergus (647 feet), and also the cliff on the north face of Carnseefin (726 feet), the name by which the north shoulder of Doughbraneen is known. On the north of Carnseefin there is a steep rocky slope extending down from the lowest terrace.

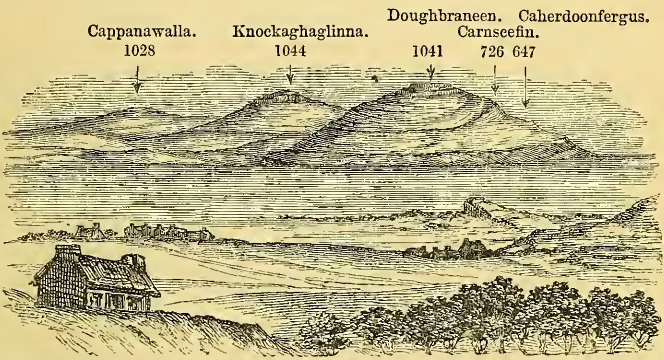


Fig. 3.—Black Head and adjoining Hills, as seen from Taylor's Hill, on the North Side of Galway Bay, looking South-west.

This escarpment is well marked, for on a clear day it is most conspicuous from the north shore of the Bay, and can be traced for miles along the sides of the hills. If we begin towards the west at Black Head, and extend the survey to the east, it will be observed along the north face of the above-mentioned hills, and winding round Cappanawalla into, round, and out of the valley in which Ballyvaughan is situated; from thence round Slieve-na-gapple into the glen at the head of Muckinish Bay, out of which it passes; it is next traceable along towards the east, until it finally disappears behind the hills that lie south-west of Kinvarra.

The third conspicuous escarpment is at about the height of 300 feet. It is well seen along the face of the hills from Black Head by Gleninagh to Harbourhill House, to the south of which, on the east slope of Cappanawalla, it disappears, as a steep rocky slope strewed with *débris* of the subjacent rocks, and extends down from the 650 feet escarpment to a level of about 150 feet. Farther east it can be again observed, and towards the west. On the S.S.W. of Black Head, it merges into a steep cliff, the Ordnance height of which, a mile

S.S.W. of the Head, is 294 feet. The Ordnance heights on this escarpment range from 290 to 320 feet; below it there is a rocky talus.

Such are the conspicuous escarpments seen in the north-west of the Burren. I shall now mention those that have been remarked in some of the other mountain groups, and shall refer the reader to the accompanying Tables, Nos. I. and II., in which all the well-marked terraces in the group of hills at the south-west of Yar-connaught and in Slieve-Aughta, are given.[1]

On examining Table I. it will be seen that in Yar-connaught, seven sets have been observed. The first is at about 130 feet, the second at 300 feet, the third between 500 and 600 feet, the fourth about 650 feet, the fifth about 750 feet, the sixth 900 feet, and the seventh 1,070 feet. Of these the 300 feet escarpment is the best marked, and next to it the 650 feet. The sixth and seventh were only observed in one place, and the third is very irregular.

In Slieve-Aughta, the mountain group that lies at the junction of Clare and Galway, there are numerous cliffs, but unfortunately the general surface of many slope at a high angle, and therefore very little can be learnt from them. Those that are nearly horizontal are noticed in Table II.

On referring to this table it will be seen that there are seven sets of escarpments, the lowest of which we may call number two, as it corresponds to the second set of escarpments in Table I. Number two is a little higher than 300 feet, number three is between 500 and 600 feet, number four is about 650 feet, number five is about 740 feet, number six is about 950 feet, number seven about 1,060 feet, and number eight 1,200 feet. Numbers two, four, and six are best developed; number seven was only noticed on two hills, and number eight only in one neighbourhood, as the other hills hereabouts are not of sufficient altitude. Number three, like its representative in Yar-connaught, is very irregular.

In conclusion I shall refer to Table III, by which the terraces, etc., north and south of Galway Bay, and those in Slieve-Aughta, can be compared.

In this table it will be seen that the sea-margins, respectively 300, 650, and 950 feet in altitude, are common to the three districts, and that the most conspicuous escarpments in the Burren correspond to those which, toward the north, are best developed in the south-east mountain group of Yar-connaught, as well as to those which, somewhat further south-east, occur in Slieve-Aughta.[2]

[1] In these tables, when possible, the height of the summit and base of the cliffs or terraces have been extracted from the Ordnance Maps, and when they are well marked, either at the base or summit, an asterisk has been put to the height.

[2] As I never had the time or opportunity of tracing out the various minor escarpments that occur in the Burren Hills, I have purposely only mentioned those that are conspicuous from the north shore of Galway Bay—the 130 foot escarpment could not occur in Slieve-Aughta, as the base of that mountain group is above this level.

TABLE No. I.—Heights of Ancient Sea Margins in Yar-connaught (South-east Group of Mountains).

(1 B. signifies Base. 2 S. signifies Summit.)

Name and Position.	1st Set. B.[1]	1st Set. S.[2]	2nd Set. B.	2nd Set. S.	3rd Set. B.	3rd Set. S.	4th Set. B.	4th Set. S.	5th Set. B.	5th Set. S.	6th Set. B.	6th Set. S.	7th Set. B.	7th Set. S.	8th Set. S.	Remarks.
Glan (North-west of Oughterard) ...	...	...	290*	...	...	...	...	660*	...	...	...	...	...	...	...	There is gravelly drift below 300 feet, and the base of the waterfalls are about 290 feet. In those parts of Glan, called Barratleva and Derroura, there are well-marked escarpments at about 660 feet. In the last named there are small mounds and ridges of drift up to the base of this escarpment.
Knockletterfore (West of Oughterard)	...	...	285*	400*	...	...	...	...	...	...	...	...	...	...	...	Drift escarpment, with sloping ridges; the base of which is 285 feet, and the highest part 400 feet.
Leam (Do.) ...	...	...	...	...	...	...	...	660*	725&	800	...	...	1063 &	1094	...	725, 800, 1063, and 1094 are the approximate heights of lines of cliffs.
Derryglinna (Do.) ...	...	...	...	310*	...	...	...	...	...	...	...	...	...	...	...	Line of cliff with gravelly drift below it.
Lettercraff (Do.) ...	...	171	...	...	...	...	...	...	...	...	...	...	...	...	...	Gravelly drift hills at the base of a Rock escarpment; the highest part of the drift is 171 feet.
Derrada (Do.) ...	...	...	290*	460*	...	...	620*	704*	...	...	...	...	...	...	...	Sloping drift escarpment. Rocky drift, which seems to be the débris of glaciers, down to 290 feet; below that is a gravelly drift. Steep rock escarpment; base, 620 feet; summit, 704 feet.
Rusheen (South-west of Oughterard)	112*	150	...	...	...	...	...	...	...	...	...	...	...	...	...	Gravelly drift escarpment; base, 112 feet; summit, about 150 feet.
Lettermore (Do.) ...	...	...	...	...	...	...	...	...	...	...	...	940	...	...	...	Cliffs; height approximate—(On the map the height below it is 930 feet, and above it 965 feet).
Lettercraffroe (Do.) ...	...	...	...	...	...	592*	...	...	...	...	...	...	...	...	...	Escarpments covered with large angular blocks.
Cloghermore (Do.) ...	...	...	...	...	470	600*	...	...	...	...	...	...	...	...	...	
Seecon (Do.) ...	...	...	...	300	...	...	...	...	...	750*	...	...	...	...	...	In the valley to the N. and N.E. of this town-land the slopes of the hills are covered with hummocks of rocky drift (glacial?) that extend down to the 300 feet level; 750 feet rocky drift cliff.

TABLE No. I.—*continued.*

NAME AND POSITION.	1st Set. B.	1st Set. S.	2nd Set. B.	2nd Set. S.	3rd Set. B.	3rd Set. S.	4th Set. B.	4th Set. S.	5th Set. B.	5th Set. S.	6th Set. B.	6th Set. S.	7th Set. B.	7th Set. S.	8th Set. S.	REMARKS.
Killaguille (South of Oughterard) ...	...	...	...	...	...	...	...	630*	...	...	...	...	...	...	...	Cliff. Nearly parallel with the base of this cliff is a low esker-like ridge of rocky drift.
Letter (North-west of Moycullen) ...	...	...	...	...	...	500	...	...	...	...	...	...	...	...	...	Cliff, well marked, but height only approximate.
Gortnamona (Do.) ...	85*	...	...	...	...	...	..	...	...	...	...	...	...	...	...	Terrace of drift.
Angliham (North of Galway)	...	150*	...	...	...	...	...	...	...	...	...	...	...	...	...	Well marked gravelly beach; 130 feet is about its average height. The height given is marked on the crag above it.
Upper Dangan (North-west of Galway)	130*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Well marked drift terrace, on which there are short ridges and mounds of drift.
Lackagh (3 miles E. of Clare, Galway)	...	189*	...	...	...	...	...	...	...	...	...	...	...	...	...	Escarpment in drift, cut like a step in the side of the hill. This locality is about 9 miles east of Lough Corrib.

TABLE No. II.—Heights of Ancient Sea Margins in Slieve Aughta.

NAME AND POSITION.	1st Set. B.	1st Set. S.	2nd Set. B.	2nd Set. S.	3rd Set. B.	3rd Set. S.	4th Set. B.	4th Set. S.	5th Set. B.	5th Set. S.	6th Set. B.	6th Set. S.	7th Set. B.	7th Set. S.	8th Set. S.	REMARKS.
Drumandoora (neighbourhood of Lough Graney)	...	...	...	320*	...	...	...	...	...	...	...	...	...	...	...	North-west of Lough Graney; long continuous lines of cliffs.
Faha (Do.) ...	...	...	...	...	...	...	...	...	775*	785*	...	...	...	...	...	Cliffs about a mile S.W. of Drumandoora.
Corbehagh (Do.) ...	...	...	...	...	...	...	636*	669*	...	...	936*	...	1089*	1190*	1241*	These are on the N.W. slopes of Knockaliss, except the last, which is round its summit.
Knocknageeha (Do.) ...	...	...	...	...	...	530	...	...	...	...	...	...	...	...	..	Near the west shore of Lough Graney.
Cloonnagro (Do.) ...	...	...	...	...	...	...	...	656*	...	...	...	...	...	...	...	South-west of Lough Graney.
Glendree (Do.) ...	...	...	...	...	...	...	...	...	...	750*	...	977*	...	...	...	South-west of Cloonnagro.
Monounta (Do.) ...	...	...	...	...	...	610*	...	...	...	...	...	...	...	...	...	South of Lough Graney.
Knockbehy (Do.) ...	...	...	...	...	...	...	...	706*	...	...	...	950*	...	...	...	East of Lough Graney.
Hills North-east of Lough Graney	...	...	300*	350*	...	...	...	665*	...	...	...	...	...	...	...	665 feet; a well marked rocky escarpment, N. of Lough Atorick.
Hills North of Lough Graney ...	...	...	290	310	...	...	...	...	...	...	...	...	...	...	...	Lines of cliffs.
Knockea (Scalpnagown Valley) ...	...	...	...	...	...	...	...	...	...	...	...	966*	1020	...	...	

North side of Scalpnagown Valley...	...	...	...	...	...	...	...	...	727*	752*	...	...	...	...	...	
West side of Scalpnagown Valley ...	...	...	...	...	...	...	...	...	...	754	...	...	...	...	...	
Doon N.W. slopes of Slieve Aughta	...	...	...	340	...	...	...	...	...	...	...	..	...	...	...	
Meebik (Do.) ...	...	...	...	384	...	...	...	...	...	...	...	...	...	...	...	This is at the summit of a long sloping rocky escarpment.
North & South of Chevy Chase { Derrybrien Valley }	...	...	300*	336*	...	...	...	...	...	...	...	...	...	...	...	
North of Derrybrien Lodge (Do.) ...	...	...	...	...	...	...	...	688*	735*	...	...	...	...	...	...	
North of Toorantoo (Do.) ...	...	...	...	...	...	...	...	690*	...	...	...	...	...	...	...	On the south slope of Cashlaundrumlahan.
Marble Hill (Do.) ...	...	...	...	...	...	522	...	...	...	...	...	...	...	...	...	This is on the summit of a cliff against which is a deep bank of drift.
East of Danesfort (Do.) ...	...	...	305*	...	...	...	...	...	...	...	...	...	...	...	...	This is at the base of a steep clayey escarpment.
Moyglass (Do.) ...	...	...	...	...	...	527	...	...	...	...	...	...	...	...	...	At the summit of a steep rocky escarpment.
South of Silverstream (Do.) ...	...	...	306*	...	...	...	...	...	...	...	...	...	...	...	...	At the base of a steep clayey escarpment.
Rise of ground West of Lough Rea	...	...	...	345*	...	...	...	...	...	...	...	...	...	...	...	
Rise of ground East of Lough Rea...	...	...	303*	...	...	...	...	...	...	...	...	...	...	...	...	First hill on the Ballinasloe road, near Saint Bridget's Well.
Rise of ground South-east of Lough Rea	...	...	296	...	...	...	...	...	...	...	...	...	...	...	...	First hill on the Tynagh road at Mount Pleasant.
Kilchreest (N. slopes of Slieve Aughta)	...	...	300*	...	500	...	649	...	...	...	...	...	...	...	...	300 feet is at the base of the steep escarpment that bounds Slieve Aughta on the N.W. and N.; 500 feet is on the cliffs at Somnagh, and 649 feet on the cliffs at Gortnagleav.
Cahertrim (Do.) ...	...	...	300*	...	...	...	...	...	...	...	...	...	...	...	...	
Hills South of Lough Rea	...	...	300	...	...	...	...	...	...	...	...	...	...	...	...	This is about the height of the base of these hills, as the surface of Brick Lough, which is close to them, is 294 ft.
Knockash (South-east of Lough Rea)	...	...	...	...	...	...	628*	707*	...	...	...	...	...	...	...	This is a well marked cliff, nearly surrounding the summit of this hill.

TABLE No. III.—Summary of Heights of Ancient Sea Margins in Burren, Yar-connaught, and Slieve Aughta.

Burren (Hills near Black Head) ...	... ...	about 300	... ...	about 650	... ...	about 950	... ...	...
Yar-connaught (South-east group) .	about 130	— 300	470 to 600	about 650	about 750	about 940	about 1070	...
Slieve Aughta	... ...	+ 300	500 to 600	about 650	about 740	about 950	about 1060	1200

II.—On Watersheds.

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

In connection with the discussion on the origin of hills and valleys, which has recently occupied the pages of the Geological Magazine, I would submit a few observations on some phenomena, in evidence of the great power of subaërial denudation, which seem scarcely to have been noticed with the prominence they deserve.

I assume that the joint action of sea and river denudation is unquestioned, and that the main point under discussion is relative to which of these processes determined the final contour of the land.

What I wish particularly to notice is that the form of the whole land surface with some trifling exceptions (as lake basins, which appear to admit of special explanation) is merely a modification of the same principle of contour as the true river valley, exhibiting a system of watersheds by which almost every part of the land is connected with the sea by adjacent land on a graduated series of levels lower than itself.

Why is it that the surface is not irregularly undulating, exhibiting a fair proportion of its area in isolated depressions, surrounded on all sides by land more or less higher than itself? and why are not the valleys shut off into watersheds of defined area, terminating in isolated lakes instead of almost invariably finding common outlets at lower levels? In other words, why is it that you can approach the sea from any point of the earth's surface in an unbroken line of descent?

The various complications of upheaval must have left the surface with every variety of outline, including a fair proportion of isolated depressions; what then is the denuding power that has since stepped in and almost obliterated them, and replaced the chaos of form by the wonderfully uniform system of graduated levels that now, from mountain top to sea coast, envelopes the whole land surface?

Is not the difference between main channels, the recognised result of river action, and the graduated undulation of the entire surface one merely of degree? and is not the cause assignable to the contour of the principal valley also applicable to its tributaries, and to the whole graduated series of inequalities leading therefrom up to the very crest of the watershed?

The connection between this graduating system of contours and the principle upon which subaërial denudation ought to act, seems so natural that the *onus probandi* of any more probable cause should fairly lie with those who dispute the power of rain to effect the final sculpturing of the land's surface.

What can be more apposite than the apparent relation between the delicate gradation of levels from the river mouths *upwards* to the watershed boundaries, and the exactly proportionate concentration of water and consequent power of excavation *downwards* from the watershed lines to the river mouths.

Marine denudation can only have had two modes of operation, either below the surface by the action of currents, or on the coast line.

In comparing the form of the sea bottom, and the land surface, it ought not to be overlooked that just as the land has been subject to marine denudation so the general form of the sea bottom may at one time have been influenced by subaerial action, and assimilated thereby to the form of the present dry land.

There is, however, one essential difference with regard to the much larger proportion of isolated depressions that occur in the ocean bed than on the land surface; as a rule the land consists of a graduated system of levels leading into each other as a connected series of watersheds, and the exceptions to it in the form of complete hollows are exceedingly rare; the sea bottom on the other hand is full of isolated depressions which would be left, on emergence, as unconnected pools and lakes, or isolated seas; this may be well observed on a miniature scale at low water on almost any shallow coast, and still better on a map of the sea bottom giving with sufficient detail the lines of equal depth. It seems impossible that such hollows should have been produced by any directly denuding force for which a line of approach seems essential.

Are not, therefore, these close sea valleys, surrounded on all sides by higher ground, invariably the result of accumulation? Similar depressions are not at all uncommon on the drift surfaces of Shropshire and Cheshire, and I believe that the close basins containing the meres and pools of these counties occur exclusively on old sea-bottom-surfaces of drift, or are the result of drift barriers closing up an ordinary watershed valley, and that a hollow of denudation of any extent, without an outlet at its lowest level, if it exists at all, is a phenomenon of the greatest rarity.

Lake basins, which seem to admit of special explanation, must, of course, be excepted; also, close valleys and depressions connected with swallow-holes, which are virtually complete watersheds in miniature.

Apart from the fact that the sea bottom as a rule is subject to accumulation rather than to any denuding process, on what possible theory can any system of marine currents excavate such a delicately graduating and ramifying system of levels and valleys as those forming the land's surface? In the first place, marine currents, though occasionally diverted by shallow barriers, are not as a rule coincident with the form of the bottom, and to refer the present shape of the ground to the action of former marine currents, you must assume that the greatest force was expended in producing the greatest depths, and this at once presents the difficulty of a system of currents diverging from the greatest depths and ramifying and exhausting themselves in every direction up what are now the river valleys to the lines of watershed; indeed, to be consistent, you must localise a branch of the supposed submarine current to fit every little depression of the ground that leads up from the watershed valleys.

Let us now look at the sea as a denuding agent on the coast line.

If marine action has been the exclusive cause of the moulding of the present contour of the land, any zone of equal height on the land ought approximately to represent an ancient sea margin, and on the re-submergence of the land the coast ought to take up nearly its old position; but lines of equal height on the land surface and neighbouring coast line have little or no relation to each other, and are generally not only different in their direction but also in the character of their outline; and the same difference of character will be observable between a coast line produced by submergence without erosion, and one moulded by denudation. The prevailing tendency of the denuding sea-line is to be straight, and of a simply submerged coast, or of lines of equal height on the land, to be sinuous, bending round the ramifying valleys of the watershed system quite unlike the most sinuous coast cliff.

This is not so obvious to the eye in an actual view, because the sight cannot grasp at a glance a sufficient area, but if you follow it from the coast inland, and return to the sea at the same height at its other end, you will find that you have travelled in a very different direction, and a manifold greater distance than the line taken by the sea; and when the land line is plotted down on paper it will exhibit a kind of structure very unlike that of the adjacent sea-board. In fact, the sea, in its erosive action on the coast, takes little or no account of the surface contour of the land; it denudes back the high land in the shape of cliffs pretty nearly at the same rate as the lower ground of intersecting chines and combes, cutting indiscriminately across, and obliterating both hills and valleys, and working on a sort of jagged straight line singularly different to the winding line representing the lines of equal height on the land, which ought, according to the marine theory, to represent ancient coast lines of sea erosion.

Will the advocates of marine denudation, who assume that the sea excavated the glens and chines, intersecting the present sea cliffs (and many of them if prolonged would extend far below the present sea margin), explain why it is that the sea utterly ignores the old outline assumed for it, and follows one entirely different? Instead of running up the valleys that are assumed to have been the result of its former action, and leaving the separating promontories untouched, as it must have originally done on the marine theory, how is it that it now breaks across both indiscriminately and removes with the same apparent ease a cliff 200 feet high and the low land that gently slopes down the glens under the sea? The coast of the Isle of Wight, and the cliffs to the east of Hastings, well illustrate the form of outline on which coast erosion really works.

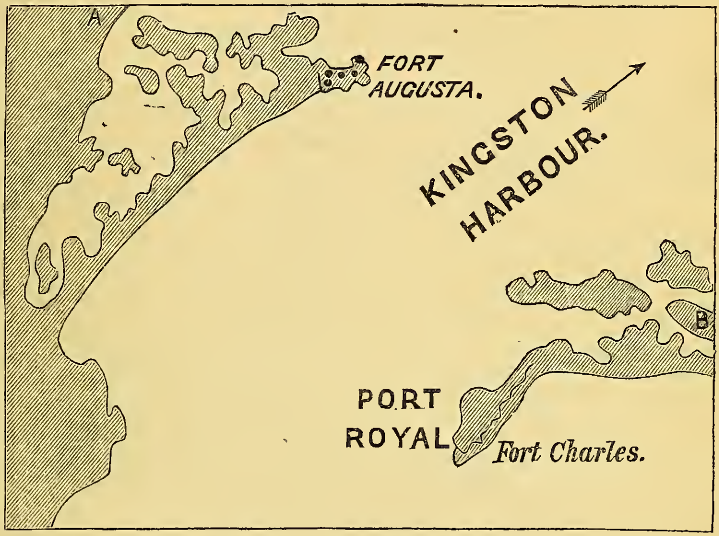
The subjoined engraving[1] of part of the coast at Port Royal, Jamaica, represents one of the very few authenticated cases of recent submergence, and affords a good example of the striking difference between a coast line produced by submergence following the form of the surface, and the ordinary coast line produced by marine erosion.

The coast at Port Royal, Jamaica, is known to have undergone a sudden subsidence in the year 1692, and has assumed an intricate outline notably distinct from any cliff-girt shore, and just the sort of

[1] Copied from the map appended to the Report of the Jamaica Commission.

form that would be expected from the sea running up among the gentle undulations of the watershed valleys. The sinuous line of the inner margin of the reef also forms a striking contrast to the comparatively straight margin of the exposed outer coast.

Another question that invites consideration is, that if marine denudation has determined the final contour of the land, how is it that erosion should have continued up the land-locked arms of the sea intersecting the submerged mountain chains, whilst the protecting flanks, exposed to the full force of the sea, remain? Unequal hardness and resistance will scarcely account for it, as the direction of the valley is not related to the structure of the rock. A map of the



A Coast Line, the Result of Submergence. Port Royal, Jamaica.
(Scale: 1 inch to a mile.)
The Coast connecting *A* to *B* takes a circuit of about 30 miles enclosing Kingston Harbour.

Snowdon district of the Italian Alps, or of a mountainous island like Jamaica, will, at a glance, exhibit the kind of outline with which the sea would surround a mountain chain at almost any zone of submergence; a large proportion of the water would be entirely land-locked, and the deep bays, where it must be assumed marine denudation continued with activity, would be protected from the active fury of the ocean.

No one will dispute that many parts of the land represent cliffs and coasts eroded by the sea; but these appear to be altogether subordinate to the watershed system, and do not, as a rule, harmonize with its outlines. The sea, in its trenchant action on the coast, may have done a greater work of erosion than subaërial denudation, but the two are inharmonious in their operations: the sea works on the coast lines, and acts with indiscriminating destruction, breaking up, and more or less ruining, the old land contours; but subaërial and river action have always returned to the rescue, healing with delicate symmetry the disorder caused by marine denudation, remodelling and cleaning out the lost river channels, and reconnecting, into watershed and valley systems, the often submerged land surface.

III.—On the Structure of the Valleys of the Blackwater and the Crouch, and of the East Essex Gravel, and on the Relation of this Gravel to the Denudation of the Weald.[1]

By Searles V. Wood, Jun., F.G.S.

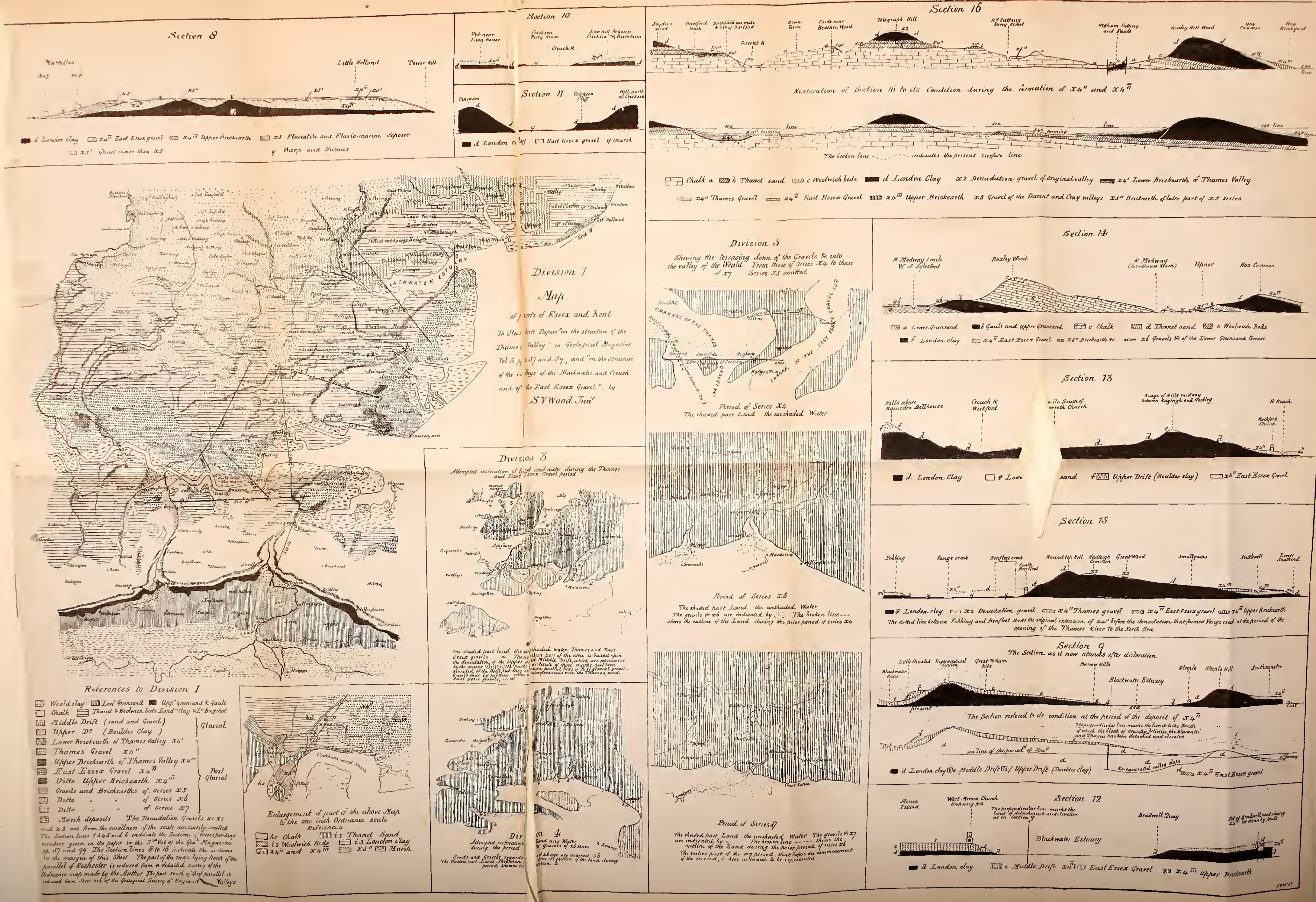
(With a Folding Map and Sections).

In a paper in this Magazine, upon the structure of the Thames Valley, I endeavoured to show that instead of being, as had been asserted, a valley of similar structure to those of the Somme and Seine, and containing deposits of nearly similar order and age, the valley in which the Thames gravel was deposited possessed no outlet to what is now the North Sea, being divided from it by a range of high gravelless country; and that, in lieu of such an outlet, the valley opened, in more than one part, over what is now the bare Chalk country forming the northern boundary of the Valley of the Weald. I also endeavoured to show that all the deposits of the Thames Valley, except the peat and marsh clay, belonged to several successive stages, marking the gradual denudation of the Boulder-clay, the lower Bagshot, the London Clay, and the subjacent Tertiaries, which had, at the end of the Glacial period, spread over the south-east of England in a complete order of succession: the sea into which this valley discharged occupying, what is now, the Chalk country of the Counties of Kent, Surrey, Sussex, and Hampshire, inclusive of the interval subsequently scooped out to form the Valley of the Weald: so that, not only was the latter valley newer than that of the Thames, and of the most recent of the Thames Valley deposits, except the peat and marsh clay, but that these deposits in themselves marked a long descent in time from that comparatively remote period of the Boulder-clay.

In a problem of this sort, the whole of the phenomena in the region affected by it should be in unison in order to render the evidence satisfactory, and the object of this paper is to show, as briefly as the multifarious nature of the evidence renders possible, that such is the case.

The East Essex gravel (which I so call from its principal development being in the east of Essex, although the southern extremity of it lies in Kent, fringing the Medway between the Nore and Rochester),

[1] This paper is intended as a continuation of that "On the Structure of the Thames Valley, and its contained Deposits," at pages 57 and 99, of Vol. III. of this Magazine, and the direction of sections 1, 3, 4, 5, and 6, given in that paper, have been shown by lines with corresponding numbers on the Map accompanying this paper.



Section 8
Little Holland
Tower Hill
d London clay
x4'' East Essex gravel
x4''' Upper Brickearth
x5 Fluviatile and Fluvio-marine deposit
x5' Gravel newer than x5
y Warp and Humus
Section 10
Crouch R
Section 11
d London clay
East Essex gravel
y Marsh
Section 16
Telegraph Hill
Higham Cutting and Fault
Restoration of Section 16 to its Condition during the formation of x4'' and x4'''
The broken line indicates the present surface line
Chalk a
b Thanet sand
c Woolwich beds
d London Clay
x2 Denudation gravel of original valley
x4' Lower Brickearth of Thames Valley
x4'' Thames Gravel
x4'' East Essex Gravel
x4''' Upper Brickearth
x5 Gravel of the Darent and Cray valleys
x5'' Brickearth of later part of x5 series
Division 1
Map
of parts of Essex and Kent
To illustrate Papers "on the structure of the Thames Valley" in Geological Magazine Vol 3 pp 57 and 59, and "on the Structure of the valleys of the Blackwater and Crouch and of the East Essex Gravel", by
S V Wood Jun'
Blackwater Estuary
Rochester
Division 5
Shewing the terracing down of the Gravels &c into the valley of the Weald. From those of series x4 to those of x7. Series x5 omitted.
Channel of the Thames
Channel of the East Essex Gravel
Period of Series x4
The shaded part Land the unshaded Water
Period of Series x6
The shaded part Land the unshaded Water
Period of Series x7
The shaded part Land the unshaded Water
Section 14
R Medway 1 mile W of Aylesford
Boxley Wood
R Medway (Limehouse Reach)
Upnor
Hoo Common
a Lower Greensand
b Gault and upper Greensand
c Chalk
d Thanet sand
e Woolwich Beds
f London clay
x4'' East Essex Gravel
x5'' Brickearth &c
x6 Gravels &c of the Lower Greensand terrace
Section 13
Hills above Ramsden Bellhouse
Crouch R Wickford
R Roach
Rochford Church
d London Clay
e Lower ... sand
f Upper Drift (Boulder clay)
x4'' East Essex Gravel
Section 15
Fobbing
Vange creek
Benfleet creek
South Benfleet
Hadleigh Common
Great Wood
Smallgains
Prittlewell
Lower Southend
d London clay
x2 Denudation gravel
x4'' Thames gravel
x4'' East Essex gravel
x4''' Upper Brickearth
The dotted line between Fobbing and Benfleet shews the original extension of x4'' before the denudation that formed Vange creek at the period of the opening of the Thames River to the North Sea
Division 3
Attempted restoration of Land and water during the Thames and East Essex Gravel period
Section 9
The Section as it now stands after dislocation
Little Braxted
Great Totham Hills
Barrow Hills
Blackwater Estuary
Steeple
Steeple Hill
Southminster
The Section restored to its condition at the period of the deposit of x4''
d London clay
e Middle Drift
f Upper Drift (Boulder clay)
x4'' East Essex gravel
References to Division 1
Weald clay
Low' Greensand
Upp' Greensand & Gault
Chalk
Thanet & Woolwich beds Lond' clay & L' Bagshot
Middle Drift (sand and Gravel)
Upper D° (Boulder Clay)
Glacial
Lower Brickearth of Thames Valley x4'
Thames Gravel x4''
Upper Brickearth of Thames Valley x4'''
East Essex Gravel x4''
Ditto Upper Brickearth x4'''
Post Glacial
Gravels and Brickearths of series x5
Ditto of series x6
Ditto of series x7
Marsh deposits
Enlargement of part of the above Map to the one inch Ordnance scale
References
h5 Chalk
i1 Thanet Sand
i2 Woolwich Beds
i3 London Clay
x4'' and x4'''
x5''
Marsh
Division 4
Section 12
Mersea Island
West Mersea Church
Blackwater Estuary
Bradwell Quay
d London clay
e Middle Drift
x4'' East Essex Gravel
x4''' Upper Brickearth

in its constituent material and thickness, intimately resembles the Thames gravel. It also presents a complete parallel to that gravel, in being capped in parts with a brickearth, into which it passes upwards through bands of "race," or gravelly brickearth. This brickearth is usually from 5 to 8 feet in thickness, but, at Hoo, near Rochester, it attains the thickness of 35 feet, which, as the deposit has everywhere been more or less denuded, may not be exceptional, but may, perhaps, represent its original depth as deposited. Like the Upper Brickearth ($x4'''$) of the Thames Valley, it is evidently a continuation of the gravel deposit, by a cessation of the sea-borne gravel material, and by the precipitation of the river-supplied mud in lieu of it. The denudation removing it has operated chiefly between Hoo and the Nore, and again, from a few miles north of Southend, as far as the northernmost extremity of the deposit. The delineation of the gravel in the Map accompanying this paper renders any description of its area unnecessary; but I should observe that, while the continuity of the gravel-sheet in its course from Rochester to Bradfield on the south of the Blackwater Estuary (interrupted only where the mouths of the Thames and Crouch cut it at right angles), as well as the uniformity throughout of its constituent material, affords satisfactory evidence of its identity, there is not the same conclusive evidence of its occurrence on the north side of the Blackwater estuary. A small fault in one of the Bradfield pits, which has let down some six feet of the Brickearth beside the gravel, and which shows also the passage upwards through "race," identifies the gravel immediately opposite the western extremity of Mersey Island as that of the East Essex sheet; while a temporary pit, some 20 feet deep, made on this extremity of Mersey Island, satisfied me (against a previous impression to the contrary) that the sand, with occasional gravel bands of that island, is not any part of the East Essex gravel, but belongs to the great deposit of the Middle Drift, which adjoins it on the north-east. On the other hand, the occurrence, in profusion, in the gravel which forms Clacton Cliff, of those fragments of minutely pitted sandstone so characteristic of the East Essex gravel in its undoubted districts, and which do not occur in the gravels of the Middle Drift, when coupled with the complete detachment of the Clacton Cliff gravel from the great and continuous tract of Middle Drift, would seem to identify that gravel with the East Essex deposit; but this identity is rendered more certain by the occurrence of a patch of the Upper Brickearth at one part of the cliff.[1]

Associated with this gravel at Clacton occurs a very rich fluviatile and fluvio-marine deposit, which has been long known. Their relative positions will appear by Section 8. (See margin of Map.) It will be seen that the fluviatile and fluvio-marine deposit ($x5$) has

[1] This patch is of limited extent, and occurs about 1500 yards south-west of Tower Hill and 500 of Holland Gap (its longitudinal dimensions are unavoidably exaggerated in section 8). About a mile and a half from the north-eastern termination of section 8, small patches of the Middle Drift sand occur on the summit of the much loftier (London clay) Cliff of Frinton. The patches are but a few feet deep, and are best exposed under Frinton Old Church, and their distinctive character from the Clacton gravel is very apparent.

been accumulated subsequent to the deposit of the Upper Brickearth ($x\,4\overline{'''}$), and that it has itself, as well as the gravel and brickearth, been overspread by a newer gravel ($x\,5'$), which has again been removed by the aqueous action that gave rise to the warp (y). A list is given by my father, in the monograph of the Crag Mollusca, of a numerous fauna collected by himself there many years ago. Since when, the Rev. O. Fisher has obtained from it *Cyrena fluminalis* and *Paludina lenta*. The occurrence of the former shell concurs with the view to which the position of the fluviatile and fluvio-marine deposits would lead us, viz., one nearly analogous to those at Grays, which are newer than the gravel and Upper Brickearth of the Thames Valley (see Section 4 in Geological Magazine, Vol. III, p. 62), as these are newer than the East Essex gravel and capping brickearth.

The valley of the Blackwater consists of two parts—the upper or river portion, and the lower or estuary portion. The latter has been subjected to disturbances subsequent to the creation of both parts, from which the upper has escaped.

In a paper "on the Structure of the River and other valleys of the East of England,"[1] I pointed out, by means of a map, that the valleys of the eastern and south-eastern parts of England, which are occupied by strata newer than the Trias, resolved themselves into regular systems of concentric arcs, diverging from several centres, of which the most important were three—one in the North Sea off Flamborough Head, another near the Isle of Wight, and a third near Canterbury; and that these arcs, inosculated more or less with each other, cutting through the Glacial series (at least through the upper and middle portions of it) with such regularity, that a rod laid over the Ordnance map from the Thames to the Nen and Welland would intersect a similar angle in all the chief valleys that it crossed; and I pointed out the evidence there was that these arcs originated by the flexures produced from lateral pressure exerted from the several centres which were foci of earthquake disturbance under the Boulder-clay sea, and which flexures, by imparting direction to the denudation, had become deepened and strongly marked by the action of denudation proportionately to the extent to which they had undergone that process. I also endeavoured to show that upon this original valley origin there had, at a later stage of the great denudation, supervened a series of rectilinear movements, accompanied by denudation; so that the valleys which having earliest emerged, and thus escaped the later part of the denudation, were due solely to the first part of this process, and those later emerged to the joint operation of the two.

The formation of the valley of the Blackwater—both the upper and the lower portions in their original condition—has been due to the first of these processes, the arcs by which they originated being those emanating from the Canterbury centre. Section No. 9 (see margin of Map), drawn so as to cross both the upper and lower portions of the valley, will show the relation borne by the East Essex

[1] Phil. Magazine for March, 1864.

gravel to the Upper and Middle Drift and the great flexure by which this valley originated. It will be observed, from the features exhibited by this section, that the position now occupied by the East Essex gravel cannot have been that in which, relatively to the Upper and Middle Drift, it was deposited, as it occupies a higher level than the nearest part of the Middle Drift, which descends to near the water's edge on one side of the Blackwater estuary, but is wholly absent on the other. The cause of this feature exists in the great disturbances which have succeeded the deposit of the East Essex gravel, and which I will endeavour to explain. By the Map, and by Section 9, it will be seen that the Middle Drift extends to the very bottom of the upper (or River) valley of the Blackwater, forming the whole of the lower level of that valley; on the north side of the Chelmer it also descends to near the edge of the river, standing at but little elevation above it. Very nearly the same thing takes place on the north side of the lower or estuary valley of the Blackwater; whereas on the south side of the valley of this estuary, as well as on the south side of the Chelmer river, the Middle Drift does not come within a considerable distance of the water, and stands at great elevations (from 100 feet upwards) above it. In short, the Chelmer River and Blackwater Estuary form a dividing line, on the south side of which the entire block of country, lying between this river and estuary and the mouth of the Thames, has been elevated without any corresponding elevatory movement having taken place on the north side, but rather the reverse. The disturbances which produced this detachment and local elevation have been accompanied, I will endeavour to show, by the re-excavation or second denudation of the country forming the south side of the Blackwater estuary and upper valley of the Crouch.

Section 9 will show that the gravel on the north side of the Estuary belongs to the Middle Drift, and not to the East Essex gravel, and also the extent to which the great flexure, emanating from the Canterbury centre, brought into existence the original valley of the Blackwater; for it will be seen that the sand and gravel (*e*) on the north-west flank of the flexure passes under the Boulder-clay (*f*), coming out both above and below that clay, thus proving its identity with the Middle Drift; and this gravel may be traced without a break over the summit of the flexure in one part down to the north shore of the Blackwater estuary.[1] This great flexure or rolling earthquake surge passes but with diminishing force through the Upper and (where that formation is present) through the Middle Drift also, nearly as far as the vale of Belvoir in Rutlandshire, forming in its way several troughs of denudation, of which the most marked are the great troughs excavated between the Upper

[1] The line of section has been chosen in order to show the Middle Drift continuous over the crest of the ridge. If, however, the line of section were drawn a little more to the north-east, all the crest of the ridge would appear denuded of the Middle Drift and exclusively occupied by the London clay; *e.g.* if the section were drawn from Inworth to Bradwell-on-Sea this would be the feature of the section, and the London clay on the crest of the ridge would be capped by summit gravel (x 1).

Drift, occupying the plateau stretching by Hitchin to Royston, and that opposite stretching from Shefford by Biggleswade and Caxton to near Cambridge, and the great trough excavated between the Upper Drift crowning the heights from Rockingham towards Market Harboro' and that crowning the opposite heights of south-eastern Leicestershire. In none of them, however, is the tumescence so decided as in the ridge shown in the section, which being nearer to the centre of origin (near Canterbury) is proportionately more decisively marked.

The valley of the Crouch like that of the Blackwater also consists of two distinct portions, the lower and the upper. The lower consists of a rectilinear fissure which has passed at right angles through the older trough occupied by the East Essex gravel, and through that gravel itself; in which respect it is identical with the mouth of the Thames. The upper valley, on the other hand, is of similar origin to that of the Blackwater estuary, having been, in fact, before the re-excavation, to which I am about to allude, a part of the same valley.

For the purpose of showing the nature of these valleys I have carefully delineated on the accompanying Map the principal valley contours. It will be seen that the great rolling ridge intersected by Section 9 is precisely a repetition of the ridge nearer the sea, which, forming one side of the valley that contained the East Essex gravel, and rising far above that gravel, is cut sharply down on its western side towards the Blackwater estuary; and that this latter ridge, after being cut through at right angles by the Crouch valley, commences again and proceeds in a continuation of the same curve to Benfleet. It will also be seen that the inland boundary of the East Essex gravel very closely coincides with this ridge, and there will be no difficulty, while keeping these features in the eye, in realizing the idea, which I am desirous to convey, that the original trough lying between these two great ridges (which had been formed, but in a less marked manner, by the denudation that accompanied the emergence of the country from the Boulder-clay sea), has been re-excavated and deepened as far south, probably, as Pitsea; and that in this way the original contour has been so sharply marked as to present the very decided features which it now possesses. It is apparent from it, too, that the Crouch, in its former more extensive estuarine dimensions —due to the lower level existing at this part at the period of its formation—cut for itself a way through the original ridge that formed the western brow of the valley in which the East Essex gravel was deposited, and appropriating to itself the south-western end of the great trough that lay on the west side of this brow, divided itself from the Blackwater by eroding the ridge which stretches from Althorn to Cold Norton. The Blackwater estuary, in its similar former estuarine extension, it will be seen, has done the same thing on the north side of that ridge, and, by the subsequent elevation of the block of land lying between the Blackwater estuary and the mouth of the Thames, the Crouch river and the Blackwater estuary have both retreated to their present dimensions.

Now the entire area of this great re-excavated and remodelled trough is totally destitute of gravel. All the other river valleys of East Anglia contain, upon their edges and in their troughs, beds of gravel, not in any way resembling the great sheets of the Thames and East Essex gravels, but dispersed in small patches, and answering in position to the series I have described in the former paper as x 2 and x 3. Even the undulating London Clay country, intervening between the south-western termination of the Crouch Valley and the edge of the Thames gravel, contains many very small and shallow patches of gravel belonging to one or other of those series; but in the two valleys under discussion there is a total absence of anything, however small in dimensions, that approaches to the character of a gravel patch—a feature which, in my experience, is unparalleled in any other valley of the east of England.[1] Now when we come to consider the relation which the East Essex gravel (through which the valleys under discussion cut at right angles) bears to the denudation of the great valley of the Weald, and the evidence which the position of the gravel beds in the latter convey of a great reversal of the drainage having taken place at a very late date, and when we reflect on the extremely late date at which I have endeavoured in the former paper to show how the Thames river, with its North Sea outlet, came into existence, and how, in all respects, this North Sea outlet of the Thames coincides in structure with that of the Crouch, we find a concurrence of evidence which points to the cause of the redenudation I have been describing, and of the formation of the mouths of the Thames and Crouch, having been the disturbances that gave rise to the reversal of the Wealden drainage, to which I have presently to allude; evidence which points also to the period of this event belonging to that very modern time when the subarctic conditions, to which the formation of gravels has been due, had passed away, and marsh mud become the sedimentary result of the occupation of the valleys by water.

The following Sections will assist the apprehension of the structure I have been endeavouring to describe. (See Sections 10, 11, 12, and 13, beside Map):—

Section 12, like Section 9, traverses the line of dislocation marked by the estuary of the Blackwater and river Chelmer, to the south of which the block of country lying between this estuary and river on the one side, and the Thames mouth on the other, has, more or less, been detached and elevated. The same apparently inconsistent relative positions of the Middle Drift and East Essex gravel present themselves as a consequence in this section as they do in Section 9. This apparent inconsistency not only disappears when the explanation of subsequent disturbances is applied to it, but the feature itself falls into unison with the many other surrounding features

[1] Except that of the Hamford Water surrounding the Naze point of Walton, which has participated in the same re-excavation and redenudation as the valleys of the Crouch and Blackwater Estuary, and like them, has on the crown of the slopes forming its valley, patches of denudation gravel, analogous to those described in the former paper under the symbol x 2.

that require the explanation of such a subsequent disturbance to reconcile them.

Section 10, drawn across the rectilinear lower valley of the Crouch, shows the East Essex gravel cut through by this rectilinear valley; while Section 11 is drawn across the same valley a little higher up, where it has cut through the London-clay side of the more ancient valley which contained the East Essex gravel. The low level occupied by that gravel in Section 10 should be contrasted with the far higher ground of London clay, through which the Crouch cuts in Section 11, in order that it may be realized that the East Essex gravel, although it is thus cut through by the altogether independent and much newer valley of the Crouch, is as truly the deposit of a valley hereabout (save that the eastern slope of it has now disappeared into the North Sea) as it is more to the south, where it occupies the lower valley of the Medway. Section 13 has been added to show the structure of the upper valley of the Crouch, which, it will be remembered, is part of the one original great trough that was afterwards re-excavated in part by the Crouch in its estuarine condition, and in the rest by the more-extended estuary of the Blackwater, and divided between them. From the section it will be seen that this original trough is cut down from the Boulder-clay on the western side, but that on the other the Bagshot sand and London clay, only, form the valley side. This is due to the peculiar structure of the Upper Drift over the south of Essex, that formation having, at its commencement, eroded the Bagshot sand and taken its place, but afterwards, by submergence of the land, overspread it; so as in one place to lie under a brow of Bagshot sand, and in another to rest upon it, in that case occupying a much higher level than in the other place. The post-glacial denudation which gave rise to the valley, has, on the east of the section, removed the Boulder-clay and left the Bagshot sand; while on the west of the section, it has partially spared the Boulder-clay, the sea of which had long anterior to this removed the Bagshot in that part. It is to this structure that the Boulder-clay does not remain on the summit of the eminences crowned by Bagshot sand, which form Langdon, Thundersley, and Hockley Hills, the Isle of Sheppey, and Hampstead and Highgate Hills, while traces do remain on the similar eminences forming the Brentwood plateau, and the Havering and Epping Hills.

In the next number of the Magazine, I propose to consider the relation which the East Essex Gravel bears to the Structure of the Weald Valley.

IV.—On the Disintegration of a Chalk Cliff.

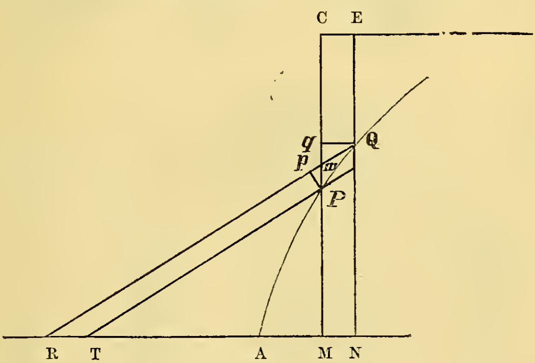
By the Rev. Osmond Fisher, M.A., F.G.S.

As a slight contribution to the elucidation of questions of denudation, and at the same time an exemplification of the application of mathematics to a geological problem, I send the following:

Noticing a lofty chalk cliff, forming the face of an old quarry in the neighbourhood of Lewes, I remarked that the action of the weather upon the surface was to disintegrate it equally all over, so that the face of the quarry remained vertical, while the stuff that fell down formed a talus, whose surface was approximately a plane, inclined to the horizon at that particular angle at which such materials will stand. The question then occurred to my mind—*What will be the profile of the solid chalk behind the talus?*

The solution of this question is given in the note. The form of the solid surface is there shown to be a semi-parabola, whose vertex is at the base of the original cliff.

It is evident that an old sea cliff deserted by the sea, or a river cliff from which the stream had receded, would disintegrate after the same law. If any subsequent circumstance, such as the return of the sea or river, should remove the talus (and it may be observed that the corollary proves that an undermining action would do so completely) we should have the parabolic form disclosed. This is the shape observed in that form of cliff known as a "Nose." The undermining action of the sea upon a chalk cliff would of itself produce a vertical wall. When, therefore, we see a cliff of a parabolic form, or vertical below, and parabolic in the upper part, it seems to me that we may expect to find that we have an ancient cliff, once deserted by the waves, now attacked again, and the peculiar form due to disintegration exposed by the removal of the talus.



NOTE.

Suppose C P to be the face of the cliff: A the bottom of the quarry: T P the surface of the talus: and let the disintegration of the face to Q E raise the talus to R Q. Then P Q will be a portion of the curve whose form we are seeking.

P p is perpendicular to R Q, Q q to C M, and R Q meets C M in m. C M = a, and the angle P T M = α. Then, because the material disintegrated from P C has raised the talus to R Q, we shall have in the limit—

$$CP \times Qq = TP \times Pp.$$

or, if $AM = x$, $MP = y$

$$(a-y)\,dx = \frac{y}{\sin\alpha} \times Pm \cos\alpha$$

$$= \frac{y}{\sin\alpha}(dy - dx\tan\alpha)\cos\alpha$$

$$= y\,dy\cot\alpha - y\,dx$$

$$\text{or } a\,dx = y\,dy\cot\alpha$$

Integrating. and observing that x and y begin together—

$$a\,x = y\,\frac{y^2}{2}\cot\alpha$$

$$\text{or } y^2 = 2\,a\tan\alpha\,x$$

which is the equation to a parabola, of which the vertex is A, and the *latus rectum* is 2 a tan α. The proportions of the curve will therefore be increased by an increase in the height of the cliff, or by an increased capacity in the talus to stand at a high angle.

We have $\frac{dy}{dx} = \frac{a}{y}\tan\alpha$
$= \tan\alpha$ when $y = a$

Hence we have the very elegant result that the curve will be continued unbroken to the very top of the cliff, at which point its inclination to the horizon will be identical with that of the talus.

V.—Some Observations on the *Zoantharia Rugosa*.[1]

By Gustave Lindström, Ph.M.

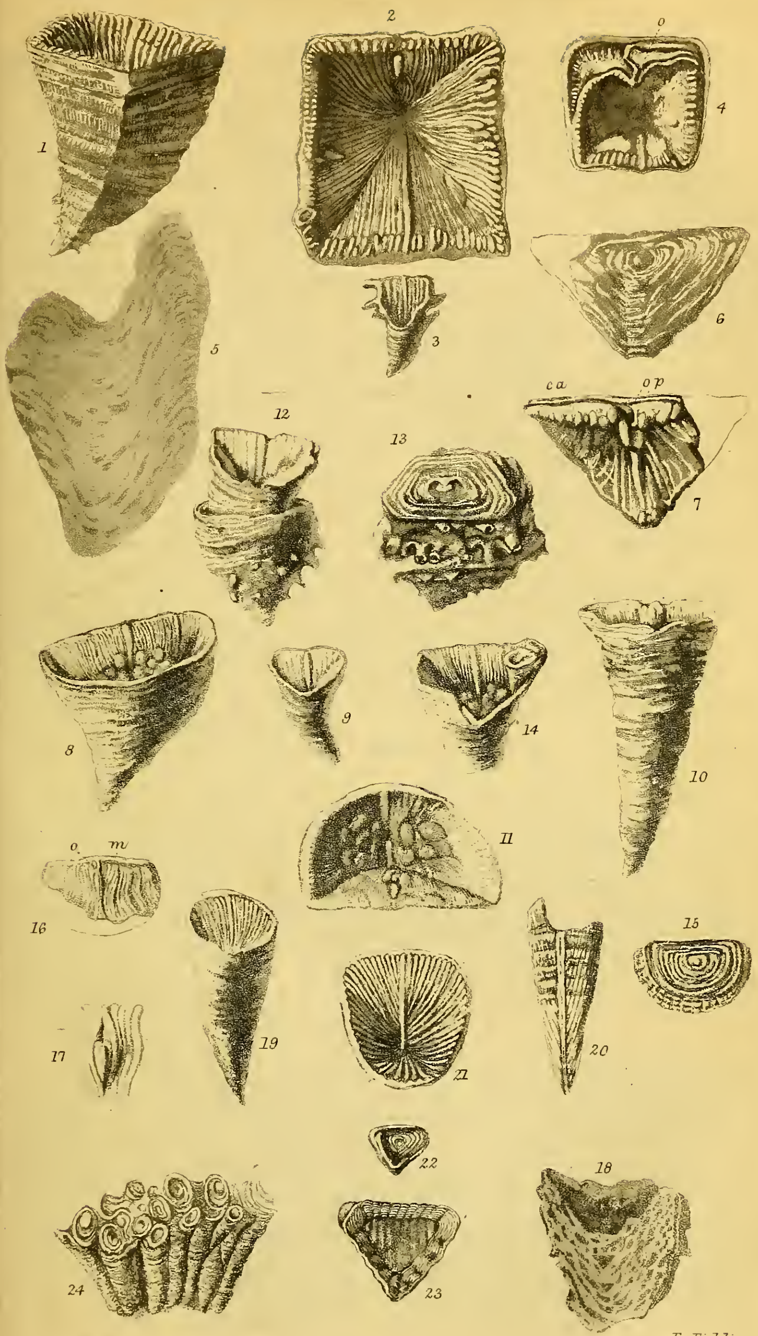
[PLATE XIV.]

PROFESSOR STEENSTRUP,[2] some years ago, questioned the fact as to whether the *Zoantharia tabulata* and *rugosa*, included by him under the common name of "*Cyathophylla*," might be considered as true polyps. MM. Edwards and Haime in framing those great subdivisions of their "*Coralliaria*," remarked their striking dissimilarity from the other *Actinozoa*. Professor Agassiz, in his grand monograph on the *Acalephæ* of North America,[3] considers these differences so important that henceforth all connection between the above-named groups and the *Zoantharia aporosa* and *perforata* will be impossible. But besides these peculiar characteristics of the *Rugosa*, such, for instance, as the compact imperforate structure of the calyx and septa (the septa originating from four primary ones), the absence of costæ, the strange septal fossæ in the bottom of the calyx, the processes resembling rootlets, the transverse floors or tabulæ in the interior, which often have a

[1] Translated by the Author, from the original Swedish—"Ofversigt af Vetenskaps Academiens Forhandlingar."

[2] On the Systematic Place of the *Brachiopoda* and the *Cyathophylla* (in Danish), p. 20, 1843.

[3] Contrib. to the Nat. Hist. of the United States. Vol. iii. p. 121.



G. Lindström del.t E. Fielding sc.

OPERCULATED RADIATA,
Of the order Rugosa, M. Edw.

cellular or vesicular structure; there is another peculiarity as yet not much known.[1]

Several *Rugosa* are provided with an operculum of very strange shape. Guettard[2] first made known the occurrence of such an operculum, and, later, Steenstrup saw it in a *Cyathophyllum mitratum*. But as several of these operculated fossils have been placed with the *Brachiopoda* and other classes, it is necessary to give a detailed description of the species, in order that their true affinity with *Rugosa* may be demonstrated.

The *Turbinolia pyramidalis*, Hisinger, from Wisby, Isle of Gotland, is, perhaps, the most remarkable form of all. Girard[3] considered it to be a *Calceola*, but his view was rejected by MM. Edwards and Haime,[4] who placed it in their genus *Goniophyllum*.

The shell, or the polyparium, as it is also named, is in its exterior shape irregularly pyramidal, with four triangular surfaces of unequal size. The largest, or the bottom surface, is that on which the shell rests when in its natural position. The lateral surfaces are somewhat smaller, and the uppermost surface is the least. The apex is generally sharply bent towards the smallest surface, just as in the common hornlike forms of the *Cyathaxoniæ* and the *Zaphrentinæ*, as well as in the *Cyathophyllinæ* and *Cystiphyllidæ*. The four corners where the surfaces meet are rounded and grooved by a peculiar shallow furrow. The lines of growth continue uninterrupted on all the surfaces, and between them are extremely thin parallel striæ. They are crossed by numerous faintly elevated striæ, which are homologous with the much more prominent folds (the "false costæ" of the *Omphymæ*, etc.)[5]

The two middle folds, which divide the surface in two parts, are

[1] With very few exceptions, as in *Actinia plumosa*, of Torell, the calyx of *Actinozoa* may be divided into two exactly similar parts by any diameter whatever. The *Rugosa*, on the contrary, are only to be divided into two equal parts by a line drawn along the longitudinal axis of the septal pit, or the largest of the four primary septa. M. Ludwig (in Meyer's Palæontographica, Vol. x. p. 179) has ranged some of the *Cyathophylla* amongst the *Aporosa*, and formed a distinct family of the *Zaphrentinæ* called *Pinnatæ*. Although his own figures show that their septa are developed according to a quarternary system, he presumes that the "tentacula" and the primary septa have been originally six, and considers the other great differences from the *Turbinolidæ* as of no value.

[2] Memoires, Tome iii. p. 516.

[3] Leonh. and Bronn, Jahrbuch, 1842, p. 232.

[4] Archives du Muséum, Vol. v., p. 404.

[5] In all the specimens of *Z. rugosa* these "costæ" alternate with the septa, there is no immediate continuation of these through the walls of the calyx as in the *Z. aporosa* and *perforata*. On the exterior wall the furrows between the longitudinal folds are opposite the septa. As above described in *Goniophyllum* two or three broad longitudinal folds or striæ are also seen, in most of the *Rugosa*, to divide the longest side of the shell in two similar parts and to form a ridge, which, as I shall endeavour to demonstrate, is homologous with the pseudo-deltidium of *Calceola*. The largest septum (or the septal-pit as seen in so many of the *Zaphrentinæ*) is situated on the interior wall opposite the furrow between these larger median folds. The smaller folds converge towards these median ones in a very acute angle, and the whole thereby takes a pinnate arrangement, as J. Hall has described it in *Streptelasma corniculum* (Pal. of New York, Vol. ii. p. 111), and F. Roemer in *S. europæum* (Foss. Fauna von Sudewitz, p. 16); see also Ludwig.

often broad, and form a faintly elevated ridge. This occurs generally on the bottom surface, but is also seen on the others. This ridge is partly formed by the border of the calyx folding outwards at the point where the median striæ occur.

From the corners and also from the middle of the bottom surface, there are seen to project narrow and bent processes, resembling rootlets. They are very numerous towards the apex of the shell, and thence decrease in number, disappearing near the mouth of the calyx. These rootlets are hollow tubes, by means of which the animal fixed its shell to other bodies.[1] The outline of the borders of the calyx, or the interior cavity (Plate XIV. Figs. 1 and 2) has the figure of a regular trapezium with rounded corners; in younger specimens the corners are rectilinearly cut off, which produces an octohedral figure. In attenuated specimens the form of the mouth is nearly quadrate. The depth of the interior cavity is very variable. In some specimens it occupies two-thirds of the total length, while in others of the same size, it is less than half of that length. The four triangular lateral walls are separated by shallow depressions, which, like the larger median groove, are also called *fosses septales* by M. Edwards. The uppermost edge of these walls forms a border above the septæ, within which the operculum probably rested. A large septum[2] projects from the middle of each wall. Those of the largest and smallest wall, opposite to each other, project the farthest,—they end at the bottom of the calyx. The median septa of the lateral walls are smaller; on both sides of each of these four septa are seen a variable number (9-13), of smaller septa, and, between these, others, still smaller and fainter. These septa of the second order on the wall are soon changed into narrow, punctuated, or irregularly indented striæ, which in the bottom of the calyx intermingle and disappear. On weathered specimens the septa appear as if cleft, or with a groove in the middle; this is occasioned by their being composed of two lamellæ, which converge inwards in a sharp edge, and leave between them an empty space, so forming the grooved appearance when weathered. This is sometimes filled with calcareous spar. At the bottom of the calyx, and also on the walls, sparse, faintly elevated vesiculæ are seen, over which the narrow septa continue, as in *Omphyma Murchisoni*.[3] The septal groove is situated close

[1] Such rootlike processes distinguish no less than eleven genera of the *Cyathophyllinæ*, namely:—*Cyathophyllum*, *Goniophyllum*, *Omphyma*, *Chonophyllum*, *Ptychophyllum*, *Heliophyllum*, *Acervularia*, *Eridophyllum*, *Rhizophyllum*, *Axophyllum*, and several *Cystiphylla*. These rootlets either project from the convex side of the shell, or are fixed all round it. Sometimes they have coalesced and are flattened into broad curved hooks ("crampons," M. Edw.). Amongst the true *Anthozoa* the genera *Flabellum* and *Rhizotrochus* alone have anything analogous. The description of the rootlets of the *Goniophyllum* can be applied to all the above cited genera, but they are perhaps not so remarkable in any one as in the new genus *Rhizophyllum*, about to be described.

[2] The term "septum" is here used, without being considered homologous with the parts so named in the *Actinozoa*. In the same manner "cardinal-margin" is used without indicating homology with the cardinal margin in the Mollusca.

[3] See Edwards and Haime, Brit. Foss. Corals, Plate 67, fig. 3 a.

to the smallest wall, on which it continues, so that the median septum of that wall is enclosed by it. It is exactly the same groove or pit which may be observed in *Cyathaxonia,* and so highly characterizes the *Zaphrentinæ,* in several of which it surrounds the large primary septum. It also occurs in the genera *Omphyma, Calceola, Cystiphyllum, Rhizophyllum,* and *Cyathophyllum.* It is always situated in the same line as the two largest primary septa, on the longest and convex side in the *Zaphrentinæ,* and on the shortest in the *Cyathophyllinæ.* This groove is not to be confounded with the rarer and more shallow depressions of a cruciform arrangement in the *Omphymæ* (the "fosses septales" of Milne-Edwards).

The principal mass of the solid interior of the shell consists of vesicular basin-shaped layers (Plate XIV. Fig. 5) approaching the structure of *Omphyma.* Very small specimens are sometimes fixed with their rootlets on the uppermost edge of the calyx, and project from the interior walls of the parent. This phenomenon corresponds to what is seen in the genera *Cyathophyllum, Acervularia,* and others, and is no doubt to be regarded as a kind of budding. *Goniophyllum pyramidale* also shows signs of these interruptions in the continuity of the growth, so peculiar amongst the *Rugosa.* The animal sometimes diminished its compass, and commenced to form a new calyx within the old one. This new calyx is either completely furnished with new walls, or it is in part formed of the old ones (Plate XIV. Figs. 4 and 12).

The smallest examples very much resemble *Calceolæ* in their prominent primary septum (Plate XIV., Fig. 3). But the form of the mouth soon becomes triangular, and at a length of ten millims trapezoidal. In some specimens the shell preserves a three-sided pyramidal form, the full-grown animal retaining the same shape as when young. Instances of this, however, are not wanting in the living creation, as in some fishes, crustacea, and mollusca.[1]

The operculum of this fossil, found fixed in its place, as well as in many instances detached, is generally of a regular trapezoidal shape (Plate XIV., Figs. 6 and 7), but it is also triangular. It is attached at its broadest margin (here called the cardinal margin) at the uppermost border of the calyx. Its exterior surface is quite smooth, with the exception of the lines of growth (Plate XIV. Fig. 6). The nucleus is above the centre, near to the cardinal line. The middle of the outer surface is depressed in a sinus, extending from the nucleus to the shortest margin, and of the same breadth. The innermost layers being thus the most depressed of all, no surface resembling an "area" is formed at the cardinal margin, only a very narrow rim. On the interior surface of the operculum (Plate XIV. Fig. 7) there is, close to the cardinal-margin, a narrow sloping area, which is joined in an obtuse angle with the other surface. This again is divided by a median tooth or ridge into two similar parts, sloping towards the side-margins. The median ridge is highest on the point where the cardinal area meets the other

[1] This Prof. S. Lovén has found to be the case in *Cottus quadricornis, Idotea entomon,* etc., and I have myself ascertained the fact in *Paludinella baltica,* Nilsson.

areas, and it then continues very narrow and low to the shortest margin. From the highest part of the median ridge two short processes jut out, and embrace a small oval pit, ending at the cardinal margin. This oval pit is often occupied by the tooth-like portion of the median ridge. The cardinal area is divided by this pit into equal portions covered with coarse and irregular teeth, which diminish in size towards the side corners. On both sides of the median ridge the inner surface is covered with narrow longitudinal and incurved striæ.

In one specimen a complete operculum is attached, in another only a fragment of it, but in both cases under very strange circumstances. In the latter specimen the animal began to form a new calyx within the old one (Plate XIV. Fig. 4). This new and narrower calyx consists, as may be seen on the figure, partly of the old walls. It is only towards the bottom surface that new walls have been formed. This new wall, during its growth, coalesced with a remaining fragment of the operculum. It is very irregular, parallel with the interior surface of the operculum, and thus is bent in a very sharp fold at the point where the median ridge of the operculum is situated. The new calyx is bent in an irregular arch, and joins the middle of one of the old side walls. It is very evident that no new individual is here formed by means of budding, as the calyx and the walls are quite the same as before, with the exception of that corner. The second specimen, with a complete operculum, shows a distance of ten millims from the apex of its largest surface, another of a different kind, which meets the former at right angles, and is separated from it only by a narrow fissure. On closer inspection this surface is found to be an operculum left behind in its old place, while the animal, as in the case before cited, was reducing and diminishing its volume and partly formed a new calyx within the old. The new walls grew all round the operculum, which exactly resembles, in its lines of growth and shape, detached opercula of the same size. Those parts above and around the operculum have by no means resulted from budding—it is only the bottom surface which is interrupted in its growth; the others continue as before. Moreover, the budding seems to be a very rare mode of propagation in *Goniophyllum*, and is only seen in large individuals where the young shells, as in *Cyathophyllum*, are placed on the highest rim of the calyx. There is no reason to suppose that these phenomena of the reduction of the size are mere monstrosities, as they are also observed in numerous other specimens of *Goniophyllum*, and frequently in *Z. rugosa*. This peculiar formation of a new calyx within the old is common to almost all individuals of *Z. rugosa*, and is repeated several times by the same individual, as, for instance, in *Chonophyllum*, when the shell resembles a number of funnels placed within each other. It may then, as in *Goniophyllum* (and as will also be shown in *Calceola Gothlandica*), be presumed that the animal, at the time of these restrictions, commonly lost its old operculum, now too large, and formed a new one, although it was sometimes left attached, in consequence of the ligament decaying less rapidly than usual. Those species again which

Pupa, and *Achatina;* bones of the Mastodon have also been discovered in it.

The Yellow Loam overlies the Loess, where that exists, and elsewhere the Orange Sand; its average thickness is from 5 to 10 feet, and its characters vary more or less in accordance with those of the underlying material, which enters into its composition, and therefore testifies to a certain amount of denuding action.

The Hummocks, or Second Bottoms, as the newest beds are called, form part of the valleys of all the larger streams of the state, and are in general most extensive where the material of the adjoining uplands was most easily denuded, so as to permit the excavation of deep valleys; while, where that material resisted denudation, the contraction of the valley, and consequent greater swiftness of the stream, have either prevented the formation of these deposits, or caused their subsequent removal.

3. *Note on the Presence of Low Forms of Vegetation (filamentous Confervæ) in the hot and saline waters of California,* by Professor W. H. Brewer.—The waters contain a variety of salts in solution, principally sulphates of iron and alumina. The highest temperature in which the vegetation grew was about 200° F.

H. B. W.

REVIEWS.

I.—Silurian Rocks of Bohemia.

By M. J. Barrande.

[Defense des Colonies. III. Étude générale sur nos Étage G-H.; avec application speciale aux environs de Hluboçep, near Prague. Par Joachim Barrande. With a coloured Map and Plate of Sections. 8vo. Paris and Prague, 1865].

More than twenty-five years ago M. Barrande began a careful search in the Palæozoic strata near Prague for fossils, whereby to learn their exact relations one with another, and with like strata elsewhere. He worked on a large scale, employing native workmen to quarry the rocks and collect every fossil and fragment of fossil, keeping special note of the layer in which it occurred. Before long this steady and perfect examination of every bed enabled M. Barrande to determine several groups of so-called Silurian strata, round about Prague, arranged in a great basin or trough, and divisible into eight successive formations or stages. Three great and distinctive assemblages of animal forms (faunas) characterize the fossiliferous part of these stages. Beneath all is the old gneiss, the marble in which has lately yielded *Eozoön* to Hochstetter and Gümbel. Stages A and B, as yet unfossilliferous, are the Przibram and other Schists, and may be equivalent to the "Cambrian" of Britain, or the "Huronian" of Canada. Stage C, or the Ginetz beds, is characterized by the "Primordial Fauna" of Barrande, and is analogous to the Lingula-flags of Britain. Stage D has the "Second Fauna," and is equivalent to the Llandeilo and other beds of the Lower Silurian. Lastly, Stages E, F, G, H, characterized by the "Third Fauna," are Upper Silurian. M. Barrande has described the details in various books and memoirs, and conspectuses of his discoveries and views have been given by Murchison, Lyell, Hamilton, and others. One of the most interesting points to which M. Barrande has drawn attention is the occurrence of what he terms "Colonies," —that is, groups of fossils having special characters, that occur in thin beds intercalated in strata having a different fauna, but subsequently re-occurring in higher beds as the predominant fauna. He regards them as migratory and temporary off-shoots, as it were, from some co-existent but distant fauna, which subsequently however came into the same area in force, displacing the older fauna altogether. Thus, in Stage D, a thin but continuous stratum is full of such fossils as are abundant only far higher up in Stage E.

M. Barrande's earlier sections were merely diagrams; and when the Austrian Geological Surveyors examined the ground, they proposed to draw better sections and explain the apparent difficulties. MM. Lipold and Krejçi offered therefore their views to the public, suggesting that folds of the strata, obliquely and otherwise faulted, would account for interventions of parts of one set of strata among another; and a discussion followed. M. Barrande's "Defence of the Colonies" has been spirited, careful, and clear. In this, the third part of the work, the author contrasts some of the sketch-sections of Lipold and Krejçi with sections drawn to scale, to the advantage of his arguments certainly, though his pencil is not facile in rendering geological features.

The study of the Stages G and H in the neighbourhood of Hluboçep, near Prague, belongs especially to the question of the "Colonies," says M. Barrande, on account of the great importance that MM. Lipold and Krejçi have attached to the stratigraphical conditions (wrongly interpreted) of that locality. Therefore, these two stages are now treated of in full, as to their strata and fossils, their subdivisions, and their exact relationship to the underlying beds that contain the "Colonies" (as shown by carefully prepared sections). Further, the representative strata in other countries, that centre paralleled with these stages, are considered; and lastly, the peculiar occurrence in G and H of Goniatites and other fossils that are elsewhere found, not in Silurian, but in Devonian rocks, is shown to be by no means a conclusive argument in favour of their being "Devonian." To Mr. Hamilton's admirable *résumé* of this Memoir in his late Address to the Geological Society, we may refer those who wish to see an English summary of M. Barrande's observations; we must here limit ourselves to calling attention to these valuable researches, so perseveringly and consistently carried on,—so well, nay, so magnificently, recorded as they are in Barrande's grand work— "Le Système Silurien de la Bohême,"—and so enthusiastically and successfully supported, in their generalizations, by their clear-headed, untiring, and single-minded author.

II.—Contributions to the Geology of China.

Journal of the North-China Branch of the Royal Asiatic Society. New Series. No. 2. Shanghai, 1866. 8vo. pp. 187. Trübner & Co. London.

THIS Society, under the presidency of Sir Harry S. Parkes, K.C.B. furnishes, in this number of their journal, some papers on the geology of China, of which the following is a summary:—

1.—Notes on the Geology of the Great Plain, by Dr. Lamprey, of Her Majesty's 67th Regiment.

a. Physical geography of the Plain.—The Great Plain occupies a considerable part of the continent of China, including nearly the whole of Pechili, a considerable portion of the west of Shantung, half of Honan and Huquang, and the greater part of Keangnan. In this area are numerous lakes of great size, many rivers, amongst which are the Hoang Ho or Yellow river, and the Yangtse Keang, and occasionally isolated hills or groups of low mountains. The country around Shanghai is especially characterized by its extreme flatness.

b. The Yangtse Keang. This river is subject to tidal influence. perceptible as far as Kinhien, about 180 miles distant from its mouth; "the water is of the same muddy colour as that noticed further down the course of the river, and in addition to carrying a large proportion of this material in a mixed state, the water, when at its highest level moves with such velocity, that it carries with it four feet of the bed of the river in a continuous stream." The number of shoals existing at the mouth of the river render navigation dangerous: they are said to increase at the rate of about one foot in height in 12 or 15 months.

c. Neighbourhood of Shanghai.—The surface of the soil around Shanghai is but little elevated above the sea-level, and water is generally reached at from four to five feet below the surface; during wet weather and at spring tides the water in the wells of the city has often been on a level with the surface of the ground, whilst along the sea shore, from Woosung to Hanchow, an earthen mound and at some places stone embankments 20 feet in height, are required to preserve the country from inundation. A portion of the embankment has lately given way, and the land is flooded with sea water over an area of 60 square miles.

d. Fossil shells.—In several places in Pootung specimens of *Cerithium, Buccinum, Cardium, Corbula* (?), and most abundantly *Grateloupia irregularis*, are stated to occur.

Scattered over the soil both in Kiangsu and Pechili, and buried at various depths, are found *Paludina, Planorbis, Unio, Anodonta, Cyrena fluminalis, Succinea amphibia, Cerithium cinctum, Helix plebeia, Cardium, Solen,* and *Bulla.*

2.—A Sketch of the Geology of part of Quang Tung Province. By Mr. T. W. Kingsmill.

Mr. Kingsmill goes more deeply into the subject than did the author of the previous paper, "his aim is to throw into some shape the scattered notes of others, and to endeavour to form a connected sequence, for comparison of the rock formations of China and other parts of the world." He illustrates his remarks with a geological map of the province, the colouring of which, however, is stated to be "mostly hypothetical;" on it are marked beds which he considers to correspond with the Trias, New Red Sandstone, and Carboniferous Limestone of Europe. The coal-measures are developed largely to the south-west of Canton, quartz, schist, and granite extend from Canton eastwards, while igneous rocks, as basalts, porphyries, and greenstones occur at some distance north of the city. The structure of the country is shown in an ideal section from Macao to Tsungwha.

Granite.—The granite, which contains a large amount of mica, as well as an excess of alkaline materials, is readily decomposed; but it is very concretionary in its structure and irregular in character, "so that in many places there are to be seen large masses of the rock which have resisted decomposition, and lie like enormous boulders imbedded in the surrounding matrix; in places exposed to the wear and tear of tropical rains this matrix has been washed away, and the undecomposed masses, left far and wide over the surface of the hills, have more than once been referred to as the results of glacial action."

Coal.—Three coal-fields are known to occur in the Quangtung province, but the coal is of a very inferior quality, except at one place to the south of the West river, where good coal is obtained.

3.—Dr. Lamprey communicates a note on the Water-supply of Shanghai. The well water of the city is generally unfit for use, owing to the large amount of impurities, chiefly nitrate of lime, which it contains. The rivers, likewise, contain a very large amount of impurity, but by being filtered through animal charcoal the water becomes sufficiently wholesome for use. The lake water, though bright and sparkling, contains much impurity, but when filtered it has a decided advantage over all the other waters supplied to the town. Rain water is generally neglected, but were it properly collected and prepared, the author thinks it would be far better than either lake or river water.

III.—American Geology.

Geological Survey of California.

This survey, instituted in 1860, under the direction of Professor J. D. Whitney, as State Geologist, has recently published two volumes of the progress made to the end of 1864. *Geology*, vol. i., contains a synopsis of the fieldwork, it is illustrated by numerous sections and views of the country, in it will be found a considerable amount of information in regard to the economical geology of the State, all the detailed descriptions of minings, however, have been reserved for a Special Report.

Palæontology, vol. i., comprises the Carboniferous and Jurassic

Fossils, by Mr. F. B. Meek, and the Triassic and Cretaceous Fossils, by Mr. W. M. Gabb.

Cretaceous rocks occur over a very extensive area on the Pacific Coast, and are rich in fossils at many localities.

Jurassic fossils have been discovered in Genessee Valley, and in the auriferous slates of Mariposa County.

Rocks of Triassic age, equivalent to the Alpine Trias, or the beds of Hallstadt or St. Cassian, occur over a vast area, and form an important part of the metalliferous belt of the Pacific Coast; the best preserved fossils have been obtained from the Nevada district.

Besides the two reports just alluded two, we have just received the first part of the second volume of Palæontology, by Mr. W. M. Gabb. It contains descriptions of all the Tertiary Invertebrate Fossils as yet discovered, the imperfect state of preservation of a large portion of them has rendered it difficult to work them out satisfactorily. These fossils have been provisionally referred to the Miocene, Pliocene, and Post-Pliocene divisions of the Tertiaries, in accordance with our present ideas of their general relations, and the relative number of living and extinct species in each group of strata.

H. B. W.

REPORTS AND PROCEEDINGS.

Geological Society of London.—June 20, 1866.—Warington W. Smyth, Esq., M.A., F.R.S., President, in the Chair. The following communications were read:—

1. "On the Structure of the Red Crag." By S. V. Wood, Esq., F.G.S.

The Rev. O. Fisher having lately published a paper in which he endeavoured to show that the Chillesford beds were beneath the Fluvio-marine Crag, Mr. S. V. Wood in this paper first drew attention to certain facts which appeared to him to prove the contrary view, especially the relations of the deposits as exhibited in pits at Wangford and at Thorpe, near Aldborough. The author then drew attention to the character of the fossils of the Red Crag as affording evidence of one of the most rapid changes in fauna that Geology affords; and he showed that this deposit contains the evidence of a transition by stages, from the oldest, where the affinities of the fossils are to a great extent with those of the Coralline Crag, and to a greater extent with the existing fauna of the Mediterranean, to the newer stages, in which the shells are very few, and confined to types peculiarly northern.

2. "Note on supposed Remains of the Crag on the North Downs, near Folkestone." By H. W. Bristow, Esq., F.R.S., F.G.S.

An examination of these sands at Paddlesworth had convinced the author of their similarity to certain ferruginous clayey sands, with masses of ferruginous grit, which occur in the Hampshire Basin, and belong to the Woolwich and Reading series; and he therefore concluded that if the Kentish beds can be proved to belong to any other member of the Tertiary series, it is only to be done by the evidence of the fossils.

3. "On the Warp of Mr. Trimmer; its age and probable connection with the latest geological events and changes of climate." By the Rev. O. Fisher, M.A., F.G.S.

The author commenced by referring to the opinion of the late Mr. Trimmer respecting the origin of soils, that they are composed of the débris of the underlying rocks, together with transported materials. He then showed that the adventitious matter usually occurs filling furrows in the subjacent rock, and appears to have been carried forward in a plastic state, and not water-drifted. The author named it "trail," and explained that the variation of soils arises from its incorporation with the disintegrated matter. The furrows were considered to be indications of the last denudation of the surface, and it was suggested that they may have been formed by land-ice. The ice-sheet having finally disappeared, the formation of the warp with its basal pebbles was considered to be due to meteoric action. The warp was then stated to be older than the last depression of the land, and to underlie the Scrobicularia-clay, while the gravels beneath the submarine forest at the mouths of many valleys were also supposed to be trail.

In conclusion, Mr. Fisher discussed the theories of M. Adhémar and Mr. Croll, showing that the events as traced in the former part of the paper agree with their views, and that their determination of the date of the commencement of the alluvial period (the period of the retirement of the sea from our lower valleys) coincides remarkably with that assigned to it on totally different grounds by Mr. Prestwich, of from 8,000 to 10,000 years.

4. "On Faults in the Drift-gravel at Hitchin, Herts." By J. W. Salter, Esq., F.G.S.

The author described some faults exhibited in a cutting of the Great Northern Railway, passing through the Chalk and Boulder-clay gravel; and remarked that, whatever system of movements affected Tertiary rocks, disturbed also the deeper-seated strata, and assigned this as a reason why the older rocks are more faulted and jointed than the newer.

5. "On some Flint Implements lately found in the Valley of the Little Ouse River, near Thetford." By J. W. Flower, Esq., F.G.S.

The sands and flint-gravel on the right bank of the River Ouse at Thetford from a terrace 8 to 10 yards above the river, and about 40 yards distant from it; at a spot called Red Hill a large number of flint implements have lately been obtained from this gravel, at from 12 to 15 feet below the surface, and within a foot or less of the chalk on which the gravel rests; and some were found in the same gravel filling pot-holes in the chalk.

The author pointed out the exact correspondence as regards geological position and relations between the Thetford gravels and the flint-implement bearing beds of Amiens, Abbeville, Fisherton, Icklingham, Hoxne, &c. He further noticed the close resemblance which these implements, and some others discovered in England, bear to those of the valley of the Somme; and concluded by expressing his dissent from Mr. Prestwich's conclusions, and stating his own views on their mode of accumulation, remarking that, in his opinion, these implements were manufactured prior to the severance of this island from the continent.

6. "On some evidences of the Antiquity of Man in Ecuador." By J. S. Wilson, Esq. Communicated by Sir R. I. Murchison. Bart., K.C.B., F.R.S., F.G.S.

The western slope of the Cordilleras was stated by the author to be occupied with projected volcanic matter distributed in terraces, the most recent of which is but slightly above high-water mark; the second rises in some places 10 feet above the former, and is well seen in the lower part of the Esmeraldos river and in the valleys of its lower tributaries; above this rise four other terraces respectively 8, 15, 12, and 6 feet above one another.

The second terrace contains in many places remains of articles of human art, broken pottery, earthen figures, and fragments of gold ornaments. This pottery stratum is traceable along a line of 80 miles of coast, and, by partial observations, is determined to occur under corresponding conditions for a distance of 200 miles more.

A section at Chancama was also described; it is 24 miles from the coast, 180 feet above the sea, and 50 feet above the Esmeraldos river, and exhibits undisturbed sea-distributed gravel and sands, 6 feet 6 inches in thickness, containing fragments of pottery.

7. "On the relations of the Tertiary Formations of the West Indies." By R. J. L. Guppy, Esq., F.G.S.

In this paper the author first briefly noticed the present state of our knowledge of the different formations occurring in the Caribean area, which he named respectively Eocene, Lower Miocene, and Upper Miocene, these names having reference to their relative position rather than to their positive age. It was stated that Eocene strata were as yet known to occur only in Jamaica; and the author then described the Lower Miocene deposits of Trinidad, Anguilla, and Antigua, and the Upper Miocene of San Domingo, Jamaica, Trinidad, and Cumana, giving sections illustrating the nature and position of the beds, and lists of the fossils found therein. Mr. Guppy then discussed the age of the Caribean Miocene deposits of the different islands, giving the evidence on which the above-mentioned classification is founded, and a sketch of the deposits in other islands not included in it. In conclusion the author discussed the relation of the West Indian Miocene deposits to the Tertiary strata of other regions, especially with regard to the migration of species and the Atlantis hypothesis; and he inferred that the Miocene of the West Indies must be included in the same great period of time as that of Europe, and may therefore be considered in a geological sense, as synchronous; that it is highly improbable that the West Indian Miocene forms reached the localities where they occur as fossils by way of the Isthmus of Panama, or by an easterly route from Europe or from the Indian sea; and that it is probable that during the early and middle Tertiaries such a connexion existed between the shores of the Atlantic as admitted of the migration of organized beings from one side to the other, although the continents may not have been absolutely joined.

8. "On the discovery of new Gold-deposits in the district of Esmeraldas, Ecuador." By Lieut.-Colonel Neale, Her Majesty's Chargé d'Affaires in Ecuador. Communicated by the Foreign Office.

The author stated that unworked and hitherto unknown gold deposits had been discovered in the district of Esmeraldas, Ecuador; and that the President of the Republic, who had received specimens of the gold of a very pure quality, purposed sending a scientific commission to report on the probable yield of the gold-district. Further, he recorded a recent influx of immigrants from California and Nevada to the gold mines of Barbacoas in New Grenada.

9. "On bones of fossil Chelonians from the Ossiferous Caves and Fissures of Malta." By A. Leith Adams, M.B., F.G.S.

The remains of more than one species of River Tortoise, agreeing in their character with the Elodians and Potamians, were stated to occur in the Maltese caves and fissures associated with exuviæ of the fossil elephant, *Hippopotamus Pentlandi, Myoxus Melitensis,* and birds —the last chiefly aquatic, including *Cygnus Falconeri,* a Lizard, and one or more frogs. The author considered that the nature and arrangement of the deposits and the conditions of their fossil fauna clearly show that they had for the most part been conveyed into the above situations by the agency of large bodies of water, which at one time overflowed the greater portion of the eastern half of the island.

10. "On the discovery of remains of *Halitherium* in the Miocene beds of Malta." By A. Leith Adams, M.B., F.G.S.

The four upper beds of the Miocene formation of the Maltese group, more especially the Sand-bed and Nodule-Bands of the calcareous sandstone, have yielded several forms of Cetaceans, teeth of *Zeuglodon,* one or more species of Dugong allied to recent forms and *Balænæ*; to these the author has added a tooth, an ear-bone, and some caudal vertebræ of the *Halitherium.*

11. "On the affinities of *Chondrosteus,* Ag." By John Young, M.D., F.G.S.

The object of this communication was to show, from the characters of the skeleton, that *Chondrosteus* belongs not to the Chondrostean division of the ganoids as stated by Agassiz, but to the Holostean division, since it posseses a well ossified basi-occipital; and the lateral walls of the cranium are composed of bones answering to the cartilage bones of ordinary Teleosteans.

12. "On new Carboniferous genera of Crossopterygian Ganoids." By John Young, M.D., F.G.S.

In this paper the following new genera were described:—*Rhizodopsis, Strepsodus, Dendroptychius,* and *Rhomboptychius*; all of which were provisionally named some years ago by Professor Huxley. Their generic distinctness has been fully established by specimens recently discovered. The relation of *Rhomboptychius* to *Megalichthys,* and the position of *Holoptychius* and *Rhizodus* in this subdivision of the ganoids, are discussed in the latter part of the communication.

13. "On supposed burrows of Worms in the Laurentian Rocks of of Canada." By Dr. Dawson, F.G.S.

The author communicated the discovery of perforations, resembling burrows of worms, in a calcareous quartzite, or impure limestone, of Laurentian age, from Madoc, in Upper Canada, but belonging to a somewhat higher horizon than the Eozoön-serpentines of Grenville.

The following specimens were exhibited :—

1. Shells illustrating the Rev. O. Fisher's paper on the "Warp ;" exhibited by the author.

2. Flint Implements illustrating Mr. Flower's paper; exhibited by the author.

3. Worm-burrows from the Laurentian Rocks of Canada; exhibited by Dr. J. W. Dawson, F.R.S., F.G.S.

4. Specimens illustrating the structure of *Eozoön;* exhibited by Dr. W. B. Carpenter, F.R.S., F.G.S.

5. Specimens illustrating the view of the inorganic origin of *Eozoön;* exhibited by Dr. T. H. Rowney.

6. A new species of *Ranina* (*R. porifera,* H. Woodw.) from the Tertiary beds of Trinidad and other fossils; exhibited by R. J. L. Guppy, Esq., F.G.S.

7. Cornish Minerals; exhibited by Dr. Le Neve Foster, F.G.S.; and two specimens of *Diallogite* from Cornwall; exhibited by Mrs. Murphy of Penzance.

8. Specimen of Rock Crystal from Japan; exhibited by H. W. Bristow, Esq., F.R.S., F.G.S.

The next evening-meeting of the society will be held on November 7, 1866.

Cotteswold Naturalists' Field-club.—The second field meeting took place on the 13th June at May-hill. This was a joint meet of the Cotteswold and Malvern Clubs. Both clubs gathered under the leadership of their respective presidents, Sir W. V. Guise and the Rev. W. S. Symonds. The members left Gloucester in carriages, halting by the way to view the *Pinetum* at Highnam lodge; from which elevated spot the prospect is extremely grand. The party next proceeded to Huntley, the new church of which demanded inspection, and is sure to elicit admiration from all who delight in good taste in church decoration. From the church, a short walk brought the party to the hospitable residence of Major Probyn, where an excellent luncheon was provided. The club next ascended May-hill, on the summit of which the President of the Malvern Club, the Rev. W. S. Symonds, described the geology of this interesting district, which lies spread around the observer from that commanding elevation. Commencing with the primæval history of the Malverns, he showed how their Syenitic masses have been thrust through the overlying Silurian strata—how the prolongation of their axis of disturbance has brought the Llandovery rock to the summit of May-hill, and thrown off the overlying "Silurians" and "Old Red" on the flanks like the coats of an onion—how the prolongation of this line of upthrust passing under Portworth and the Bristol Coal-field is traceable over a vast area; giving rise to a series of dislocations and upheavals most important in an economical point of view, as bearing upon the practicable working of many of our beds of coal and iron. The speaker pointed out the Oolitic escarpment of the Cotteswolds, and the geological features of the vales of Worcester and Gloucester. He described the action of ice and water, which, in the course of ages, has ground down and worn away the superincumbent strata, leaving only a gravel-bed here and there, to tell of what once has been; and he wound up by an eloquent account of the appearance of man upon the scene, in company with the extinct gigantic mammalia—the mammoth and the hairy rhinoceros—now no longer living on the face of the earth, but whose bones, entombed with the works and remains of man, have been of late years frequently found associated, under circumstances which render their contemporaneity no longer doubtful.

The address was loudly cheered; but a fall of rain caused a somewhat hurried return to Gloucester, where, at the Bell Hotel, about thirty-five members sat down to dinner.

After dinner, Dr. Wright made a communication "On the Distribution of the Coral-beds of the English Oolitic rocks." He first gave an account of the coral-reefs of the Pacific, their structure, mode of growth, and geographical distribution; he pointed out how that these formations occupy in our present seas a great area of depression, in which the land has been sinking for long periods of time; that the polypes which form these reefs build at no great depth from the surface of the ocean; that as the land goes down these tiny architects build up, and that where coral is found at depths of from 1500 to 2000 feet, it is not that polypes live at such depths, but that the land on which they once built has sunk; that these animals only thrive in water above 66° Far., and that wherever the temperature of the ocean falls below that point they are no longer found. The magnitude of some of these structures far surpasses that of any other animal product, for the barrier-reef on the north-east coast of Australia is about 1250 miles in length, and in the low Archipelago many thousands of miles of ocean waste is studded over with these zoophytic structures. If there was any one character more remarkable than another, in a zoological point of view, by which the present epoch was distinguished from the past, it was by the magnitude and extent of the coral-reefs and islands which were developed within 28° of latitude north and south of the equator. Dr. Wright then proceeded to describe the character of the coral beds found in the Lias, of which he enumerated three in different zones. He then pointed out those in the Inferior Oolite, of which he described three; the lowest found in the Pea-grit of Crickley-hill, Cubberley, at Brown'shill, near Painswick, and other localities, was well worthy of attention; it was the nearest approach to our modern reefs that they possessed, as it covered a considerable area, and was from 20 to 25 feet thick. The Oolite-marl was the second coral bed, but was of inconsiderable thickness. The third was found among the uppermost Ragstones capping Cleeve, Leckhampton, Painswick, Stinchcombe, and Dursley hills. In the Great Oolite there was a coral-bed about the horizon of the Forest Marble, near Fairford; the Oxford Clay was without such structures, but in the Coral Rag and Coralline Oolite, coral-beds were again found. Steeple Ashton, in Wiltshire, had been long famous for its coral-banks, and in the Coralline Oolite, near Scarborough, there was a very considerable development of a coral-bed, some of the best road material in that region being obtained from the crystalline limestone raised out of the old coral-bank of the Oolitic sea. The Kimmeridge Clay, like the Oxford Clay, was devoid of coralline structures, but in the Portland Oolite another coral-bank was found at Tisbury, in Wiltshire. One fact worthy of note is this, that the species of corals found in all these different beds are quite distinct specifically from each other, every period of time having had different forms of architects in building these structures in the ancient seas, and all of them generically distinct from those which exist at the present period. The great lapse of time which our present modern reefs and islands represented was next pointed out, for it could easily be demonstrated that as the coral-polypes raise their structure very slowly, a long period of time was required to build up a structure like the barrier reef of Australia, which represented a wall of coral rock that would extend over 1250 statute miles in length by from 10 to 90 miles in width. The calculations that had been made of the age of these modern structures showed that many thousands of years were requisite for the work which had been performed by the existing races of the coral polype.

Dr. Wright's address was followed by a paper on the Geology of Canada, by a member of the Malvern Club, Captain Serocold, whose discourse, illustrated by a well-drawn map, treated with great ability the general features of the country, with their "Laurentian," "Potsdam," and "Trenton" beds, in many respects so different from anything in this country, yet presenting in their contained organisms features of analogy which have enabled geologists to correlate them with our own more familiar geological areas, so that they have been found mutually to illustrate each other.

With this paper the proceedings were brought to a close, and the party broke up, after a day of great enjoyment.

Great credit is due to the Honorary Secretary, Dr. Paine, of Stroud, for the excellence and punctuality in the arrangements.—T.W.

CORRESPONDENCE.

DISCOVERY OF WULFENITE, ETC., IN PEMBROKESHIRE.

To the Editor of the Geological Magazine.

Dear Sir,—It may be interesting to some of your readers to know that I have lately discovered, in Pembrokeshire, small, but well-formed, tabular crystals of Wulfenite (Molybdate of Lead), at the Treffgarn Rocks, between Haverfordwest and Fishguard. They occur in small cavities, which are irregularly dispersed through the rock (a felstone according to the geological map of the district), are of a brown or honey-yellow colour, semi-transparent, with the edges bevelled, and in form answer to fig. 5 in Phillips' "Mineralogy" (4th edition). I also obtained a substance of a greenish-grey colour, disseminated in small veins and patches, which is probably the same mineral in a massive form. Minute but exceedingly perfect crystals of tin likewise occur, similarly to those of the Wulfenite; but, as far as I have been able to observe, in a separate portion of the rock.

I may as well mention that I have recently found some fine black crystals of Blende (sulphide of zinc) at the tunnel near the Patchway Station on the Bristol and South Wales Union Railway. I am not aware that this mineral has been met with before in Gloucestershire, or the neighbouring counties.—I remain, dear Sir, yours very truly,

SPENCER GEORGE PERCEVAL.

SEVERN HOUSE, HENBURY, BRISTOL, *June 11th*, 1866.

THE REV. T. G. BONNEY ON "TRACES OF GLACIERS IN THE ENGLISH LAKES."

To the Editor of the GEOLOGICAL MAGAZINE.

DEAR SIR,—In reference to the paper by the Rev. T. G. Bonney on "Traces of Glaciers in the English Lakes" in the July number of the GEOLOGICAL MAGAZINE, the author will find that the subject has already been discussed to some extent by Mr. R. Chambers, and more recently by myself in a paper, with illustrations, "On the Glacial Vestiges of the Lake District," published in Vol. xi. of the "Edinburgh New Philosophical Journal," (1860), and that the remarkable ice-worn rock on the north side of St. Mary's Churchyard, Ambleside, is figured both in that paper and subsequently in Lyell's "Antiquity of Man," p. 269. The Glacial phenomena of Wastdale (or Wast-water), not the "Wastdale" of Professor Phillips' Memoir, are also described in one of the last numbers of your Magazine's predecsssor—"The Geologist;" and the whole subject, with its relations to the glacial phenomena of North Wales, as worked out by Professor Ramsay, is touched upon in a recent number of the "Memoirs of the Literary and Philosophical Society of Manchester" (1864). The exact reference to which, absence from home prevents me from giving. I hope Mr. Bonney will not suppose that, in sending this information, I wish to underrate whatever is new and interesting in his paper, which is far from my intention.

I remain, very truly, yours,

EDWARD HULL.

DOUGLAS, ISLE OF MAN, *9th July*, 1866.

ATMOSPHERIC FORCES.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—I am grateful to Professor Jukes for his handsome acknowledgment of the influence exercised on his "views of the amount of atmospheric forces," by my argument of thirty years back, drawn from the volcanic region of Central France. I may mention that another distinguished geologist, Mr. A. Geikie, has also, in his paper on Auvergne, printed in "Notes of Travel by Vacation Tourists," 1861,' borne similar testimony to the "enlarged views" he obtained there of the "enormous potency of rain and rivers in effecting the degradation of the land."

With regard to any difference still existing between Professor Jukes and myself as to the amount of influence exercised by "internal" or subterranean force upon the external configuration of the earth, I think with him that it can amount to little more than a question as to the meaning of the words he employs, since I now understand him to explain that by the phrase "form of the ground" he only means the latest touches given to the surface, such for example as are seen in "the abrasion of a volcanic cone by winds or rain in the course of a few years" (p. 332), not the grander superficial inequalities of mountain and valley, dry land and subaqueous hollow, which alone I intended to refer in a large degree to the agency of subterranean forces.

Some little misunderstanding may yet remain under cover of the Professor's use of the word "direct," as when he says (p. 332) "The direct effect of earthquakes in cracking, or bending the surface are surely very insignificant, etc." Now, if by "earthquake" is meant (as of course must be meant) those oscillations of level which have in some localities carried up beds of recent sea-shells to heights of hundreds of feet, and Tertiary marine strata to that of thousands, above the sea level, while portions of the same beds, once continuous with these, and even now at no great horizontal distance, have remained unmoved, or have been proportionately depressed, I cannot understand how such effects can be styled "insignificant," or be considered of little moment in an inquiry as to the causes of the "form of the ground."

The paramount influence exercised by subterranean energy in determining the configuration of the earth's surface, might indeed be inferred *à priori* from the considerations, (1) That no upheaval or depression of surface-rocks could take place without leaving proportionate inequalities of superficial level; and (2) That the inequalities so produced must have always largely determined both the direction and the force of the external denuding agencies. That such changes of level have been taking place throughout all time down to the present day, and upon the largest scale, though probably never on the large scale "*per saltum*," but rather by slow continuous movements, or frequently repeated jerks, such as are characteristic of recent earthquakes, Mr. Jukes will not of course deny. All geologists, indeed, recognise as a natural law the tendency of all the external denuding forces to reduce the surface of the earth to one uniform level, so that but for the opposing agency of the subterranean forces no dry land could long exist. It seems, therefore, like a paradox to deny to the latter power any "direct" or considerable share in the external configuration of the earth.

But there is something more than this to be said. Mr. Jukes, as I before remarked, makes the large admission that all volcanic hills and mountains are superficial protuberances "directly" produced by internal force. Now, on examination of any map of the globe showing the position of the known volcanos and volcanic formations, it will be seen that they are for the most part arranged in linear bands bearing a remarkable parallelism to the nearest non-volcanic mountain ranges. Must there not be some common cause for this remarkable correspondence of direction? May we not presume that while the volcanic mountain ranges have risen by means of the eruption through linear fractures of the earth's crust of subterranean matter in a liquified or gaseous condition, the non-volcanic mountains have been contemporaneously rising through parallel fractures, in consequence of the upward pressure of subterranean matter, which, not being able to find an issue in a liquified or gaseous form, has forced itself, in a more or less solid or pasty state, into and through the overlying rocks, carrying them up with it, or shouldering them off on either side,—and thus bringing up to or near the surface those bulky crystalline masses and corrugated metamorphic strata of which the axial portions of such mountain ranges are so often seen to consist? It seems certain, for example, that the Alps and Pyrenees were rising by degrees from below the sea while the intermediate granitic plateau of Central France remained stationary in level, but gave birth to a series of volcanic eruptions which deluged its surface, and that of the lacustrine strata, that filled its hollows with lava-beds. A similar series of eruptions were about the same time taking place along a band of country north of the Alps and nearly parallel to their main direction, reaching from the Rhine through Central Germany to Hungary. If we are ever to acquire any definite notion of the changes that have taken place in the crust of the globe, and the causes of its varying external configuration and internal structure, we must not lose sight of considerations such as these, or undervalue the internal forces which have unquestionably contributed quite as much, if not more, than external denuding agencies to produce the results in question.

It was simply to remind Professor Jukes and geologists in general of this, and not to go more deeply into a subject of such importance, that I ventured to challenge his apparent negation of the "internal forces" of the globe as one of the "direct" causes of its superficial configuration.

G. Poulett Scrope.

Castle Combe, Chippenham, *July* 10*th*, 1866.

THE SEA AGAINST THE PLOUGH.—REPLY TO MR. G. POULETT SCROPE.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—I can scarcely suppose that the banks and lynchets[1] with which Mr. G. Poulett Scrope is most familiar are of the same nature as those which I believe to be old *sea-coast lines,* and which every Lyellian geologist should expect to find in situations favourable to their formation and preservation. The terraces in the Cretaceous and Oolitic districts of the south of England, to which I have all along alluded, are generally speaking from 15 to 40 feet in height, and from 15 to 60 feet in breadth; but many of them are much smaller, and not a few very much larger, embracing even the whole of an escarpment. The smaller, however, are often so associated with the larger as to leave little doubt of a common origin.[2] They may be seen in great variety between Mere and Hindon, between Blandford and Sturminster, in the neighbourhood of Bridport, etc. They present the same aspect as many lower level terraces in Somersetshire, commencing on the Coast, and running inland beyond Glastonbury, and in Dorsetshire near Bridport harbour, etc. They are likewise similar to many systems of terraces in the neighbourhood of the Moray Frith, and the Great Glen, in Scotland. That the inland terraces of Dorset and Wilts are not covered with "shingle or rolled pebbles" is no presumption against their marine origin, for it is now well known that on shores fringing steep slopes, where there is little facility for the drifting of materials, the sea often fails to round fragments of rock, and that chalk flints under *ordinary* conditions require to be subjected to a second or even third stage or period of attrition before they can become rounded. [Lyell's Elements, p. 370].

It is true that a section of several lynchets near Warminster, kindly furnished by Mr. Codrington, F.G.S., exhibits an apparent addition of made ground to their general profile, in a way however that the plough will not explain; but it is only reasonable to suppose, as I have before remarked, that man may have tampered with and rendered less sloping the platforms of these and other terraces, or even imitated nature in making entire terraces. Still there are peculiarities connected with the fundamental form, structure, and arrangement of those I have observed which the sea only will account for, such as the extent to which their profile corresponds with the indentation in the rock beneath; their frequent waved or inclined

[1] See Mr. Scrope's Article "The Terraces of the Chalk Downs," in the July Number of the GEOLOGICAL MAGAZINE, p. 293.

[2] The extent to which these terraces have preserved their sharpness of outline, supposing them to have been formed during a pre-glacial submergence, furnishes no real objection to the theory of their marine origin, as grass-covered lands away from the courses of temporary or permanent streams are capable of preserving their surface-configuration for an indefinite period. Mr. G. Poulett Scrope himself, in the article I am now answering, attributes to grass a power of checking the descent of silt, greater than would be required for ordinary surface-protection.

deviations from longitudinal horizontality,[1] where it may have been caused by locally-unequal elevation or depression, and where it could have served no economical purpose; the varying breadth of many of the terraces, and the occasional merging of a lower into a higher cliff, as might be expected, supposing them to be successively worn-back coast-lines; the way in which they narrow off or vanish, and re-appear; the positions they occupy, which are often the least eligible for cultivation, if not beyond its reach; the historical or archæological evidences of their extreme antiquity which, I believe, can be adduced; and, above all, their great number and extent.

So far as my observations have extended, the plough would appear to obliterate rather than form regular systems of terraces such as those above described. Mr. G. Poulett Scrope believes that the agricultural theory of their origin is the one generally received. But it is well known in the south of England that antiquarians have claimed these terraces, and that those of them which encircle hills have been regarded as the remains of Phœnician hill-cities. If they originated, as Mr. Scrope supposes, in the cultivation of longitudinal strips of land by separate owners or tenants, the upper cultivator "careful not to allow the soil of his strip to descend to fertilize his neighbour's below," the arrangement must have been worthy of a very short-sighted race of farmers; for most of the terraces are so *narrow* that the part really available for cultivation could not have been more than two or three yards in breadth, or so *wide* and *high* that the amount of labour necessary to farm them must have been too great for a profitable return; and one can scarcely help supposing that the cultivators might have invented a more economical and less troublesome boundary than the accumulation of a bank of soil, impoverishing the inner part of a "strip," and requiring the constant watch of its jealous owner. There are other points in the agricultural theory which not only suppose a cause disproportionate to the effect, but involve a series of improbabilities one would not expect to find in an explanation set forth as the opposite of a "preposterous idea."

I regret that I have to write from memory, and that I may not have an opportunity of corroborating the above statements by re-visiting the localities for several months to come. Meanwhile several competent gentlemen are kindly making observations, the results of which will soon be published.

In conclusion I would venture to call the attention of geologists to the necessity for subjecting the theory of the non-submergence of the South of England during any part of the glacial period, to the test of facts, by following up the observations lately made by Mr. Maw, in Devonshire.

D. Mackintosh.

[1] I should not go so far as to assert that each of the smaller terraces (which are frequently not parallel) indicated a pause in the rise or fall of the land, as we know that the sea often leaves terraces, regular and irregular, between the extreme highest and lowest tide-levels.

MISCELLANEOUS.

Eruption Produced by an Artesian Well.—At an artesian well, fifty metres deep, in progress of being bored, near the Church of St. Agnes, at Venice, on the 11th of April last, when the workmen had left off work, a subterranean rumbling was heard, and a jet of water the diameter of the opening, and to the height of a house, was thrown from the mouth of the well. After some time the noise increased, and solid smoking masses were thrown up with the water, falling upon the houses near. It is even stated that the violence of the eruption was so great that a considerable crack was made in the wall of the church, and the inhabitants of many of the neighbouring houses were compelled to leave them. As soon as possible a large number of workmen were brought to the spot, and openings were made to allow the water to escape, which prevented further mischief. The eruption appears to have continued till half-past eleven at night.—*Journ. Soc. of Arts.*

Growth of Peat.—An old proverb still lingering in Weardale is :—"A wise man may cut peats thrice in his life, where a fool will only cut once." My informant who had heard it half a century ago from his then aged grandfather, living in Weardale, explains it to mean that by providing for the lodgment of water in the hole whence peat has been extracted, it will re-form in the course of about twenty years, so as to be again available for use.—S. R. P.

Another New Wealden Reptile.—The Rev. W. Fox, of the Isle of Wight, who last summer discovered his *Polacanthus Foxii*, has just brought to light another new Wealden Saurian. The discovered parts of this animal are limited to the bones of the sacrum, consisting of five cemented vertebræ with the sacral ribs and portions of the other iliac bones. The remains, therefore, are quite sufficient to show that the reptile to which they belonged was of the Dinosaurian order. It was small compared with the other monsters of the world of efts, the sacrum being only six inches in length; yet, apart from its size, it had as much of novelty about it as any of the previously discovered dragons. The bones are more hollow, light, and compact in structure than the bones of birds, and quite as much so as those of the pterodactyls, with foramina for the admission of air into them, like the bones of the last-named reptiles. Such a formation was evidently given for the purpose of leaping from tree to tree, or for bounding from the grasp of other reptiles with an elasticity of spring equalling that of the grasshopper. With the approval of Professor Owen, who has examined the bones, this new reptile has been dedicated to him by its discoverer, who has given it the descriptive name of *Calamospondylus Oweni* from the fact of its backbone being hollow, smooth, and compact like a reed.—*Athenæum.*

Level of the Dead Sea.—"On the 12th of March, 1865, the party reached the Dead Sea, when its level was found to be 1,292 feet below the level of the Mediterranean; but it was ascertained that at some time of the year, probably after the winter freshets, the water rises 2½ feet higher, which would make the least depression 1289·5."—Sir H. James, *Proc. Roy. Soc., May*, 1866.

Geological Map of Southern Norway.

By Theodor Kjerulf and Tellef Dahll. Christiania, 1866.

The Geological Survey of Norway was instituted in 1858 by order of the Royal Government, and this map, comprising the whole of the country to the south of the Dovrefield and Langfield Mountains, is the result of the work done from that time to 1865, by the authors and fifteen assistants, who were engaged during the summer months.

The map is a very neat production, the colours being clear and distinct; it is rather to be regretted that none of the physical features, with the exception of rivers and lakes, are delineated on it, but this omission is in some measure supplied by a number of horizontal sections (uncoloured).

The greater part of the country is composed of granitic and the older Palæozoic rocks, which in the mountainous regions are much disturbed, the granites being of an eruptive character, dislocating and upheaving the sedimentary rocks.

The following is a table of the strata exposed in Norway, as determined by the Survey, and coloured on their map:—

Post Tertiary	Alluvial and Post-Glacial Formations. Glacial Deposits.
Devonian (?)	Conglomerate, Sandstone, Red Argillaceous Schists. (No fossils at present found.)
Upper Silurian	Limestone with *Orthoceras cochleatum*, Schists with Graptolites. Limestone with Corals, Schists, with *Pentamerus*.
Lower Silurians	Sandy Limestones and Schists. Schists, Limestone with *Chasmops*. Schists with Graptolites, Limestone with *Orthoceras vaginatum*.
(?)	Micaceous, and Alcose, and Chloritic Schists, with some Silurian fossils. Dolomitic beds.
Upper Taconic (?)	Quartzites and Schists of the high mountains. Argillaceous Schists with *Dictyonema*. Limestone with *Olenus*. Dolomitic beds.
Lower Taconic.	"Spragmitic" strata—conglomerates, Schists. Dolomitic beds.
Azoic (?)	"Fundamental rock," Schists and Gneiss with bands of Limestone. (No traces of organic remains.)
"Eruptive Rocks"	Granite, Syenite, Porphyry, Serpentine, etc., of different ages.

THE

GEOLOGICAL MAGAZINE.

No. XXVII.—SEPTEMBER, 1866.

ORIGINAL ARTICLES.

I.—On the Geological Epochs at which Gold has made its Appearance in the Crust of the Earth.

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

In the Geological Magazine, 1865, Vol. II., p. 308, reference is made to the recent discoveries of Whitney as to the occurrence of Gold in the rocks of California even of an age as recent as Cretaceous. These discoveries fully confirm my previous results in South America,[1] yet the examination of a series of specimens recently sent me from California makes me communicate these few observations upon the relations of the gold-bearing rocks in question and some remarks on the views which I have expressed[2] with reference to the geological periods at which gold has made its appearance in the crust of our globe.

When Mr. Whitney speaks of auriferous Triassic and Jurassic strata, the impression left upon the mind of the reader seems to me to be, that the strata pertaining to these formations contain sedimentary beds having gold disseminated in them.

Not having been able to obtain as yet the original reports of Mr. Whitney, I cannot judge conclusively whether this is his exact meaning or not; but the examination of the rocks and other specimens sent me from California makes me believe that such impression is decidedly not the reality of the case, but that the mineral deposits of California are precisely identical with those which I have met with in Chile, Peru, and Bolivia, and in part described.

In South America I do not state that the Upper Oolitic strata, etc., are auriferous; but I report that the presence of gold in such strata is due to the eruption of Dioritic rocks of still younger age, which carry up the gold into the neighbouring rock in the form of veins, or metallic impregnation, extending a greater or less distance into the sedimentary strata, which are more or less altered by contact with the eruptive rock. Where we have no Diorite in the neigh-

[1] Geol. Soc., Nov., 1860. Quart. Journ. Geol. Soc., vol. xvii.
[2] *Vide* abstract, Geological Magazine, January, 1866, p. 23.

bourhood, or have no reason to suppose the existence of Dioritic rocks which may not come quite to the surface, there we find no gold.

The specimens from California which I have alluded to, fully confirm these views—and specimens of Diorite are mineralogically and chemically the same as those of similar age from Chile, Peru, and Bolivia—whilst the microscopical examination of their sections gives strikingly identical results.

With regard to the time of introduction of gold, or rather auriferous eruptive rocks, into the crust of the earth, a continued study of the subject, and the collection of more data from other parts of the world, not only confirms me in the views expressed in a communication to the British Association, in 1865 (a short abstract of which is given in the Geological Magazine, for January, 1866, p. 23) but makes me further believe the views therein expounded to be of universal application, and—

> § bearing in mind that any bed of sedimentary origin may contain fragmentary débris of any auriferous eruptive rock or vein substance which was of previous geological age—

I am of the opinion that gold is not in itself characteristic of any sedimentary stratum or formation, and when found in such beds, introduced otherwise than stated in the proviso §, that its presence there is due to subsequent intrusive causes.

My researches have led me to conclude that, universally, gold has been introduced into the crust of the earth at two[1] very distinct geological epochs, and that in both these cases it has been carried up in direct consequence of, and in conjunction with, the outbursts of distinct and characteristic plutonic rocks.

These two epochs of auriferous impregnation I designate respectively as—1. The older or auriferous granite outburst. 2. The younger or auriferous diorite outburst.

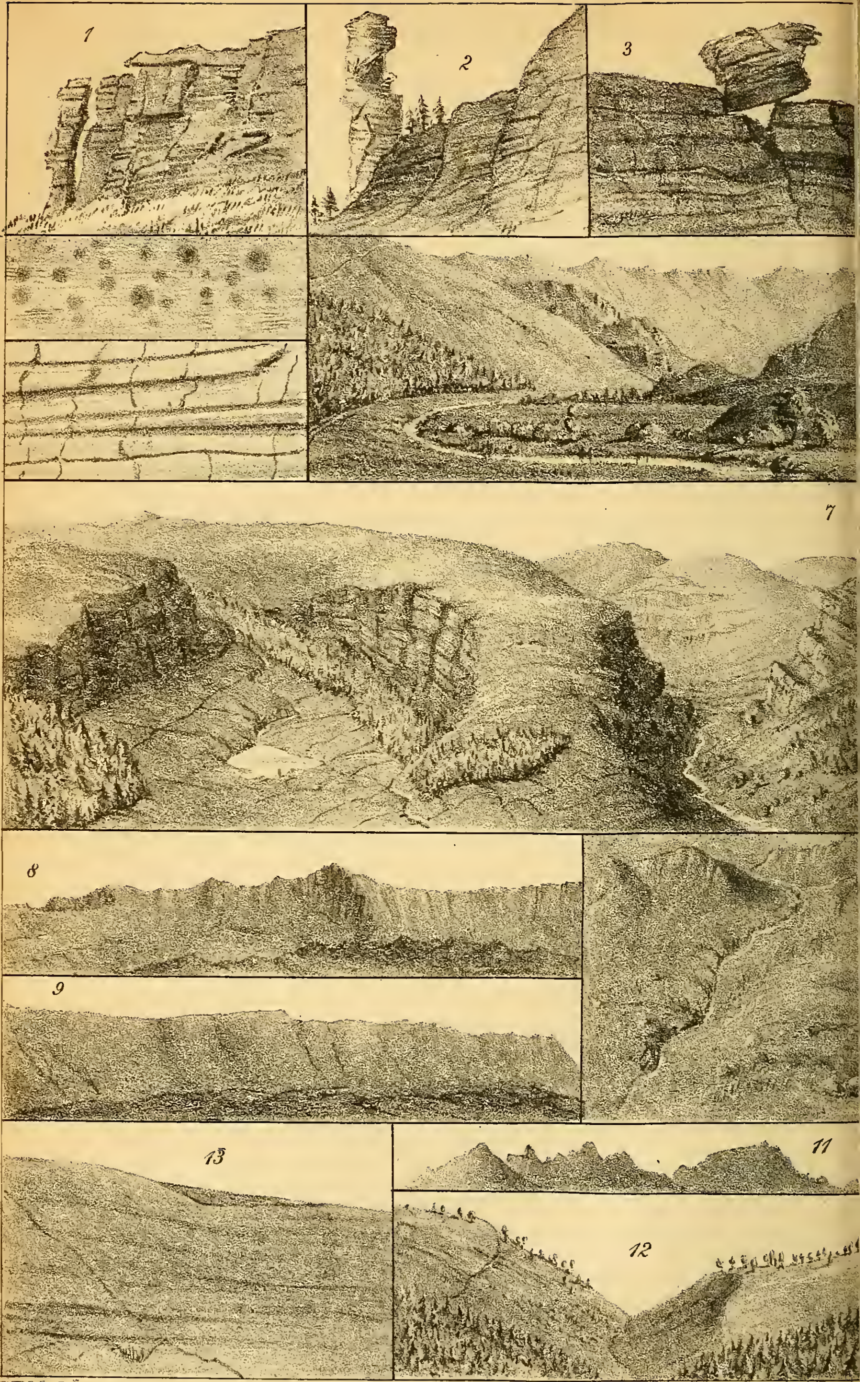
(1). The older, or auriferous, granite intrusion appears to have occurred at some time between the Silurian and Carboniferous period; certainly not older than the Upper Silurian, or younger than the Carboniferous strata; probably not younger than the deposition of the first members of the latter formation.

Gold formations, belonging to this period, present themselves in Australia,* Bohemia, Bolivia,* Brazil, Buenos Ayres, Chile,* Cornwall, Ecuador, Hungary, Mexico,* New Granada, Norway, Peru,* Sweden, Ural,* Wicklow.

To this period and cause I also attribute most of such deposits of gold as are found intruded as quartz nodules and veins in many places, as if interstratified in the Cambrian and Silurian (and probably also Laurentian and Devonian) systems, which I believe to

[1] Although subsequent researches may render it necessary to modify these conclusions, at present I am not inclined to admit that gold has appeared at other than these two epochs.

* These so marked, as well, I believe, as California and many others, have gold deposits of both ages.



W.D. Mackintosh, delt. F. Waller Imp.

CLIFFS GORGES & VALLEYS OF WALES
to illustrate Mr. Mackintosh's paper.

have arisen and been rendered auriferous solely from their proximity to invisible or now superficial granites.[1]

(2). The newer, or Dioritic, outburst I have called Post-oolitic as the veins containing gold, and which proceed from its centres, cut through strata containing fossils of decided Post-oolitic forms, and possibly may be as late as early Cretaceous. These strata are frequently much altered and metamorphosed by the contact of the igneous Diorite, and, at such points, often become auriferous, or are cut by auriferous veins proceeding from the Diorite head mass. Although the results of an extended examination of these deposits in Chile, Bolivia, and Peru, occupying me from 1857 to 1863, are extremely interesting, I have only had time to publish comparatively few of the observations made. Since my return to Europe, however, I have been able to collect sufficient data to show me that this occurrence of gold is not at all confined to South America, as I had at first imagined, but appears also to be common to all the other quarters of the world. I have seen auriferous Diorites from Italy, and some auriferous rocks of this class are known to occur in the Ural; and, as before-mentioned, I have specimens from California, and I some time back received very similar specimens, through Lieutenant Aytoun, from the gold districts of India; and, lastly, within a few days, I have had the opportunity of examining a fine series sent over to the Jermyn Street Museum by Mr. Aveline, the head of the Geological Survey in Victoria, which are all strikingly similar to those examined by myself in various parts of South America.

11, York Place, Portman Square, London.

II.—Results of Observations on the Cliffs, Gorges, and Valleys of Wales.

By D. Mackintosh, F.G.S.

[Plate XV.]

THIS article will be devoted to the consideration of the indications of marine and fluviatile denudation furnished by the cliffs, gorges, valleys, and other phenomena, of some parts of Central and North Wales. With the view of collecting facts, the author, during April and May of the present year, resided successively at Builth, Rhayader, Aberystwyth, Dolgelley, Newtown, and Llangollen, so as to have opportunities for repeated observations; and the following notes refer chiefly to the neighbourhood of these towns and the intervening districts.

Abereddw Cliffs.—On entering the narrow part of the valley of the Wye beyond Three Cocks Junction, I began to be struck with the dim outlines of terraces at a considerable elevation above the river, until the romantic tiers of cliffs near Abereddw suddenly came into sight. They are the culminating point of what, in their absence,

[1] See Forbes on Peru and Bolivia, Quart. Journ. Geol. Soc., vol. xvii.

might be regarded as unsatisfactory indications of raised coast-lines, situated chiefly, though not exclusively, on the east or Radnorshire side of the Wye. Whatever amount of erosion the river may possibly have accomplished in pre-glacial times, these cliffs, and subjacent drifts, render it certain that it has not flowed above the level of its gravel banks since the occupation of the valley by the sea. But before proceeding to describe the cliffs in detail, it may be well to try to dispose of an apparent objection to the idea of their being in reality old sea-margins. Generally speaking (not always) the platforms coincide in inclination with the outcrop of the strata which here mainly dip at a small angle to the N.N.W., or *contrary* to the fall of the river-channel. This fact (which, coupled with others, furnishes a strong presumption that neither the river nor a valley glacier could have had any share in the formation of the cliffs) can, I think, be sufficiently explained by the very probable supposition that the original correspondence between the horizontality of the outcrop of the strata and the sea-level may have been the reason why here and elsewhere such a succession of regular terraces should have been formed, while, under less favourable conditions, the sea failed to carve out very distinct coast-lines. But if these rocks can be shown to be sea-cliffs by a strict application of that analogical induction on which the whole superstructure of geology as a science is founded, then such seeming difficulties as the above may be left out of consideration.

The Abereddw cliffs consist of Ludlow rocks of varying compactness, the hardest often forming their base. They run along the side of the valley for at least half-a-mile. There are four principal lines of cliff, with several subordinate ones, the latter apparently worn back at intervals so as to merge into the principal. At their northern termination they are separated from a single lofty cliff by a dry inlet, the sides of which present cliffs of the same form as those fronting the valley. The existence of this inlet, the floor of which rises up obliquely to the planes of stratification, is, at the very outset, a fatal objection to the theory that the cliffs have been formed by the atmosphere, and it is equally inexplicable by river-action. On the north-side of this inlet there are several pillars which present a smoothed outline very distinct from any shape communicated to the rocks by weathering (see Plate XV. Fig. 2). Beyond the upper termination of this inlet the left-hand line of cliff is continued, and here and there its base exhibits small caves, beautifully smoothed and rounded in a way that streams of fresh water (supposing them ever to have been here) could never have accomplished. At the base of the lowest main line of cliff, and at perhaps fifty feet above the railway, there are several caves with arched entrances. In one cave two lateral openings communicate with the main entrance; and on one side of the latter a pier only a few inches in diameter supports the superincumbent fabric. The interior of this cave is here and there rounded and smoothed in a way as much resembling modern marine architecture as a ripple-marked slab of sandstone is like ripple-marked sand on the sea-coast. If the first is not the work of the sea, neither is the latter. Further to the north there are several detached or nearly detached square pillars of rock, one of which is represented in Plate XV. Fig. 1. At this spot the rocks show no sign of weathering; but in most places weathering has proceeded to a very considerable extent. Its effect, however, is to *ruin the cliffs*, and most assuredly not to *form* them. It is precisely undoing what the sea has accomplished. The line of demarcation between the rough, splintered faces of rock invaded by weathering, and the smoothed and sculptured faces left by the sea, and preserved in sheltered situations, is often clearly defined. On the broad level platforms at the bases of the lines of cliff there are here and there a few very large blocks which could no more have fallen from the cliffs than from the moon. One of these blocks, between twelve and fifteen feet long, rests on the outer edge of a wide platform, and might easily be mistaken for a *bloc perchè*. It appears, however, to be simply an unscathed mass of mudstone, nearly *in situ*, excepting that on one side the enlargement of a joint has allowed it to slip down (See Plate XV. Fig. 3).

The Abereddw cliffs vary in height from a few feet to twenty. The platforms vary in breadth from a few yards to 150, and are generally covered with silt or loam. The third platform, reckoning upwards, inclines 3° transversely and 5° longitudinally. In several places a line of cliffs turns round at nearly right angles, similar to what may be observed on modern sea-coasts, and beyond the abrupt corners the rocks are frequently the most smoothed and rounded. No agent *passing by* could possibly have given rise to such phenomena. But they are precisely such as the face-to-face action of the sea produces on lines of cliff, irrespective of their direction. The mossy covering on the above smooth and unweathered faces of rock is often quite one-eighth of an inch thick.

Marks left by the Sea.—The most convincing marks left by the sea on many parts of these cliffs consist of smooth curvilinear grooves, and finely-graduated shallow pits, which have been formed independently of any peculiarity of structure in the rock. The most perfect fac-similes of the grooves may be seen on the sea-coast at Aberystwyth. The pits are likewise there represented, but not so much on the vertical faces of the cliffs as on the rocks lying under high water. Both are apparently the result of the motion of small stones wielded by the waves as instruments of abrasion (See Plate XV. Figs. 4, 5, the first representing pits and the second grooves on the Abereddw cliffs).

Between the Abereddw cliffs and Builth a large terrace extends for some distance along the eastern side of the valley at a considerable height above the river, and, farther on, the remains of successive terraces may now and then be traced. At Builth the comparatively narrow gorge, through which the Wye has hitherto flowed, opens into an irregular basin, fringed with cwms, which merges into the great plain of Central Wales.

Valleys excavated by Streams.—On travelling along the above plain towards Newbridge Station, I was finally led to admit what I had previously suspected, namely, the probability of streams having mainly excavated the uniformly-continuous V-shaped valleys that furrow the south-eastern side of the hilly desert of Central Wales, which at one time must have been a comparatively level table-land. To assert, however, that the same agency could have levelled down the plain would be to attribute to rivers a power of performing the most contradictory feats. To be consistent, subaërialists must admit that there is a tendency in brooks and rivers to *persist* in the channels they have selected, and to wear these channels *downward* as long as there is a sufficient inclination to give excavating power. A river when it enters a plain may wander over its surface to any extent; but a plain even approximately level, or a wide smooth valley or basin, must be the result of a wide-spread denuding action. That the sea, under certain conditions, planes down the land all must admit; but it is likewise, under other conditions, capable of producing inequalities. Rivers (apart from deposition during floods) can only produce the latter.

The Great Denudation Puzzle.—One of the best districts for studying denudation in South Britain may be found between Newbridge and Marteg Bridge. On following the course of the Wye from Newbridge northwards, you pass through a narrow gorge, and soon find yourself in the open valley of Doldowlod. You see on your left a transverse gorge running into the bosom of the hills and suddenly terminated by a cliff. You can scarcely resist the idea that this is an old inlet of the sea scooped out backwards, and not excavated by any descending stream. Still following the Wye, you again pass through a narrow gorge, and suddenly arrive in the irregular plain of Rhayader. Within the space traversed you have had a sufficient example of what may be called the Great Denudation Puzzle—the problem to be grappled with before any real progress can be made in determining the relative claims of the sea and rivers, namely, the *cause* of the narrow gorges which connect comparatively wide and level areas—gorges which cut through ridges, escarpments, and sometimes table-lands. Two theories have been advanced by the subaërial school of geologists to account for these gorges.

Professor Ramsay's Theory.—The following explanation is given by that formerly able advocate of marine denudation, Professor Ramsay:—"It is a trick that rivers have; they will cut through escarpments in what seems an unnatural fashion" (*Physical Geology of Great Britain*, p. 145).[1] But the very *abrupt commencement* of the gorges under consideration would seem to be inconsistent with the idea of their having been worn through by any *obliquely-directed* aqueous action, or an action which must have had a vent along the base of the escarpment while the cutting-through process was going on.[2]

Professor Jukes' Theory.—Professor Jukes has lately advocated the

[1] Professor Ramsay says of the estuary of the Humber (*op. cit.* p. 147), "*The sea effected a breach in the rocks.* Then suppose these lands to have been heaved up, ... the river then ran through *it.*" Prof. Ramsay says *much more* in proof that he *does not deny* the efficacy of marine denudation, but we have not space to quote it here.—Edit.

[2] Many of the gorges are so narrow that a river could not have found room to bend round and return during the progress of the supposed excavation.

theory that a narrow connecting gorge is the expression of an original river-channel, as its waters flowed transversely off a table land, and that the longitudinal vales or plains were worn down by the river and its tributary streams in easily denuded rocks during the time that the river alone was gnawing out a narrow passage or outlet in a zone of tough rocks which eventually become a ridge or strip of elevated ground. It is admitted that this explanation will only hold good where the rocks of the wide depression are of a kind more easily eroded than those composing the ridge: that is, supposing a gorge one-sixth of a mile in width, and a vale three miles in width, the materials of the vale must have been eighteen times more easily washed away than those in which the gorge was excavated. I do not think that the assumed correspondence between the atmospheric denudability of the rocks of the respective areas has been proved as regards many if not most of the districts where the denudation puzzle is exhibited. It would require an extensive series of observations and experiments to determine which rocks most readily give way to atmospheric, fluviatile, and oceanic action. Rivers affect rocks, as regards their relative composition and structure, much in the same way as oceanic currents, though they do not give rise to precisely the same form of effects. The atmosphere, apart from running water charged with abrading matter, as I have already shown, accomplishes its task chiefly by chipping or splintering, which, strictly speaking, does not come under the denomination of denudation until the fragments are carried away by streams. Mere rain has so little influence on hard rocks that, in considerations of this kind, it may be left out of the question.[1]

[1] This I have endeavoured to prove as regards millstone grit and other rocks (see article on Brimham Rocks—Geol. Mag. April, 1865). But I think it can be shown that limestone is more or less exempt from any process of dissolution caused by the atmosphere apart from the grinding action of streams. Many limestone cliffs would appear to be both rain-proof and air-proof, as they still retain the smooth grooves and undercuts imprinted on them by the sea. These marks may be distinctly traced on those parts of the Eglwyseg rocks, in Denbighshire, which are not undergoing fragmentary dilapidation. The most striking proofs, however, of the resistance offered by Caboniferous Limestone to mere rain may be seen on a table land to the north-west of Minera, and about eight miles from Llangollen. A number of nearly square flags of limestone, separated by a very regular system of joints, lie flat on the surface. From a distance they look like a vast assemblage of grave-stones. Here and there whole flags or ranges of flags have been carried bodily away, without leaving the slightest trace of their existence, and that, most assuredly, by no kind of atmospheric action. Nearly every remaining stone presents a series of peculiar marks, consisting of smooth, semicircular grooves, from an inch to eight or nine inches in depth. These grooves are generally straight, but sometimes winding, and generally, though not always, roughly parallel; they often turn round at nearly right angles, and run into each other or vanish at the border of the flag. They sometimes terminate in circular perforations. No one would say that glaciers could have formed such a number of deep and complicated grooves. Rain is out of the question, its effect being evidently, as one may see on the spot, to roughen, and that to no very great extent, the smooth curvilinear outlines of the grooves. There is no appearance of any former river-channel, and rivers, had they been here, could not have given rise to such indentations. There is only one explanation left, and it may be seen exemplified on the sea-coast of Wales—(I have seen this at Aberystwyth)—namely, the backward and forward motion of pebbles driven by the advancing and receding waves of the sea. Similar wave-worn flags may be seen farther to the south, and I have no doubt in other localities. Their position must be at least 1000 feet above the present level of the sea.

Gorges and Open Areas not simultaneously Denuded.—The more the forms of the hollows of Central Wales become imprinted on the memory, the more one is led to the conclusion that the longitudinal vales and transverse gorges were not excavated at the same time. The vales and surrounding slopes, with the exception of occasional rocky projections and cliffs, are either level, gently undulating, or smooth and continuous in their outline. The gorges commence most unexpectedly on the sloping side of a ridge, and run right through, with steep, rough, and bare rocky cliffs. (See Plate XV. Fig. 6, which represents the commencement of a gorge to the south of Rhayader.) That rivers often flow through them, and not longitudinally along the open country, does not necessarily imply that they were excavated by rivers. These gorges would naturally become deeper and more cleared of gravel than the open area, supposing them to have been formed along the course of a previous slight depression, by a swift oceanic current, as the land was rising; and rivers would afterwards find their way more easily through them than along the adjacent drift-encumbered vales.[1] I can at present see no theory so little beset with objections as that which would regard these gorges as deep sea-straits formed after the general outline was given to the neighbouring country; and this view is confirmed by the fact, that on the sides of some of these gorges the rocks appear to be sea-worn rather than river-worn. It is likewise favoured by the fact that river-drifts, or traces of river-drifts, suddenly terminate at a small elevation above the present river channel, as may be observed in the neighbourhood of Rhayader.[2] With regard to the excavation of the plain on which Rhayader stands, there are proofs of sea-action on the rocks beneath the drift deposits, consisting of grooves, hollows, and smoothed projections, which are distinct in form from those now observable in the bed of the neighbouring river,[3] and equally distinct from ice marks.

Cwms and Deep Basins near Rhayader.—In the neighbourhood of Rhayader there are phenomena adjacent to, or associated with, the above gorges, which show that the power to which the gorges owe their present form, was sufficient to effect the greater part of their excavation. I allude to the cwms and deep rocky basins, which no river-action or glacial-action will explain. Towards the left of the area represented by Plate XV. Fig. 7, there is a shallow valley descending from the table-land, which, in all probability, was at one time uniformly continuous with the valley in the foreground. Superimposed on this valley, and apparently formed at a later period, there is a remarkable cwm, with Gwyn-llyn[4] at its bottom, which must have been scooped out by an agent assailing the land backwards. This cwm is identical in form with many hollows on

[1] It is a remarkable fact, that narrow gorges are generally very free from accumulations of drift.

[2] The best example of this may be seen about two miles to the north of Rhayader, on the left hand side, near to where the railway crosses the Wye.

[3] Mr. Randall, F.G.S., tells me there are similar marks on the rocks under the marine drift near Coalbrookdale.

[4] Sometimes erroneously called Llyn Gwyn.

our present sea-coasts. To the right there is a basin with three outlets. The Wye enters on the right hand behind Ganallt Hill, and escapes by the valley in the foreground. In the background there is a basin with lofty cliffs, one side of which is skirted by the Wye, and into this basin a small brook enters from the west by a series of cascades, or rather water-slides (the latter not represented in the sketch). The sides of the basin look very unlike any cliffs the river is now forming, and no trace of river-drift can be found at an elevation of more than a few yards above the river. A very powerful current must here have entered a previous hollow, or series of hollows, and by a gyratory movement scooped out the basin.

On arriving at Marteg Bridge the Wye is joined by the Marteg River. As we proceed along the banks of the latter by railway, we see the most extraordinary complication of gorges, some with streams, some dry, but generally speaking the size of the stream is *not* proportioned to the size of the gorge. During the journey to Llanidloes many short Y-shaped gorges on the sides of hills or table-lands, may be seen, some with, and some without streams.

Action of the Sea at Aberystwyth.—A whole article might be written on the gorges, cwms, and precipices to the south of Llanbrynmair station, but I must hasten to the sea-coast. At Aberystwyth the subaërial geologist will find himself in comfortable quarters. Here the sea is forming a plane of denudation, and cutting with equal facility along the sides, and across the ends of ridges and valleys, without producing indendations beyond a small cwm. Were the floor of the sea to be elevated, we should here have a land plain bounded on the eastern side by an escarpment, with rivers debouching on the plain where they now enter the sea. But are we to conclude from this that the sea produces nothing but planes of denudation, and that it can only originate land surfaces in the form of plains with bounding escarpments? It is a remarkable fact that in channels, and on comparatively protected coasts, the sea generally forms approximately straight lines of cliff; but what do we find on the western shores of Ireland,[1] Scotland, and Norway, where the land is directly confronted by the sea, and exposed to the full fury of storms, and the undeflected force of currents? If some of the sea-lochs and fiords can be shown to be submerged land-valleys, this argument will not apply to all deeply indented sea-coasts, for the following reasons:—*At any given time the greater part of the earth's surface must be covered by the sea; during the gradual or intermittent submergence and re-emergence of the land, every part of it in succession must figure as a sea-coast; the average time*[2] *required for a submergence and re-emergence must be sufficient to allow the sea to efface*

[1] Why is not the sea cutting across ridges and valleys on the west coast of Ireland? Because in Ireland it is *now* forming ridges and valleys as it *anciently* did in Wales. On any given coast the sea must be either *destroying* or *producing* inequalities.

[2] Any given area of the earth's surface must, during a given lapse of time, be longer below than above the sea-level, otherwise the proportions of land and sea could not be maintained.

all the inequalities produced by subaërial denudation; the majority of the inequalities below the sea-level must, therefore, at any given time, be the result of marine denudation.[1]

Remarks on Cader Idris.—From the sea on the west, and the valley of the Mawddach on the north, a succession of cliffs and platforms, in some places regular, in others very much interrupted, rises up to the summit of the narrow table-land of Cader Idris. The northern rocky escarpment of this mountain looks more like an old line of sea-cliffs than any form with which subaërial agents are capable of investing rocks. On this and other escarpments of the mountain there are extraordinary cwms or semicircular indentations. One of these is occupied by Llyn-y-Gader. Its excavation must have been accomplished in a very wholesale fashion, if we are to judge from the immense number of stones choking up its entrance and distributed towards the west—stones which merge into, but in their immediate derivation are distinct from, the dèbris of the adjacent cliffs. Lyn-Cae, on the other side of the peak, is situated in a still more striking cwm. Ice may have had a share in the excavation of both; but to attribute to land ice any *great* amount of denudation in this district would be inconsistent with its surface-configuration, which could never have admitted of an ice-shed worthy of the name. There are several cwms towards the northern end of Cader Idris (two of them represented in Plate XV. Fig. 8) which appear in very unlikely situations to have been excavated by streams of either ice or water. From the summit of Pen-y-Gader peak (the highest point of the mountain) many cwms, quite distinct in form from any possible modification of a river channel, may be descried. Not a few of them would seem to have been hollowed out in the gable-ends of old headlands. The beholder may see a cwm of this kind, at a high altitude, staring him in the face, as he looks towards the northern side of the valley of the Mawddach.

Sea-worn Summits of Hills.—On Mynydd Gader, between Cader Idris and Dolgelley, the hard, rocky surface has retained the peculiar characteristics of an ocean-floor. The general form of certain parts is more or less rounded, but in detail the surface is very uneven. Both hollows and projections, however, are here and there smoothed in a way indicative of the backward and forward motion of stones in water. Indeed they present fac-similes, only a little roughened by rain, of rock-surfaces now under high-water on the neighbouring Welsh coast. The granular disintegration of rocks is here almost unknown. The mountain streams, after long-continued rains, are as clear as crystal, excepting when they flow through an exceptional superficial deposit of clay or mud. The river Mawddach itself, at Dolgelley bridge, I observed to be quite transparent during and after heavy rains. We have no *à priori* reason therefore to attribute the inequalities of the rocky hill-summits to rain. The ridges of the

[1] The shores of the intricate channels and inlets on the Pacific coast of British North America, if elevated from the sea, would present but slight difference from sides of the narrow valleys in the Rocky Mountains at an altitude of 3,500 feet."—Dr. Hector, Quart. Journ. Geol. Soc., Vol. xvii. part 1.

hills between Cader Idris and the river Mawddach are generally very serrated (see Plate XV. Fig. 11, which represents one of these ridges as seen from near Dolgelley); and the inequalities in detail present a more or less sea-worn configuration. Before quitting the Cader district, I may remark that I saw one striking instance of what I have occasionally noticed elsewhere, namely, a stream flowing very nearly along the summit of a rocky ridge, and apparently possessed of as much denuding power as streams in the neighbouring hollows. It may be seen about halfway between Llyn Guernan and Llyn Gafr.

Torrent-ruts on the Kerry Hills.—The previous remarks may prepare the tourist for understanding how the grass-covered escarpments he may see on his right hand on travelling from Llanidloes to Newtown, should present no signs of mere pluvial action. At considerable intervals, however, the otherwise smooth and continuous outline of these escarpments is broken by temporary or permanent torrent-ruts, and occasionally good-sized gulleys. Kerry Hill, to the south of Newtown, presents the best example I have yet seen of the relative effects of subaërial and marine denudation. The northern slope is wonderfully smooth and continuous. The ruts and narrow gulleys caused by rain water collecting at intervals, and by a few small streams, are evidently *disfiguring* and not forming the inclined plane of marine denudation represented in Plate XV. Fig. 9. Farther towards the east, in the direction of Bishop's Castle, the hills are deeply indented by gorges and large Y-shaped hollows, which I had not time to examine.

Retrogressive Excavation by Waterfalls (?).—About a mile and a half to the south of Newtown there is a short deep gorge terminated by a high cliff with a picturesque waterfall. But the latter cannot be credited with having excavated the gorge backwards for the following reasons: the breadth of the stream and of its channel above is not equal to the extent of the cliff, and the continuity of the face of the cliff has not been broken or indented by the waterfall, but presents the appearance of the inner precipice of a previously scooped out hollow. The same remark applies to many of the waterfalls of Wales, which are merely falls or slides over transversely-continuous cliffs. The waterfall near Aber furnishes a striking instance of a stream tumbling over a long and continuous cliff of hard rock, which forms the inner boundary of a valley containing marine drift. At the bottom of this valley, and distinct from its general outline, the stream flows along a clearly defined channel. A similar channel may be seen above the fall; both are the work of the stream, but the falling over the cliff is merely an accident in its history.[1]

[1] To the west of Aber, the channel excavated by the Ogwen may be traced from the sea to Llyn Ogwen as a depression distinct from the outline of the wide area over which it flows in the lower part of its course, and equally distinct from the great gorge of Nant Francon, which, with the precipice of Ben Glog, must have existed before the supplementary action of the river commenced. Fig. 10, Plate XV., is a view (from a photograph) of all that a considerable-sized tributary of the Ogwen has been able to effect in modifying the outline of Nant Francon.

Valleys and Cliffs near Llangollen.—On entering the old bay of the Murchisonian, or Severn Sea, now called the Vale of Llangollen, the river trick, or denudation puzzle, again presents itself, and is repeated as far up as Corwen.[1] But in whatever way the directly or obliquely-transverse valleys, and their connecting gorges, may have been formed, it is very obvious that the sea must have been here at no very distant period, geologically speaking. There is a true marine strait, or mountain pass, at a considerable altitude behind Barber's Hill.[2] The footpath from Llangollen to Try-Carreg Farm leads through it. At both ends the ground rapidly declines, and no freshwater stream could ever have traversed it. The rocks on the south side present indications of sea-action. It may have been formed, or, at least, modified, during the glacial submergence. The Eglwyseg range of cliffs on the opposite side of the irregular Vale of Llangollen are, in some parts, a fac-simile of cliffs now or lately washed by the waves at Llandudno. There are seven rounded promontories, with six intervening inlets. Of the latter, four are dry, and two are traversed by insignificant streams. It would be going too far to assert that the successive terraces mark as many pauses during the rise of the land above the sea. But that they have been carved out by a great body of water appears evident not only from the general configuration, but from features already referred to (page 391).[3]

Remarkable Assemblage of Raised Beaches.—To the south-west of Llangollen I met with the most extensive and perfect series of raised beaches I have yet seen in South Britain. They commence on the side of a hill about a mile to the South of Llantysilio railway station; and the stream which falls into the Dee, close to the station, interrupts their continuity in the upper part of its course. They consist of main and subsidiary terraces; and as many as nine can easily be distinguished. The lower and more striking terraces, near Try-Carreg Farm, are not now under cultivation, and from the circumstance of several erratic boulders of trap lying on the platforms, one would suppose they have never been cultivated. The upper terraces have evidently been much effaced by the action of the plough. The cliffs of the lower terraces are more or less rocky, and appearances justify the belief that they have been undermined by the sea. The breadth of the platform C (Plate XV. Fig. 13, which roughly represents a part of these terraces as seen from a distance) I found to be about 150

[1] Between Llangollen and Corwen, on the left hand side of the road, streams with cascades may be seen descending from the Berwyn Mountains, with little or no channel to mark their course. Behind Corwen a powerful stream has, in some places, excavated no channel at all, in other places a miniature gorge. The excavating power of this stream is assisted by a steeply-inclined course, and numerous cascades; and the gorge may, with the greatest safety, be regarded as the measure of its denuding capabilities, as the ground on each side rather falls away from it than towards it.

[2] Fig. 12, Plate XV., is a distant view of this pass. In most of the wet passes of Wales and the Lake District, with which I am acquainted, the streams which flow away from the cols could have had no share in the formation of the cols themselves, which indicate an agency cutting straight through a ridge, and cannot be referred to an improbable linear coincidence in the original sources of the streams.

[3] See Mr. Kinahan's able article on raised beaches in Ireland, in Geol. Mag., Aug., 1866.

feet, and the height of the escarpment below from 40 to 50 feet; and this may be regarded as about the average size of the main terraces. The platform C, where I examined it, was very nearly level, both longitudinally and transversely. It was covered to a considerable depth with clay and loam, mixed with well-rounded, semi-rounded, and angular small stones. The platform B is covered with similar silt, and is here and there more or less swampy. These terraces, which are probably the most elevated of any yet discovered in Great Britain, furnish a proof of numerous and long-continued pauses, and a consequent presumption in favour of considerable denudation, during the intermittent rise of the land above the glacial sea. But the advocate of marine denudation is not necessarily limited to the glacial period of submergence. The *general* form communicated by the sea to the rocky surface of any particular area, may be capable of resisting atmospheric denudation for an indefinite period.[1] The style of architecture may remain after the details of the structure have been laid in ruins; but during a secondary submergence of the land, the sea may be able to repair the havoc committed by the powers of the air, and re-impress its seal on the blanched and shattered monuments of its primeval sway.

Note.—Since the above was written, Mr. Maw's able article on *Watersheds* has appeared in this Magazine (August, 1866). I have only space to express my opinion that his observations on the graduated series of levels extending from watersheds to the sea are applicable only to certain areas where the sea may first have formed an inclined plane of denudation, and afterwards hollowed it out into valleys. I do not believe in the existence of *systems of valleys* as a general rule. In most districts large valleys run approximately parallel to the lines of watershed, and are only transversely connected at long and irregular intervals by narrow and apparently accidental gorges. It is through these gorges that rivers, after much wandering about and change of course, find their way to a lower level; and they often seem (the Severn for example) to have the greatest difficulty in reaching the sea at all. With regard to marine denudation, it ought to be remembered, that on many coasts the sea is not only running up previously-excavated valleys, but *forming fresh inlets*, frequently long and winding; and that its excavating power in these inlets is often increased rather than diminished. It is not true that the sea acts on the *principle* of making straight lines of coast, for we everywhere find it taking advantage of the slightest crevice or inequality in the composition of rocks as a commencement of indentations which are small in protected situations, but extensive beyond any assignable limit on coasts that are fully exposed. I believe that coast indentations increased by current action during gradual submergence, and current indentations in-

[1] Excepting at intermediate levels where streams have had space to acquire considerable volume, without descending so far as to lose sufficient inclination of channel. This may be called the *zone of maximum* atmospheric *denudation*—the higher and lower lands the *minimum zones.*

creased by coast-action during emergence, may assume forms identical with most of the valleys and gorges which diversify the surface of the land. (See some excellent observations on the marine origin of valleys in *Lyell's Elements.*)[1]

III.—On the Relation which the East Essex Gravel bears to the Structure of the Weald Valley.

By Searles V. Wood, Jun., F.G.S.

[Continued from the August Number, p. 354, which contains the Map and Sections referred to.]

In the former paper[2] I adverted to the evidence which the Thames gravel afforded, that the channel in which it was deposited opened out over the Wealden area, and the corroborative evidence which the East Essex gravel furnished of a similar state of things.

The Map accompanying this paper (see the August number) shows the East Essex gravel running down from the NN.E., *across the mouths of the Thames and Crouch,* its course becoming as it nears the Weald parallel with the eastern edge of the Thames gravel. In consequence of the extent of marsh on the eastern side of the Medway, between Chatham and Sheerness, the extension of the gravel in this direction does not appear; but the southern termination of the great sheet at Hoo, near Rochester, is an abrupt one, extending along a line parallel with the Chalk escarpment of the Weald at that part.

In the Thames Valley paper, I showed (see Section 7 of that paper, p. 103 of Vol. III. of this Magazine) that the Thames gravel was cut down by a sharp denudation *in the opposite direction to the river Thames, and in the direction of the Weald,* and that a newer gravel ($x5$) extending to the Chalk country, forming the north side of the Weald Valley, had been formed under the brow of the Thames gravel. Now the features exhibited by the East Essex gravel are similar in this respect; for the great sheet which thus terminates parallel with the contiguous chalk escarpment, is cut down in the most decided and abrupt manner towards that escarpment.

Owing to the dip imparted by the upheaval of the Weald country to this gravel near Rochester, it descends eastwards by a rapid slope to the Medway, and northwards more gradually towards the Nore; but a line drawn from the very high ground occupied by this gravel on Hoo Common, to the nearest scarp of the North Down, shows this cutting down very distinctly. (See Sec. 14 beside Map.)

In this Section the gravel ($x4\overline{\overline{7}}$) is divided from the Chalk by a considerable thickness of London clay and Lower Tertiary sand, and the whole have been cut down together to the Chalk at Rochester, and a newer post-glacial bed ($x5\overline{\overline{7}}$) has been formed at their foot.

[1] Answers to other parts of Mr. Maw's article will be found forestalled in the preceding pages.
[2] Geological Magazine, Vol. III., pp. 57 and 99.

The relation thus borne by the East Essex gravel to the adjacent Lower Tertiaries is preserved all along its termination, although from the original form of the trough the London clay thins towards the Medway. Another line, however, drawn half a mile further east than that of Sect. 14, would give the cutting down still more abruptly.[1] Unless the Section so given can be shown to be erroneous, how (irrespective of the other and concurrent evidence derived from the grouping of the gravels within and without the Weald Valley,) can the conclusion, that the denudation which exposed the Chalk through which the Weald Valley is cut was posterior to the East Essex gravel, be escaped? The Section (14) has been prolonged into the actual valley of the Weald, in order to show the distinct terracing down of the East Essex gravel, ($x4^{\prime\prime}$,) to the series $x5$ that here rests in the Chalk, and from that to the series $x6$ that occupies the Lower Greensand terrace; the distinction in this case from ordinary terracing being, that the great elevatory action which was contemporaneous with the denudation, has elevated the more recent terraces, and depressed the older. To make the terracing appear to descend, the junction lines of the Chalk, Gault, and Lower Greensand should be produced (with the same inclination that they have in the Section) as far as Hoo Common, and the lowermost of them then treated as the horizon for viewing the Section.

In order to show the complete separation of the channel of the East Essex gravel from that of the Thames gravel, we will take a series of sections across the country dividing the two channels. (See margin of Map for them.)

In Section 13 a ridge of very high land, extending through Rayleigh and Hockley, upon part of which an outlier of the Bagshot sand still remains undenuded, formed a well-defined and lofty boundary and valley slope to the western side of the East Essex gravel; while in Section 15 (which cuts the same ridge more to the south, but which, for the purpose of testing the possibility of any former connection of the two gravels along the Thames mouth, is carried within a mile of the marshes, and parallel to that mouth) we see that this dividing ridge is equally well marked, and is moreover capped at Hadleigh Common and Great Wood by a denudation gravel ($x2$) corresponding to one of those shown in the section of the north side of the original Thames Valley. (Section No. 1, Vol. III., p. 58.) Section 16 (drawn still nearer the point where the two

[1] In the mapping, by the Geological Survey, of the only portion of the East Essex gravel that has yet been published by them, that within two miles of Rochester, the gravel is made to overlap the junction of the London clay with the Woolwich beds at Cockham Wood Reach, whereas, it is really divided from the Woolwich beds there by a considerable thickness of London clay, and all three beds, including the gravel, should sweep round parallel to Cockham Wood Reach, *and to the scarp of the Downs.* The gravel is also not carried far enough in the Survey sheet to the west, there being several exposures beyond the boundary given to it there. The delineation of the gravel in the Survey sheet is so made as to appear at this part as though the chalk sides of the Weald Valley had been formed before the gravel came into existence. The corrected delineation at this part is given in an enlargement at the foot of the Map accompanying this paper. No distinction is of course made in the Survey Map between this gravel and those which I have grouped as several successive series.

channels converged) shows the dividing ridge, the summit of which is occupied by Ratley Hill Wood, equally well defined. This section has been extended so as to cross both the arms into which the Thames gravel channel is here divided by a small island, formed by what is now Telegraph Hill, near Swanscomb, on the summit of which also occurs a patch of the denudation gravel $x2$. In consequence of the great extent of the break-up and denudation that followed, the Upper Brickearth having so altered this section from its condition during the Thames gravel period, a restoration of it to this condition has been attempted beneath the section. The section is carried to Hoo Common to show the position that the starting point from which the Weald terraces down in Section 14, occupies relatively to the Thames gravel channel.

I submit that unless Sections 13, 14, 15, and 16 can be shown to be inaccurate, the conclusion cannot be escaped that the East Essex and the Thames gravels were the deposits of independent channels opening into a common sea at a point of inosculation near Rochester. This sea occupied all, except the extreme north-west corner, of the county of Kent. The sections illustrating this former geographical feature might be multiplied, but those given seem sufficient for the purpose without enlarging further upon this part of the subject.

If my readers will now look at the Map, and at the grouping of the gravels ($x6$) that occur on the Lower Greensand terrace, which opens out beneath the escarpment of Chalk near Snodland, and that near Otford,[1] they will see that in both cases these gravels lie at the mouth of the trumpet-shaped openings, through which the rivers Darent and Medway now flow *from the Weald;* and that these openings expand towards the Weald as the mouths of rivers would do if a sea were there, *but in the opposite direction to that in which these rivers now flow.* More than this, however, they will see that the gravels of the Lower Greensand terrace *expand with these mouths,* and that the area of the strip of Lower Greensand which underlies the Chalk escarpment, is broadest opposite these trumpet-shaped openings, and regularly narrows off as it recedes from them. Does not this, I would ask, point distinctly to a copious watershed, coupled with a tidal entry and reflux, having taken place at this part contemporaneously with the elevation of the country, by which the Chalk has been in this part more extensively denuded, and the Chalk escarpments pushed proportionately further back? In these two trumpet-shaped openings we have respectively the mouths of rivers into one of which, that opening by Snodland, the broad channel of the East Essex gravel had shrunk; and into the other of which, that opening by Otford, the drainage collecting in the dessicated Thames Gravel Valley made its way to the sea. The succession of the gravels does not, however, end with $x6$, for it may be seen that the (impure) gravels of the Weald clay bottom ($x7$) open

[1] This is the portion of Map that has been reduced from the Geological Survey Sheet. Whatever hesitation may be felt in admitting the accuracy of the part (that north of the parallel of Rochester) which has been reduced from my own survey, none, I presume, will be entertained as to this portion.

out in identically the same manner as those of the Lower Greensand area, lying at the mouths of the trumpet opening of Snodland, and are a repetition of them on a wider scale. They lie at the mouth of a narrow and less deeply cut valley, that expands in a similar way towards the south, near Yalding. The configuration points very obviously to these gravels being the accumulation at the mouth of the river-discharge after the Lower Greensand area had been elevated, and the sea reduced to the Weald Clay portions of the Weald Valley. From the ramifications of these gravels up the courses of several streams, however, it seems probable that their deposit continued after the reversal had begun, and the flow of the drainage directed into its present course.

The gravels and brick-earths grouped in the sections under the symbols $x5$, $x5^1$, $x5^2$, etc., form a series of several gradations in age when compared in position with each other, but none of them mark any abrupt or decided horizon in the denudation. They generally tail off on to the bare Chalk country of the Downs, and seem to have been accompanied by a continuous elevation, without any such change as would give rise to a line of coast, sufficiently decided as to be now recognizable; but in the line of the scarp of the Chalk Downs we reach a stage at which some very powerful cause must have come into play so as to give rise to the sharply marked geographical feature which this stage represents. I think that the state of things which can be traced as having existed during the East Essex and Thames gravel periods will throw light upon the origin of this marked feature.

In division 5 of the Map I have, in order to render the argument intelligible, represented what I conceive to be the terracing down of the Thames and East Essex gravels, first to those of the Lower Greensand terrace, and then to those of the Weald clay bottom, or in other words the successive southerly advance of the coast line; while in division 3 of the Map I have delineated what the distribution of the Thames and East Essex gravels indicates as the geographical outline of that period.[1] In it the sea occupies the Chalk country of the South of England and the place were the Weald valley was afterwards excavated.[2] Now if we imagine the upcast of the country, occupied now by the North Downs, and thence continuously across into Northern France, to have succeeded this state of things, and to have been accompanied by the formation of the series $x5$, $x5'$, $x5''$, etc., we can realize that by it the sea of the South of England would have shrunk into a much smaller compass, and that its northern limit was marked by the line of the North Downs, stretching across the straits of Dover, and passing round the Bas Boulonnais. The limit thus supposed is delineated in division 4 of Map, the North

[1] Restorations, such as are attempted in division 3 and 4, are regarded, and justly so, with much suspicion. I have only resorted here to that course in order to render my views of the progress of the great post-glacial denudation intelligible at a glance, when pages of description would fail in that object.

[2] The attenuation of the Chalk over the Weald centre, and exposure of the upper part of the beds beneath it at this time, as also the possible erosion of a part of the Lower Tertiaries over the Weald during some part of the Middle Tertiary period, may be remembered here, for exactness sake, but it is not material to the argument.

Sea, or rather that part of it which intervenes between Essex and Belgium, not having, according to the evidence afforded by the valleys of the Crouch and Blackwater, and by the mouth of the Thames, yet come into existence. Now if we apply to such a state of configuration the result which takes place where the tide, passing up a long funnel-shaped opening has no outlet, we shall get a tidal erosive action of which our present coasts offer no parallel; for the funnel, whose head terminated in the Weald valley, would have its base far down towards the South-West of England. The Bay of Fundy, it is well known, acts in this way, the tide having no outlet, and were the isthmus between Dover and Calais restored, I can see no reason why the same should not recur in the British Channel. At the present day, however, the branch tidal wave, which, parting from the great ocean tidal wave beyond the Land's End, flows up the British Channel, is met near Beachy Head by another, and more rapidly travelling branch wave, that passes round Scotland, flows up the North Sea, and the erosive power, or excessive rise and fall of tide, which would be produced by each, if arrested by an isthmus between Dover and Calais, is thus neutralized. It seems to me that in such a power[1] we have an agent equal to the formation of the scarp-line of the Downs; and when we know that this line is distinctly carried round the Bas Boulonnais, and only broken through by the Straits of Dover, it seems rational to adopt it in explanation of the case presented. Let us, then, suppose a series of further upcasts over the Weald, accompanied with those disturbances which we have seen evidence to consider took place at a very late period, and produced the rectilinear mouths of the Thames and Crouch, gave rise to the re-excavation of the valleys of the Crouch and Blackwater Estuary, and brought into existence the North Sea between Essex and Belgium, with eventually a reversal of the drainage of the Medway and contiguous rivers. We should, in the state of things supposed, have the North Sea much as it is, and the British Channel only differing from its present form between Kent and Sussex, and the French coast by an extension of it up that portion of the Weald Valley, which is occupied by the Weald clay bottom, and both seas exerting their tidal scour until by the giving way of the isthmus, by fracture, or erosion, the present neutralizing effect of the tidal meeting ended that state of things, and allowed the rise of the land to proceed without the counterbalancing effect of this erosion.

In this review of hypothetical causes, I have supposed the North Sea as exerting, though in a less marked degree, the same erosive tidal power near its head by Essex, and we should look for some evidences there of its action. I think that these may be found in the lofty inland cliffs of London clay, bounding the marshes of the

[1] Probably aided by the passage of shore-ice, as suggested by Mr. Brodie in reference to the Somme Valley (Vol. III., p. 278, of this MAG.). In that view of Mr. Brodie, so far as it goes, I concur, as I regard the Somme Valley as contemporaneous with that of the Weald, but without the previous formation of an isthmus to cut off the North Sea tide, I cannot see how any more tidal rush could arise in the old trough of the Somme than now exists in the equally funnel-shaped mouth of the Thames River.

Thames mouth on the north side, and in those through which the Crouch passes above Cricksea; and especially in the deeply-scoured Upper Valley of the Crouch and Valley of the Blackwater Estuary; and in the formation of the ridge from Althorne to Stow-Mary, which has divided these valleys, and formed them out of one original valley into their present separate condition.

I must ask my readers once more to look at the Map, and to observe that the trumpet-shaped openings by Snodland and Otford are, after all, only the continuations of the great curvilinear trough which forms the Upper Valley of the Crouch, and the valley of the Blackwater Estuary. The original inequality of surface, imparted by the forces causing the elevation of the Boulder-clay (or Upper Drift) sea, has taken this symmetrically curved form; the symmetric repetitions of the curves, shown on the Map, cutting through the Boulder-clay as far as Rutlandshire.[1] Of the powerful (earthquake) wave-like lateral thrust, giving rise to these inequalities we have an example in the ridges intersected by Section 9. It is the deepening effect of denudation that has made these troughs so conspicuous in some places to what they are in others. This denudation has been great in the valleys of the Blackwater Estuary and Upper Valley of the Crouch, but far greater in the trumpet shaped mouths of Snodland and Otford. The excessive scour of the eastern part of the Weald—whose direction transverse to these older curvilinear troughs has been (west of Maidstone) induced by the rectilinear direction of the movements that succeeded the Thames gravel—has almost obliterated the curves in the Weald Valley, but they re-appear in the less denuded area of the South Downs. These curves are only one set of a numerous and intricately inosculating series that extend not merely over the whole of the area south of Flamborough head, occupied by deposits from the Lias upwards, but also over the area occupied by similar deposits in France.[2] Some of those, originating far away in France, can be traced into England, and into inosculation with those that, in so marked a manner, cut through the Boulder-clay and Middle Drift here. Their intricate connection with each other, were their system shown on a map, would satisfy, I think, any observer of the unity and contemporaniety of their origin; while the relation they bear in this country to the Boulder-clay shows them to have originated subsequently to that deposit, and before the formation of the Thames gravel; in a word, shows them to have originated under the Boulder-clay sea, and by denudation during its emergence. This fact, with the structure of the gravel beds, which in these papers, I have been endeavouring to elucidate, and the features of the denudation that has accompanied them, does, in my mind, point

[1] Of these arcs cutting through the drift, the repetitions of the arcs forming the curved valleys (shown in Division 1 of the Map), the principal is that extending from Reading to Hitchin. The symmetrical coincidence of this arc, and the cut which (between Hemel Hempstead and Royston) it makes through the Upper and Middle Drift, may be seen in the small sketch Map in Division 3. The next great repetition is the arc by Market Harboro, Rockingham, etc., which cuts in a similar way through the Upper Drift, capping the heights between those places.

[2] I have carefully extracted them all from the French Ordnance Maps.

irresistibly to the extension of the Boulder-clay sea over the north of France, and to the denudation which I have traced having been the result of the emergence of the country from that sea, greatly prolonged in some parts, and accompanied by much subterranean disturbance.[1] The importance of this, the Post-glacial period, has yet to be realized, and the length of its duration, marked rather by the amount of deposits denuded than by those formed in it, is, I believe, scarcely imagined. The Upper Drift or great Boulder-clay of the eastern and central counties of England (for there is one and possibly even two Boulder-clays older, as well as, at least, one that is newer in these counties), bears, wherever it rests on strata newer than the Trias south of Flamborough Head, evidence of having been affected by a series of disturbances, apparently simultaneous, and taking this curvilinear form, which were followed by its elevation from the sea. This disturbance, or physical break, I regard as a natural dividing line between the glacial and post-glacial periods; all the beds termed post-glacial occupying, over this area, a position that is, *in effect*, unconformable to the Upper Drift, although they be, for the most part, not in contact with it. On the older side of this dividing line, the disturbances, or unconformity between the successive formations, are insignificant; while on the newer, or post-glacial side, they have

[1] Mr. Prestwich takes a totally opposite view to that which I have been endeavouring in these papers to establish, for he says (Quart. Journ. Geol. Soc., vol. xxi. p. 441), "The old rivers of the Wealden area debouched, as do those of the present day, outwards into the Thames valley, but were of much greater size and extent." In describing the Gravels of the Weald Valley, also, Messrs. Le Neve, Foster, and Topley (Quart. Journ. Geol. Soc., vol. xxi. p. 464) expressed the decided opinion that the excavation of that valley between its Chalk escarpments had been due to the action of the Medway '*flowing in the same direction as at present*' during the Glacial period, the Weald, they say (p. 465) "not appearing to have been under water at all during that period." That the latter gentlemen should have arrived at the opinion that the denudation forming the valley and giving rise to the gravels was caused by the Medway flowing in this direction, in the face of their own carefully drawn map of those gravels, seems strange. Pressed by the difficulty that the chief part of the material composing the gravels of the Greensand terrace came from the north, these gentlemen have resorted to a small tributary of the Medway that in one part of its course approaches the Tertiary area, as the source from which the principal part of the material of these gravels was derived; and from the direction of the green line in the map accompanying the "Theoretical Considerations" of Mr. Prestwich, in the Philosophical Transactions, part 2, 1864, that gentleman, it would seem, takes a similar view of the origin of the cretaceous débris. With respect to the converse of this proposition, *i.e.* the presence of pieces of Wealden sandstone in these gravels, there seems no reason why it should not have arisen by shore ice transport from islands which had, at this period, come into existence in those parts of the Hastings sand country that are most elevated. The occasional occurrence of land and freshwater shells in some of these gravels is not *conclusive* evidence that the gravels were of freshwater origin, as we find these shells intermingled with such saltwater forms as *Scrobicularia piperata* and *Tellina solidula* in the Clacton bed; but when we consider that these gravels were formed at the mouth of a river, and reflect how likely it is that a closed sea, such as that of which I have been supposing the Weald Valley to have formed the head, should, under subarctic conditions, have approached (except in the existence of a tide) the brackish condition of the present Baltic, the obstacle to the marine theory, arising from the presence of freshwater shells, does not appear a very serious one. The formation of gravel at all during the latter part of the period in the Weald may, indeed, have been due to this freshwater condition permitting the formation of ice.

been excessive and repeated. Denudations, rivalling that which I have, in these papers, endeavoured to establish, and contemporaneous with it, have, I believe, taken place in other parts of England; of which the greatest effects are exhibited by the region of the Isles of Wight and Purbeck, of Somersetshire, and of the combined district of South-east Yorkshire and North Lincolnshire. In the latter instance there is, I think, evidence to show this; but in the other cases the evidence is defective for want of a starting point of Upper Drifts nearer than that crowning the brow of the Thames valley. What is wanted in the case of the Isle of Wight area is a starting point Upper Drift resting on the Upper Bagshot series of Hampshire; and, notwithstanding the general denudation of the Upper Drift south of the Thames, it is not unlikely that patches of this formation may remain on the great Tertiary tracts of the south of England. Very small patches of it frequently occur in the east of England in the midst of wide tracts of the denuded inferior beds, frequently from having been let down by faults; and I am not without hope, therefore, that, if the attention of geologists resident in the neighbourhood of the great Bagshot tracts of Chobham and Frimley, and that of the New Forest, were directed to this object, some trace of the Upper Drift might be discovered there.

No confirmation of the supposed occurrence in the Thames gravel of the flint implement found in Gray's Inn Lane, and described by Mr. J. Evans,[1] has yet been obtained; and the extensive and freely worked sheets of the Thames and East Essex gravels have failed to yield what has occurred in such abundance in the gravels of the Somme, Seine, Little Ouse, and Lark valleys, and in those of the Avon at Salisbury, of Hampshire, Biddenham, etc. I would not hazard a conjecture whether or not man dwelt in Britain during the Thames and East Essex gravel period; but certainly the absence of his remains in that gravel does accord with the far higher antiquity assigned to it here over those in which his remains have occurred. From the delineation I have given of the outlines of land and sea during the Thames gravel period, it will be seen that I regard the Chalk country, out of which the valley of the Somme and of that at Salisbury was formed, as undergoing denudation by the sea at this time; and that it was not until this denuded Chalk was elevated, that the valley of the Somme, the Avon, and of the Weald, were cut out of it. In this state of things the gravels of the Somme, Seine, and Avon, would come more into corelation with those described under the symbol, $x5$, etc., or else of those of the Wealden Greensand terrace ($x6$), and, taking all things known of them into consideration, I think nearest with the latter ($x6$). It is true that in the former *Cyrena fluminalis* occurs, which does not seem to have been detected in the latter; but as this shell has retreated in a south-easterly direction towards the Nile, in the interval between then and now, its presence in France, and its absence in this country, during the period marked by series $x6$, may not be inconsistent. The gravels of Bedford and

[1] Archæologia, vol. xxxviii., 1860.

the brick-earth of Hoxne may, so far as their *position* affords a clue, be of any age subsequent to the Boulder-clay; but those described by Mr. Prestwich, near Reculver, containing *Cyrena fluminalis*, as well as those of Sangatte, near Calais, would, both by their position and organic contents, seem to fall into the series $x5$; while those at Wissant, described by Mr. Day at page 115 of the 3rd volume of this MAGAZINE, would seem to come nearer to the series $x6$ than any other. "The clay with flints" and "brick-earth" of the Ordnance Surveyors, which occupies a belt of the Chalk country, stretching from near Marlborough to High Wycombe, seems by position to come nearest to the group $x5$.

IV.—SOME OBSERVATIONS ON THE *ZOANTHARIA RUGOSA*.

BY GUSTAVE LINDSTRÖM, Ph.M.

[*Continued from the August Number, p.* 361.]

[PLATE XIV.[1]]

THE next operculated species which claims our attention is the *Calceola Gotlandica* of F. Roemer. This species has been removed from the class *Brachiopoda* in a list of the Upper Silurian Brachiopods which I published in 1860. I now give my reasons for so doing (then but briefly indicated).

The shell presents on its exterior two different surfaces, one almost flat and triangular, the other convex (Plate XIV. Figs. 8-11, etc.) The shell has thus the shape of an irregular semi-cone. Close and irregular lines of growth continue interruptedly across these surfaces, and give the flat one, especially, a wrinkled appearance. Rectangular to these lines, or parallel to the longitudinal axis of the shell, are seen extremely delicate and dense striæ. The flat surface is divided in the middle by a longitudinal ridge, which is formed by two or three larger striæ, and by a regular folding outwards of the rim of the calyx. At the rounded angle, where the two different surfaces meet, rootlike processes project, just as in *Goniophyllum.* They often occur in pairs, in some instances on the flat surface, in others (Plate XIV. Fig. 12 and 13) on the convex side. By means of these rootlets they fixed themselves in their young state to *Halycites*, *Favosites*, and other marine bodies. The rootlets are perforated by a very narrow channel, which opens within the calyx. Of all the *Cyathophyllinæ* provided with rootlets none so clearly shows the connection between the channel of the rootlet and the cavity of the calyx as this species. The membrane which lined and secreted the walls of the calyx then formed small branches, which also secreted calcareous matter around themselves and thus formed these rootlike tubes. Their function of attaching the shell ceased when this became of too great a size, they then curve backwards along the flat surface, and terminate on it without opening; consequently, they continued to be formed long after their original

[1] For Plate XIV. see GEOL. MAG., August, Vol. III., p. 356.

function had ceased. During growth the flat surface was elevated above the body on which it originally rested, and became more curved. It is probable that the shell became free when its size became too large in proportion to its points of attachment, as in *Goniophyllum*, or more clearly in *Palæocyclus porpita.* The form of the shell is very variable. The conical shape is seldom regular. The apex is commonly bent towards the convex side. Sometimes the shell is extremely long and narrow (Plate XIV. Fig. 10). In this species, also, the animal reduced its shell and formed a new calyx within the old one (Plate XIV. Fig. 12); this is not, however, to be confounded with the budding as described below.

The opening of the calyx (Plate XIV. Figs. 8 and 11) is semicircular; it is highest at the flat surface. The interior cavity occupies almost three-fourths of the total length in short and broad specimens, and is only a shallow depression in the long shells. The bottom and the walls of the calyx are covered with convex vesiculæ, having a diameter of nearly five millim. The bottom ends in a pit, which continues on the concave wall. In the middle of the flat wall there projects a short and blunt ridge or tooth, homologous with the median septum of the other *Rugosa.* This wall is also covered with narrow, close and indented striæ, parallel to the middle tooth. They are very short, and but few stretch over the vesiculæ before they terminate. When the shell is weathered it seems as if the flat wall were covered with long and narrow rows of small depressed points, instead of these septa of the second order, which are then very obscure. In place of the middle tooth there is seen a shallow groove or depression. The opposite vaulted wall is rather smooth above the vesiculæ; its striæ or septa are distant, low, and more indistinct. The middle one opposite the tooth of the flat wall is more prominent and long, and and reaches to the bottom of the pit. In the angles between both the walls are seen small depressed points or holes, the openings of root-channels. In the young shells (Plate XIV., Fig. 9), the mouth of the calyx is more oblique, the primary septum is more prominent than in the older, it almost reaches to the bottom; the vesiculæ and the lateral septa are indistinct and small, the mouths of the root-channels are very apparent.

In the propagation of this species budding seems to have been of great importance (see Plate XIV. Fig. 14). In thirty-two specimens out of ninety young shells only six, from five to seven millims long, are independently fixed. This attachment of the young to the parent might, at first, seem quite accidental as when shells of other animals (*Syringopora*, *Cyathophylla*, and *Favositidæ*), have grown in the interior cavity of *Calceola.* In such cases, however, it is evident that the shell had lain empty on the bottom of the Upper Silurian sea for a long time after the soft parts of the animal had been decomposed. The operculum has only once been found attached to its shell, and the shells themselves are generally covered with foreign bodies. All idea of accidental attachment in the position of the young shell ceases when it is seen that they are, without exception, fixed in the angles between the flat and the vaulted wall, never on the walls, as other bodies (Plate XIV. Fig. 14). The apex of the young shell seems actually to shoot forth from the shell-matter of its parent, generally from a groove between two vesiculæ. If the embryo had fixed itself, when the shell became empty after the death of the parent animal, it could not, of course, have penetrated in this manner the mother shell.

The characteristic shape of the *Calceola* is distinct in specimens of a length of three millims. They are connected with the large shell by small rootlets, as well as by their first point of attachment. There is commonly but one bud, seldom one in each corner, more rarely two in each, and only in one instance three on each side. In a specimen of seven millims in length there are already two small buds, they all start from the same point, following, during their course, different directions, generally upwards, but also towards the sides and downwards. Such small shells, as are found attached to other bodies, must have originated in the common manner by the extrusion of free swimming embryo from an ovum. As no aggregate groups of individuals are found, it is probable that the buds having gained a certain size, became free. As to the interior structure of the shell, it consists of basin-shaped layers of oval vesiculæ (Plate XIV. Fig. 18), enclosed by a thin exterior coating, formed by the septa, and consisting of narrow longitudinal striæ.

The operculum of this shell is quite as semicircular as the mouth of the calyx (Plate XIV. Figs. 15 and 16). It has only once been found attached to its shell (Plate XIV. Fig. 13), although it cannot be considered very rare. The outside is marked by faint longitudinal striæ and concentric lines of growth. The nucleus is central and projects in a small point. It is circular, in accordance with the cylindrical form of the smallest shells, which soon become flattened on the side upon which they rest. The operculum is thickest in its centre, and convex on the outside, the interior surface being slightly concave. The uppermost edge, or what may be called the cardinal margin, is much thicker than the very thin or rather sharp side margins. Although thick, there is no such regular area at the cardinal margin, as in *Calceola sandalina*. On the interior side (Plate XIV. Figs. 16 and 17) there is, in the centre, a narrow longitudinal ridge, which disappears almost before it has half reached the inferior margin. It is largest and highest at a distance of two millims from the cardinal margin, where it also ends. Above is a small oval pit, enclosed by two processes, which originate in a common point on the cardinal margin; they also embrace the median ridge. In addition to this, the interior surface is covered with 18–20 striæ on each side of the median ridge, curved in an arch towards it. They are arranged in pairs, but each ray has its distinct starting point at the cardinal margin, parallel to which runs a shallow grove, only interrupted by the oval pit before mentioned.

The operculum in this species was also deciduous, but nevertheless some specimens show that it continued its function during the reduction of the shell. Some opercula are extremely thick, with the interior or youngest stratum far less extensive than the next exterior ones, so that a very broad cardinal margin, composed of the accumulated strata, projects in an oblique direction above the interior surface. *Calceola Gotlandica,* ranked by F. Roemer among the *Brachiopoda,* is thus found to coincide with the *Rugosa,* in the form of its calyx, in the internal structure of the shell, the rootlets, and its external sculpture.

Of all known forms it seems to me that *C. Gotlandica* most nearly resembles *Calceola Tennesseensis,* F. Roemer.[1] It is true that the rootlets are wanting, but a glance at fig. 1*c.* in Professor Roemer's work, makes it at once evident that the two species have a great affinity. The base of both is covered with vesiculæ, as in *Goniophyllum* and *Cystiphyllum*; the same groove is seen in both on the same side. Instead of the projecting tooth in the middle of the flat wall, there is an elliptical depression, and the cardinal margin is finely crenulated without striæ. But these differences are no doubt produced in the same manner as in *Calceola Gotlandica,* namely, by weathering, so that the tooth, or primary septum, resembles that part in weathered specimens of *Goniophyllum* and *C. Gotlandica.* The shell, to judge by figs. 1 *b, e, op. cit.,* appears to be quite as irregular in its shape as *C. Gotlandica.* Fig. 1 *a* shows in the centre of the so-called "area," the same ridge as the Gothlandic species, only somewhat larger. The operculum (fig. 1 *d, op. cit.*) resembles more that of *C. sandalina,* with its triangular area, with the nucleus close to the cardinal margin.

If we now extend our comparisons to the third known species of the genus *Calceola,* the *C. sandalina,* we find true homologies between it and the two preceding forms. We then only see accidental exterior resemblances with the *Brachiopoda,* amongst which this, as well as the last two mentioned species, have so long been numbered. The regular form of its shell, the similarity of the flat surface with the area of the *Brachiopoda,* and that of the middle ridge thereon with a pseudo-deltidium, may explain its having been retained in that class. Some authors have compared it to *Cyrtina* and *Cyrtia*; others again, in consequence of the "area" of the small valve, with certain *Strophomenidœ.*[2] But this "area" does not form a strictly circumscribed part, nor does it possess peculiar sculpture, characteristic of the species, and different from that on the rest of shell, as in the *Brachiopoda.* On the contrary, this sculpture is quite of the same nature, as on the rest of the surface, the lines of growth continue without interruption on it. The area of the shell is longitudinally sculptured by fine striæ or folds, the centre ones forming the ridge, which is considered by many authors to be homologous with the pseudo-deltidium of the *Brachiopoda.* But this ridge is precisely the same as that met with in almost all specimens of *Zoantharia rugosa.* Besides *Goniophyllum* and *Calceola,* there are a great many *Rugosa* which have a flat surface, somewhat resembling an area, and almost all have such a one during their young state,

[1] Die Silurische Fauna des Westlichen Tennessee, p. 73, Pl. v. figs. 1 a–e.

[2] Eine kleine grobfaltige Abanderung (of *Spirifer trapezoidalis*) nannte Defrance "*Calceola heteroclyta.*" Quenstedt. Handbuch der Petrefactenkunde, p. 479.

when they adhered to other bodies. In some species (*Calceola, Goniophyllum, Hallia calceoloides*), this flat side remained, while in others it soon became convex, and the shell assumed a cylindrical shape, when it began to raise itself freely above its point of attachment.[1] If we now look at the interior cavity of *Calceola sandalina,* all likeness with the *Brachiopoda* at once ceases. We there again see a groove in the bottom completely coinciding in size and position with that of *Goniophyllum,* other *Calceolæ, Omphyma,* etc. Opposite this pit is the middle septum, completely homologous with that in the species just named, and environed by smaller ones. The operculum agrees perfectly with that of *Goniophyllum* and *C. Gotlandica* in its elements, but modified in details. There is a middle ridge on its interior side formed in the same manner, and above it the small oval pit enclosed by two lateral processes, the same striæ on the sides curved towards the middle ridge; indeed, all those points of structure are common to these species. The structure of the shell by no means resembles that so characteristic of the *Brachiopoda,* which is prismatic and often perforated by small pores. It consists of thin, funnel-shaped layers, as in so many of the *Rugosa.* In consequence of all these affinities with the *Z. rugosa* (both with those that are provided with an operculum, and those without), *Calceola sandalina* must be removed from the class *Brachiopoda,* and henceforth considered as one of the *Rugosa.*[2]

But if we again compare *C. sandalina* with *C. Gotlandica* and *Tennesseensis,* we discover more than specific differences, and it seems impossible to retain them any longer in the same genus. *C. sandalina* is distinguished by its more regular shape, and by the absence of all rootlets. The septa are also more regular and complete, the middle septum of the flat wall larger, and the bottom is void of all vesiculæ. It seems, moreover, not to have propagated by means of buds.[3] The figures of *Calceola sandalina,* which have been given in various palæontological works, vary much from my description. This is caused by their having been drawn from weathered specimens. The middle septum is then, as it were, decomposed into its elements leaving two lamellæ with a deep groove between them. In others only the uppermost part of the septum is left, with a depression or groove beneath. This is the case in weathered specimens of *Goniophyllum* and *Calceola sandalina.* The punctated lines between the septa of the second order have, as in the other species, been occasioned by the weathering of the small teeth of the septa. It is easy to prove the existence of a true septum in the middle, and not a

[1] *A Cystiphyllum,* having a shape between a cylinder and a four-sided prism, comes near to the pyramidical form of *Goniophyllum.*

[2] Sir Charles Lyell, in the sixth edition of his Manual, says (p. 537) that some naturalists have lately referred *C. sandalina* to a coral. "They suppose it to be an abnormal form of the order *Z. rugosa,* differing from all other corals in being furnished with a strong operculum." In this opinion I cannot join, because, as I have endeavoured to show, I do not consider *Calceola sandalina,* or the other *Rugosa,* as corals. Neither is the *C. sandalina* an abnormal form of its order.

[3] The best figures of *C. sandalina* are in all probability those seen in Goldfuss's Petrefacta Germaniæ, vol. ii., pl. clxi. fig. 1.

groove, by separating the operculum from a shell, which has been fossilized with it adhering, and has therefore not been exposed to weathering. It is then seen that the smaller septa are finely serrated. The interior structure differs from that of *C. Gotlandica* in not being vesicular. The chief mass of the solid shell consists of very close and thin strata, which end downwards in a very acute apex. The operculum is more regular and has a larger triangular area, and is moreover provided on both sides of the middle ridge with a series of small tooth-like protuberances ("apophyses"), which are totally wanting in *C. Gotlandica*, but are represented in *Goniophyllum* by small irregular teeth on the cardinal area. There is consequently no reason to unite *C. sandalina* with the other two species in one genus, and I therefore propose that *Calceola sandalina* alone should form the genus *Calceola*, that *C. Gotlandicæ* be the type of a new genus[1] under the name *Rhizophyllum*, while *Calceola Tennesseensis* may perhaps represent another genus very closely allied to the last, but I cannot decide this, as I have not examined any specimens of it. The genus *Calceola*, as now limited, must, no doubt, be placed in the family of the *Cyathophyllinæ* amongst the allied genera; *Goniophyllum* may be placed close to *Omphyma; Rhizophyllum* with its strongly developed vesicular structure and indistinct septa, comes so near to *Cystiphyllum*, that it may be considered as intermediate between the *Cyathophyllinæ* and *Cystiphyllinæ*. The chief difference in the *Cystiphyllinæ* is that they have no distinct septal groove, and are wholly vesicular. As to *Calceola*, the inner surface of its operculum would give it a place near *Goniophyllum*, but it is removed from that place by its internal structure, which most closely resembles *Chonophyllum*, which, as far as known, also consists of the same thin and funnel-shaped strata. *Calceola* may then, at least, till further knowledge is gained, be placed between *Chonophyllum* and *Goniophyllum*. The series of the principal genera now mentioned would then be; *Chonophyllum, Calceola, Goniophyllum, Omphyma, Rhizophyllum, Cystiphyllum.*

There is reason to believe that there are other families besides the *Cyathophyllinæ*, in which some of the genera have been furnished with an operculum. In the oldest strata of the Isle of Gotland near Wisby, a fossil is occasionally found having, as it seems to me, the nature of an operculum of one of the *Zaphrentinæ*. It is irregularly triangular with rounded corners, generally very thin and almost concave on the outside (Plate XIV, Figs. 22 and 23). The nucleus is either central or lateral. On the interior surface is a triangular or circular area (Plate XIV. Fig. 23), around which the margins form an elevated border. This interior area is smooth, sometimes wavy, and crossed by from 8–9 filiform parallel and straight striæ, which

[1] *Rhizophyllum*, n. gen.; Testa semiconica, appendicibus radiciformibus instructa, structura interna cellulosa, calyx vesiculosus, in fundo fossa septali, septis perexiguis. Operculum nucleo centrali, areâ prætenui, in superficie interiori dente medio valido, foveâ ovali superaddita, dentibus lateralibus nullis. Species unica *R. Gotlandicum*, F. Roemer, in divisione suprema formationis Siluricæ in Gotlandia reperta. *Calceolæ*, or rather forms resembling *Calceolæ*, are by no means characteristic of the Devonian formation, as such also are found in the Lower Silurian strata of Western Gotland in the mainland of Sweden.

originate at the straightest margin. This must be considered as the cardinal margin and the others, where the striæ end as the lateral margin. Next within this border there is a depression with small pits between the striæ. This operculum belongs to a type quite different from that of the preceding fossils, being destitute of any prominent ridge in the middle, but it may, as I suppose, have been fixed to an animal of the same class. Its shape as well as its interior surface make it impossible to join it with any of the *Gasteropoda* which occur in the same stratum, and which are all *Holostomata.* Nor is there any tube of Annelids to which it might have belonged. The striæ on the inner surface are, in all probability, homologous with those of *Goniophyllum* situated on both sides of the median ridge. In the same stratum with this operculum there occurs only a species of *Hallia,* to which it in some degree corresponds. It has not yet been decided with certainty if there is a true connection between both, as the outlines of the calyx and the operculum are somewhat dissimilar. The area on the interior surface of the operculum within the border has, nevertheless, the same semicircular form at the mouth of the calyx, so that it is highly probable that they were connected and that the elevated border of the operculum projected outside the rim of the calyx when this was covered by the operculum. The shell of this *Hallia,* which, by reason of its exterior resemblance to *Calceola,* may be named *Hallia calceoloides* (Plate XIV. Figs. 19–21), has one surface flat and the other convex, the former, with a middle ridge consisting of two or three folds. Towards this ridge other smaller folds converge in a pinnate arrangement. When the shell has attained a length of about 25 millims its flat surface also becomes convex, and the form of the shell is cylindrical. On old specimens the outline of the calyx is circular, in younger ones semicircular. The shell is long and slender, sharply pointed, without any rootlets. In the interior of the calyx (Plate XIV. fig. 21) there is only one large septum of the first order, so characteristic of the genus *Hallia.* It is situated on the middle of the flat wall and reaches to the bottom of the calyx. It is surmounted on both sides by septa of a second order, which correspond with one another. They are 28 in number, with smaller ones between them, which only extend half as far as the wall. The septa continue, uninterrupted by tabulæ, &c., to the middle axis of the shell.

Many more specimens of *Z. rugosa* than those now mentioned have been provided with an operculum. The description and the figures of Guettard of a *Cyathophyllum*[1] with an operculum are sufficiently clear and evident not to be doubted any longer. It has already been mentioned that Professor Steenstrup observed a *Cyathophyllum mitratum* with a fragment of the operculum still *in situ.* He has also remarked that a small border noticeable around the interior rim of the calyx indicates, in many species, that they probably had an operculum.

I have been favoured with a kind communication from Thomas

[1] Mémoires, vol. iii., p. 510, plate 52.

Mr. R. Lechmere Guppy describes and figures twenty-seven new species of Miocene Mollusca from Jamaica, three new species of Miocene Brachiopoda from Trinidad, and three new species of *Echinolampas* from the West Indies. He makes some interesting remarks on the relationship of the Miocene beds of Jamaica, and gives a list of the fossils and their distribution. Mr. Davidson adds a note on the Brachiopoda.

Dr. Young gives a detailed anatomical description of *Platysomus* and allied genera; also a note on the scales of *Rhizodus*.

Then come a number of abstracts of papers relating to the recent volcanic disturbances in the neighbourhood of Santorino, with which the Society has been literally deluged.

Mr. Jukes' exhaustive paper on the Carboniferous Slate (or Devonian Rocks) and the Old Red Sandstone of South Ireland and North Devon concludes this number of the proceedings of the Society.

In the Miscellaneous part are abstracts of papers by Herr von Koenen on the Fauna of the Lower Oligocene Tertiary Beds of Helmstädt, near Brunswick; by M. E. Hébert, on the Nummulitic Strata of Northern Italy and the Alps, and on the Oligocene of Germany; and by Professor Gümbel, on the Occurrence of *Eozoön* in the Primary Rocks of Eastern Bavaria.

III.—Quarterly Journal of Science, July, 1866.

MR. HULL, of the Geological Survey, gives an account of the New Iron-fields of England. The supply of the Coal-measure iron-stones in the Staffordshire, Shropshire, and Glasgow districts is rapidly diminishing, while every year the demand for iron is increasing. "How this demand was to be met, without drawing largely on the resources of foreign countries, is a problem which received its solution just at the time when it began to occupy men's minds," by the discovery of the "New Iron Fields" here described. They occupy a broad belt of country extending from the Cleveland Hills of Yorkshire to the Cotteswolds of Gloucester and Somerset. The Iron-stone occurs at the top of the Marlstone, or Middle Lias, and at the base of the Great Oolite.

Mr. Boyd Dawkins, of the Geological Survey, contributes a paper on the Habits and Condition of the Two Earliest Races of Men. "He traces man from his earliest appearance on the earth down to the borders of history, and shows how, as he grew older, he profited by his experience, and slowly widened the chasm between himself and the brutes, by making his life more and more artificial."

Mr. Archibald Geikie, F.R.S., gives some hints to Home Tourists on the advantages of a knowledge of the elements of geology, and points out the study of our old British volcanoes as a "field of research where the reapers have not been so numerous as in some others adjoining, and where, in consequence, there still remain a good many sheaves to be gathered." [See Mr. Geikie's article "On the Permian Volcanos of Scotland," Geological Magazine, June, 1866, p. 243.]

There is an interesting review of Geological Maps, and the relation of Geology to Agriculture and the question of the Coal-supply.

In the Chronicles of Geology and Palæontology will be found discussions on several questions of theoretical interest, more particularly an account of Mr. Croll's "Speculations on Cosmical Causes of Changes of Temperature, and on the Submergence of the Northern Hemisphere during the Glacial Period," and of the papers by Messrs. Heath, Carrick Moore, and the Rev. Professor Haughton on the same subject, in the "Philosophical Magazine."

REVIEWS.

I.—Rocks Classified and Described, a Treatise on Lithology. By Bernard von Cotta. An English Edition. By Philip Henry Lawrence. Revised by the Author. 8vo. pp. 425. 1866. London: Longmans, Green & Co.

[1st Notice.]

A TREATISE on Rocks, by Bernard von Cotta, rendered into English by Mr. P. H. Lawrence, and revised by the author, is a book that must of necessity find a place in the library of every geological student. We are not altogether sorry, however, to find that it does not (as we anticipated it might have done) supersede our trusty referee, "Bristow's Glossary of Mineralogy,"[1] which still holds its own against the veteran invader.

Dr. Cotta's work consists of three parts. Part I. is devoted to Mineralogy; Part II. to Rocks, and Lithology proper; Part III. to the mode of formation and metamorphism of Rocks.

Without any desire to withhold the meed of praise due to the author for Parts II. and III. of this most valuable book, we cannot refrain from offering a few needful critical observations upon Part I. which we hope will undergo great revision in another edition.

In Part I. chapter the first (p. 3), the author observes:—"As to the much-debated question of classification of the minerals, we have adopted one which appeared to us best suited for our present purpose; it is not exactly that of any one author. We have placed a few of those minerals first which are of the most frequent occurrence; otherwise the arrangement adopted will be found to correspond in several respects with Dana's 'System of Mineralogy.'"

This attempt of Dr. Cotta's to combine several systems of classification in one has given rise, as will presently be seen, to many difficulties, for the *media via* of mineralogy does not here prove to be *tutissima*.

The classification of Minerals, or, in fact, of any other natural

[1] A Glossary of Mineralogy. By H. W. Bristow, F.G.S., Senior officer of the Geological Survey of Great Britain, 1861. 8vo. pp. 466. (Arranged alphabetically, with numerous woodcuts.) London: Longmans, Green, and Reader.

kingdom, should be into—1, Classes having at least one important character in common; 2, Into genera, having this and *other* leading characters also common to the family; 3, Into species, having, of course, special and individual peculiarities. We find, however, that the classification adopted by Dr. Cotta does not satisfy any of these general principles of arrangement. For instance, in the 1st section (p. 5) are placed together the oxides of Silicon and Aluminum. Now, what character have these two substances in common, save their combination with oxygen?—an almost universal character in minerals with which the geologist has to deal.

Quartz and Corundum are not alike in any of the properties usually considered important by mineralogists and chemists. Their mode of occurrence—their chemical constitution[1]—their crystalline form—and, in fact, every other character, would separate them.

The only character given for Amethyst (p. 6) is, that its colour is violet, whereas it may be, and frequently is, yellow, or colourless; its real character being its right and left handed forms in the same crystal, as shown long since by Sir David Brewster.

Sodalite, Lapis-lazuli, Haüyne, Nosean, Leucite, and Nepheline, are all classed together (p. 14); we cannot see on what grounds.

The Andalusite section (p. 34) is made to include Tourmaline, Topaz, and Lievrite.

Under the heading of "Oxides of Elements of the Hydrogen Group," (p. 60) we find the most wonderful *olla podrida* in the whole chapter. The group is divided into "A. Hydrous," and "B. Anhydrous." What is an element of the Hydrogen group? Dr. Cotta implies that the classification he has adopted is a chemical one, whereas we find that, instead of containing the oxides of the chemist's hydrogen group, which are Hydrogen, Potassium, Sodium, Lithium, Silver, and some others, we have Spinel, Magnetite, Chromite, which should have been, and are generally, put together as a separate group of oxides [$RO + R_2O_3$] placed with Hematite, a sesquioxide—with Rutile and Cassiterite, oxides of di-atomic, or tetra-atomic elements—with Pyrolusite, Hausmannite, and others equally incongruous. Amongst these there is *not one* that can with any good reason be placed within the Hydrogen group, which is essentially mono-atomic, whereas the elements placed in it by Dr. Cotta are di-, tri-, or tetra-atomic. He has omitted entirely from this group the oxide of its type-element, to wit, Water or Ice, which is equally interesting to the geologist and mineralogist, playing as it does such an important part both on the surface and in the interior of our globe. We find it, however, in the Miscellaneous division of Part II. (p. 347), under the head of "Ice," but the notice of it is rather meagre.

The Augite (p. 16), Zeolite (p. 28), and Feldspar (p. 8) sections, seem well arranged, and contrast advantageously with the foregoing misalliances.

[1] Dr. Cotta's adoption of the formula $Si\,O_3$ for Quartz brings it no nearer to Corundum, which is a sesquioxide; the modern school of chemists seem to consider Silicon either di-atomic or tetra-atomic.

The working petrologist requires nothing beyond the knowledge of such of the properties of the minerals he is likely to meet with, as will enable him readily to recognize them. The student who knows enough of chemistry or mineralogy to teach him the affinities of any mineral, would never find it in the group where it ought naturally to be found, and must refer to the index. Why not then have at once adopted an alphabetical arrangement?

However we may object to the arrangement of the minerals in the first part of Dr. Cotta's work, we could not well make the same objections to his "Classification of Rocks" (Part II.) These are objects of which no natural classification seems possible. They have no definite chemical constitution, or even composition, except in the few cases where they consist of only one mineral, tolerably pure. They seem destitute of any properties or distinct characters of sufficient importance to mark out any clear natural groups. They run so much one into another, and by such insensible gradations, that whatever genera and species they may be divided into, it seems impossible to tell absolutely where to place the line of demarcation between one and another. (Take for instances, the Syenite group, p. 176; the Itacolumite group, varieties, p. 248; the Argillaceous group, pp. 265–266.)

The objections to his own, and to all other classifications possible, are well set forth in Dr. Cotta's introduction to Part II. (p. 124).

"A scientific classification of rocks is a task of more difficulty than might at first sight appear; as yet, no one has succeeded in producing a perfectly consistent, and comprehensive system. Not only do the nature of the subject and our own imperfect knowledge present many serious obstacles to consistent arrangement, but in many cases, established usage and nomenclature, too firmly rooted to be lightly disturbed, prevent our changing an old classification, even when based on error.

Even were our knowledge far more certain than it is, and were we free to overthrow all previous errors and misconceptions, we could not lay down a logically complete system of classification to embrace all rocks, on any principle, whether of ORIGIN. TEXTURE, or COMPOSITION (chemical or mineralogical). We do not find the mineralogical differences between rocks coincide with those of their chemical composition, nor are either of those dependent on geological position or stratification. There are no rigidly defined classes in nature."

Dr. Cotta proposes the following general classification for rocks:

"I.—Igneous Rocks (Eruptive Rocks), all of which are most probably products of igneous fusion.

A. Rocks poor in silica, or basic rocks:—

(*a*) Volcanic.—Of which the basalts are the principal representatives.

(*b*) Plutonic.—Of these the principal representatives are the so-called Greenstones (diabase, diorite, etc.).

B. Rocks rich in silica, or acidic rocks:—

(*a*) Volcanic, *e.g.* the trachytes.

(*b*) Plutonic, *e.g.* the granites.

II.—Metamorphic Crystalline Schists.—Most probably the product of the transmutation of sedimentary rocks, but in respect of their mineralogical composition closely allied to the igneous, *e.g.* gneiss, mica-schist, chloride-schist, etc.

III.—Sedimentary Rocks.—The product of deposit:—

1. Argillaceous rocks, such as clay and argillaceous shale.
2. Limestone rocks, such as limestone and dolomite (including gypsum and anhydrite).
3. Siliceous rocks, *e.g.* Sandstones and conglomerates.
4. Tufa formations.

The above are the groups of principal rocks which occur in masses of great extent.

IV.—We shall next range those rocks of less frequent occurrence, or which only form subordinate strata or separate beds, and whose origin is in part still doubtful, without attempting, in their case, a logical classification. To this series belong, for instance, many silicates, the carbonaceous rocks, the ironstones, serpentine, etc., and some other rocks of problematical character.

V.—Finally we shall instance those rocks which are essentially composed of one mineral, such as quartz, opal, etc."

The author's observations on the probable mode of formation of minerals are very trustworthy and reliable, and he has evidently devoted much time and labour to the subject.

Dr. Cotta's Classification of Rocks will, no doubt, be the students manual for many ensuing sessions in all colleges where lithology is taught, but *Bristow's Mineralogy* must still be in demand by every student, because the work is so carefully executed, its arrangement is so simple, and the book so handy for reference at all times.

We shall notice Dr. Cotta's work again in a future number.

REPORTS AND PROCEEDINGS.

Edinburgh Geological Society.—On May 30th, the eleventh ordinary meeting of this Society for the session was held in their rooms, No. 5, St. Andrew Square.—Mr. Roderick A. F. A. Coyne, C.E., Vice-President, in the chair.

Mr. Thomas Smyth read the second part of a paper "On the Upheaval of the Shores of the Firth of Forth, and part of the East Coast of Scotland, during the Human Period." He briefly recapitulated the evidences of upheaval contained in his former paper (a report of which appeared in the June number of the Geological Magazine). The second part of the paper was entitled, "On the Upheaval of our Shores between the time when a Celtic population first inhabited the Lowlands of Scotland and the present day; with special reference to a Rise of the Land since the period of the Roman Occupation, and to a Rise within the last half-century." He exhibited a stone celt, which was found near Errol, in the Carse of Gowrie, beneath a deposit of fine laminated clay (containing recent shells), 8 feet 10 inches in depth, and 26 feet 5 inches above high-water mark, showing beyond doubt that there must have been a rise of land of 26 feet at least since a rude population inhabited that part of Perthshire. Mr. Smyth then stated the objections that had been adduced to the opinions held by Sir Charles Lyell, Bart., Mr. Archibald Geikie, and many others, including himself, that there had been a considerable upheaval of the shores of the Firth of Forth since the period of the Roman Occupation. Mr. Smyth then quoted the statements of numerous authorities, which proved that the Romans had a harbour which extended from Fisherrow to the foot of the hill near Inveresk, and one at Cramond (the ancient Alaterva); and that the positions of these harbours, as shown by the remains of the Roman dock-walls, could not have been less than 25 feet above the present high-water mark. He also stated that a general tradition is current in Falkirk and the surrounding district that there was once a harbour near Camelon, in the vale of the Carron, upwards of three miles from the sea. As Camelon was the "Statio ad vallum" of the Romans, when we take into account the corroborative evidence of the Roman remains found at the place, it is not unlikely that the harbour near Camelon was used by the Romans. Mr. Smyth also stated that a friend and himself had some time ago found, in a sand-pit between Dunbar and Linton, a Roman lachrymary and a coin of Antoninus Pius. The place where they were found was in a thin deposit of mud or clay, beneath a perfectly undisturbed marine deposit of stratified sand and gravel, 7 feet 10 inches in depth. The place was exactly $24\frac{1}{2}$ feet above high-water mark, and about a mile from the sea. Many Roman remains have been found in the district. Indeed, from Dunbar to Cramond, altars, coins, medals, pottery, and many other remains, have been at various times discovered. Near the same place where the coin of Antoninus was found, but only about 4 feet from the surface, another coin (of Constantine the Great) had been found by a boy who belonged to the place. As Antoninus Pius reigned in the second century, it follows that when one Roman dropped his lachrymary, and another a coin, into the mud (either in the sea or along the sea-shore), the land must have been at least $24\frac{1}{2}$ feet lower (seventeen centuries ago) than it is at present. This difference could only be accounted for by upheaval. The amount, however, of this upheaval during any particular century, except the present, is unknown, because since the time the Romans occupied this country we have unmistakeable evidence of periods of repose.

Mr. Smyth then proceeded to lay before the Society the additional evidences of upheaval of $2\frac{1}{2}$ feet during the last half-century. He stated that during the last fifteen months he had made a systematic examination of the shores of the Firth of Forth, and that part of the east coast which lies between Dunbar and Berwick-upon-Tweed, for the purpose of ascertaining if there had been an upheaval of our shores within the memory of those who are still alive. Mr. Smyth stated that persons yet alive have informed him that fifty years ago, when smuggling was carried on to a considerable extent between the Continent and the east coast of Scotland, boats used to land near St. Abb's Head and Fast Castle, in Berwickshire, at places where they could not find sufficient water to land at present. The luggers remained in the offing, a short distance from the shore, and two of the principal places where the boats used to land, laden with Hollands, brandy, tobacco, and silks, were in the coves at and near Lumsden shore and near Dowlaw shore. They landed on ledges of solid rock, where no boats could land at present, even at the highest tides. He had measured the height of several of these ledges. He found one 6 inches, another 8 inches, and a third 9 inches above high-water mark; and taking the moderate computation of only 2 feet of water for floating a boat laden with goods, we shall have an elevation or a rise of the land of from 2 feet 6 inches to 2 feet 9 inches within the last fifty years. He also stated that several iron rings still remain as silent witnesses of the smuggling operations. Mr. Smyth then said that all along the coast, especially at Redheugh, Prestonpans, Portobello, North Queensferry, and Aberdour, he had found evidence, though not so definite as the foregoing, that the sea reached a point fifty years ago 2½ feet above the present high-water mark. As corroborative of this, he entered into a minute description of the Leith tide-gauges. The records were first taken in 1806-7; but the first portion of the books had been lost, so that the first register now begins only in the year 1827, yet we have internal evidence from the marginal observations on one of the sets of books, that in the year 1810 mean tides rose to a point 2 feet 10 inches higher than they do at present. Mr. Smyth said that, in his calculations, he had taken all the changes in the docks into account, and he was irresistibly drawn to the conclusion that there had been an upheaval of the land of at least 2½ feet with the last half-century. Mr. Smyth, in conclusion, stated that the upheaval, which is at present taking place on the shores of the Firth of Forth, and in Berwickshire, has its counterpart in Caithness, which is rising at nearly the same rate; and he said it was probable, seeing that Norway and Sweden are also rising, that this slow upheaval of our shores extends to Scandinavia.

The Geological Society of Glasgow held their second summer excursion on May 12th, when they spent a delightful summer afternoon on the Gleniffer Braes. The party, under the guidance of Mr. R. W. Skipsey, examined the outcrop of a bed of Coal, known as the "Lady Anne" seam, here calcined by an overlying bed of volcanic ash. They next visited and examined the overlying Carboniferous Limestone, here tilted up by the trap. Very few fossils were discovered.

II.—On June 9th the Society made an excursion to High Blantyre and Calder Glen. The resident members, acting as guides, were the Rev. P. J. Gloag and Dr. James Bryce, F.G.S. The quarries visited were those of Newfield and Broomhouse, situated in East Kilbride, and rendered historical as the spots explored by the Rev. David Ure, who, in his "History of Rutherglen and East Kilbride," figured and described many of the fossils found in them. The quarries are worked in the Carboniferous Limestone, and present a variety of beds, some of which are very rich in organic remains. The geological portion of the trip ended by a visit to Calder Glen, where is to be seen a precipice 140 feet of perpendicular rock, exhibiting 40 distinct strata.

III.—On June 30th a joint meeting of this Society, with the Edinbugh Geological Society, was convened at Edinburgh for the purpose of visiting the many interesting localities where the eruptive rocks are seen—in the Castle Rock, The Calton Hill, Salisbury Crags, and the columnar basalt of Samson's Ribs. The party were received by their metropolitan fellow-geologists, who entertained them at breakfast in their rooms, and Mr. David Page, F.G.S., acted as guide, assisted by other members of the club.

Botanical Society of Edinburgh.—This Society met on the 12th July, in the Histology Class-room at the Royal Botanic Garden—Dr. Alexander Dickson, V.-P., in the chair.

Among other communications read was one,—"On the Structure and Affinities of *Lepidodendron* and *Calamites*." By William Carruthers, Esq., F.L.S., of the British Museum,—of which, the following is an abstract:

After referring to the fragmentary condition in which the remains of fossil plants generally occur, the author noticed the causes which interfered with the satisfactory preservation of the coal plants, and the difficulty of identifying fragments of the same species. Consequently the various portions of the same organism not in actual contact, which exhibited different appearances, had been referred to different genera. Root, stem, branches, leaves, and fruit, were each placed in a different genus. As the result of continued observation, and the occasional discovery of more perfect specimens, this unavoidable multiplication of generic names is being reduced, and the scattered fragments united to form the complete plant. *Lepidodendron* and *Calamites* were shown to be striking examples of this, and both genera were described in detail.

Lepidodendron was restored as a tree, like a huge *Lycopodium cernuum.* The trunk consisted of a large cellular pith, surrounded by a cylinder of wood of thickness varying according to the age of the plant. This was surrounded by a cylinder of cellular substance, traversed by numerous vascular bundles, which passed upwards and outwards, and, penetrating a second woody cylinder, terminated in the bases of the leaves which were immediately beyond. This singular arrangement had been determined by Mr. Binney from a large series of beautifully prepared specimens. The author showed that the arrangement of parts was similar in the trunks of some *Cycadeæ*, which presented a further resemblance in having the outer surface composed of the bases of the leaves, and so marked by a similar series of stigmata as those occurring in *Lepidodendron.* An examination of the minute tissue, however, showed that while this general resemblance existed between the two stems, there was no real affinity between the plants, for though *Cycadeæ* were the simplest form of *Coniferæ* their wood was made up of disc-bearing vascular tissue, was laid on in separable exogenous layers, and was traversed by medullary rays; while in *Lepidodendron* the wood was entirely made up of scalariform tissue, without any trace of medullary rays, or a true exogenous arrangement. The histological examination of the stem showed the fossil plant to be cryptogamous, but having a stem with a structure more highly organised and more nearly approaching to that of phanerogamous plants, than any known cryptogam. This opinion was confirmed by an examination of the organs of fructification, which were shown to be *strobili,* bearing a single sporangium on the upper surface of each scale, as in *Lepidostrobus,* or several, as in *Flemingites.* The sporangia contained both large and small spores, and are consequently more nearly allied to *Rhizocarpeæ* than to *Lycopodiaceæ.*

The stem of *Calamites* was composed of a cylinder of scalariform tissue surrounding a large cellular pith. The author had been shown by Mr. Binney, a beautifully preserved specimen, showing the relation of the parts. The vascular tissue was developed from a series of equidistant parts around the pith, and grew outwards, and laterally, until they united in a continuous cylinder, fluted on the inner surface, and with the flutings filled with the cellular tissue of the pith. The early vascular bundles in the young shoots of exogenous plants, have a similar structure, but they speedily unite to form a woody cylinder, with a clearly defined and smooth inner surface towards the pith. This early condition is, however, permanent in the stem of some arborescent species of *Cactus*—which, in this respect, closely resemble *Calamites*—but it is only as imilarity in the arrangement of the parts without any true affinity, for the stems differ as much as *Lepidodendron* does from *Cycas.* The woody cylinder formed constrictions at regular intervals round the pith, as in some *Artocarpeæ.* The fruit of *Calamites* was a *strobilus,* the whorls of which were alternately barren and fertile. The barren whorls were developed as scales protecting the fertile whorls, which consisted of spines, each supporting four obovate sporangia. Both genera—*Lepidodendron* and *Calamites*—were certainly cryptogams, differing, both in structure of stem, and in the organs of fructification, from each other, yet both agreeing in main characters with the vascular cryptogams, although possessing more highly organised stems than exist in any known members of that class.—*Edinburgh Evening Courant.*

The Richmond and North Riding Naturalists' Field-club.—On the 31st of July the members of this club had an excursion to the interesting locality of Saltburn-by-the-Sea, to examine the geology and natural history generally of Saltburn and Huntcliffe. The weather was anything but favourable, yet the members mustered well, with their respected president (Mr. E. Wood, F.G.S.) at their head. A considerable part of the day's programme had to be abandoned owing to the incessant rain, else it had been arranged to explore one of the celebrated iron-stone mines the property of Mr. Pease, M.P,, who had kindly given directions for the due reception of the club. About one hundred members and friends of the club dined at the Zetland Hotel at the generous invitation of Edward Wood, Esq., F.G.S., the president. The health of the chairman was received with great enthusiasm by every one present. In responding he said it was satisfactory to know that the affairs of the club were in a most satisfactory state; the members constantly increasing, and the Museum ever receiving valuable contributions in objects of Natural History.—*Darlington and Stockton Telegraph,* August 4th, 1866.

A Geological Ramble.—Under the name of "Hythe Penny Rambles," Mr. H. B. Mackeson, F.G.S., of Hythe, Kent, is endeavouring to spread a taste for Natural History, etc., by a series of field-lectures in the vicinity of the town. The first meeting was held on the 10th of July last, at which a numerous attendance of the inhabitants of Hythe and its vicinity were present. Mr. Mackeson pointed out some interesting indications of the change of coast-line, evidenced by an ancient escarpment of the Lower Green-sand, now far inland; no doubt the sea formerly washed the very foot of the hill above the Church at Hythe, where they then stood. He called attention to various geological facts, and gave capital illustrations of the practical use of both geology and botany. The Rev. Thomas Wiltshire, F.G.S., who was also present, gave an explanation of some of the geological features of the adjacent quarry and neighbourhood, with especial reference to the physical changes that had formerly operated to produce the series of deposits which now make up the Weald of Kent. Attention was called to the numerous fossils—*Ammonites, Nautili, Trigoniæ,* etc., scattered around; and explanations were given of their peculiar forms. Great interest was displayed throughout by the company present, and hearty thanks were returned to Mr. Mackeson and the Rev. Thomas Wiltshire for their interesting addresses.—*Kentish Express.*

CORRESPONDENCE.

GONIOPHYLLUM PYRAMIDALE, HIS.

To the Editor of the Geological Magazine.

Dear Sir,—*Apropos* to Mr. Davidson's note in the June number of your Magazine, calling attention to the occurrence of *Goniophyllum pyramidale*, His. in the "Upper Wenlock Shales" of Dudley, it may be interesting to some of your readers to learn that the same species has occurred also in the Malvern district, several specimens having been found in the heap of rubbish near the Wych, which was thrown out in the construction of the tunnel through the hills. Three of these specimens are in my own possession, and there are at least two others in the collection of Dr. Grindrod, of Malvern; besides which, if I have not been misinformed, there is a specimen from the same locality in the cabinet either of Mr. Fletcher or of Mr. Gray, of Hagley. The most fully grown of these Malvern specimens corresponds to Mr. Lindström's fig. 2 in size, but they are all of them more depressed in form than his fig. 1, and have the point more curved upwards. Moreover, most of the specimens have grown up in a somewhat spiral manner, giving a slight twist to the body of the coral. (See Geol. Mag., Vol. III., pp. 356 and 406, Plate XIV.)

The species first appears in the flaggy beds of the May Hill Sandstone in the Gullet Wood, near Eastnor Obelisk, above the purple sandstones, as a mould, and in this condition appears to be identical with the *Petraia quadrata*, McCoy, from the Upper Silurian rocks of Ireland (Sil. Foss. t. 4, f. 18). The tunnel specimens are from the shales interbedded with the Woolhope limestone, or base of the Wenlock Shale; but the specimen referred to in Mr. Davidson's note appears to belong to a higher position in the series, for if by "Upper Wenlock Shales" it is intended to indicate the shales above the limestones, these shales, notwithstanding the Wenlock aspect of their fossil fauna, are considered on good authority to belong to the base of the Ludlow series.

There is nothing like an operculum to any of the Malvern specimens.

Believe me, dear sir, yours very truly,

Harvey B. Holl.

Worcester, *August 4th.*

EOZOÖN IN BOHEMIA AND BAVARIA.

Dear Sir,—In your Magazine for July there is, in the article "Eozoön in Bohemia and in Bavaria," the following passage:—"Dr. A. Fritsch has found Annelid-marks in this Grauwacke at Przibram; and Dr. Reuss has detected Crinoidal and Foraminiferal remains in a limestone equivalent to the above near Reichenstein."

This remark contains several errors,[1] which I beg leave to correct.

1. The Annelid-marks are not found at Przibram, but in the dark blue "Kieselschiefer" at Labkovitz, at Skrej, and in the Scharka valley, near Prague. This Kieselschiefer belongs to the Przibram schists. (*Barrande's Etage B.*)

2. The Crinoidal and Foraminiferal (?) remains are not detected by Professor Reuss, and not found near Reichenstein, but I found them myself in September, 1864 and August, 1865 in the black limestone at Pankratz near Reichenberg. This black limestone, which belongs to the range of the "Teschkengebirge," lies between Phillits, and its age is still very doubtful, its external appearance most resembles Mountain Limestone. The Crinoids have a nice

[1] Introduced partly by Gümbel, partly by T. R. J., translator.—A. F.

5-radiate star in the centre, some have only a round spot. The second kind of fossil is a snail-like irregular spiral of 1″ diameter, and its foraminiferal character is still very doubtful. Both will be very soon figured and described.

Yours truly,

ANTON : FRITSCH, M.D.

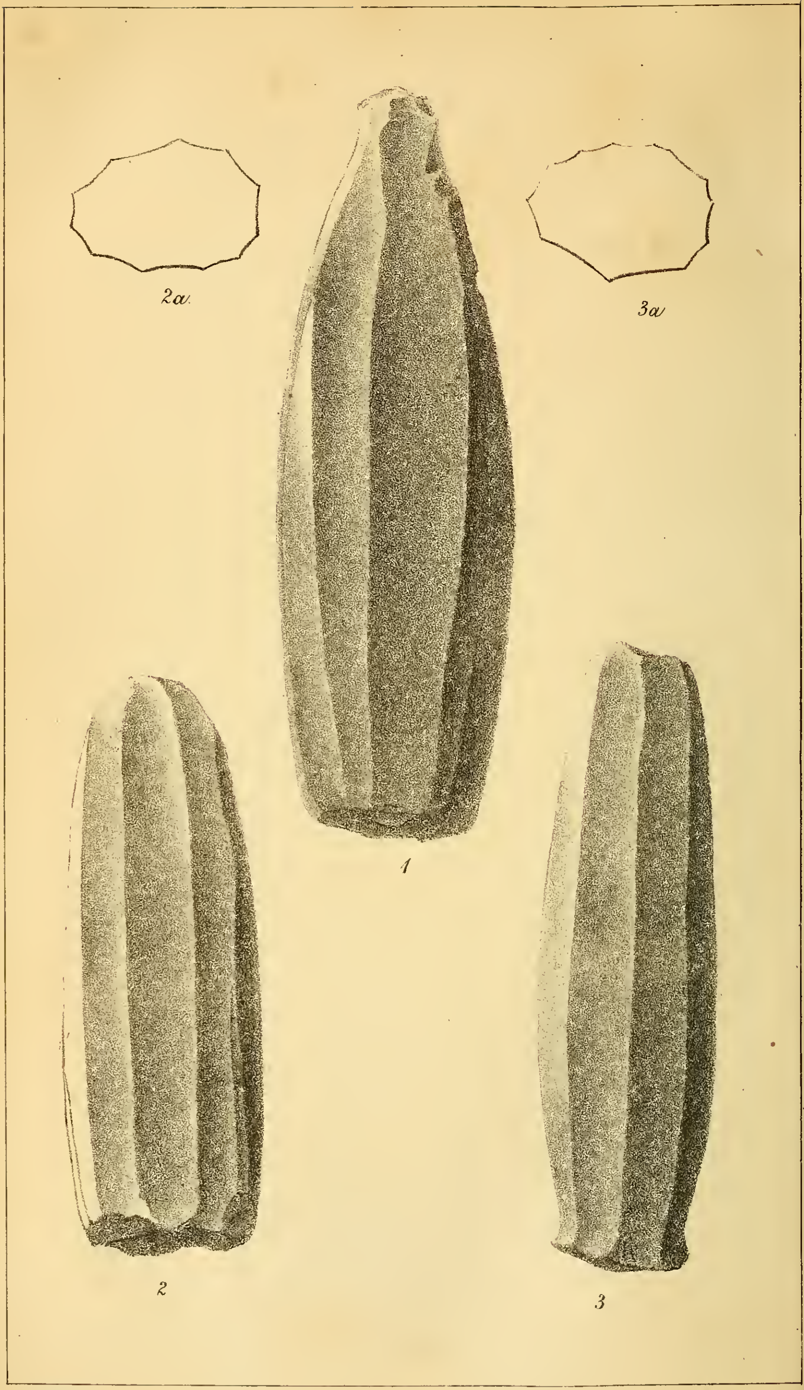
ROYAL BOHEMIAN MUSEUM,
PRAGUE, *July*, 1866.

MISCELLANEOUS.

CHLOROPAL IN CORNWALL.—Professor A. H. Church announces in the *Chemical News* (August 10th), that "Chloropal occurs abundantly in a granite quarry close to an old tin-mine known as Carclase. This mine (Wheal Ludcote), now worked mainly for China-stone and China-clay, is not far from St. Austell, in Cornwall. The Chloropal occurs with fluor in the fissures of the granite, and resembles that variety of Chloropal which has been termed "gramenite," from Menzenberg, near Bonn."

CRYSTALLIZED STEPHANITE AND ARGENTITE FROM CORNWALL.—On a specimen of indistinctly crystallized Argentite associated with filiform Native Silver, from an abandoned mine, the Wheal Ludcott, near Liskeard, Cornwall, I have observed some very characteristic crystals of Stephanite, the Melan-glanz of the Germans. The crystals are very brilliant and in short prisms about 1½ lines long by 1 thick. Colour black, like Iron-glance; streak black; before the blowpipe, on charcoal, yields no perceptible trace of Arsenic, but deposits a sublimate of Oxide of Antimony; and with borax, yields a globule of Silver. Though found in comparative abundance in some countries, it has not hitherto been recorded as occurring in a crystallized state in the British Isles, but is said to have been found massive and pulverulent at Wheal Duchy and Herland, in Cornwall. In the same locality specimens of Argentite have been found crystallized in well-defined cubo-octahedrons, nearly half an inch in thickness. These are by far the largest crystals of this mineral yet discovered in Britain. T. D.

DR. GREVILLE'S DIATOMACEÆ.—The extensive collection of *Diatomaceæ*, belonging to the late Dr. Greville, together with all his notes and drawings, has become the property of the Botanical Department of the British Museum. It includes the specimens of the Recent and Post-tertiary species described by the late Professor Gregory, many of which are very obscure. Added to the type-collection of Professor Smith, the original monographer of this tribe of British plants now in the Museum, it will make the National collection invaluable to every student of the *Diatomaceæ*.



E Fielding, Lith. F. Waller Imp.

FLINT CORES FROM THE INDUS

THE

GEOLOGICAL MAGAZINE.

No. XXVIII.—OCTOBER, 1866.

ORIGINAL ARTICLES.

I.—On some Flint-cores from the Indus, Upper Scinde.

By John Evans, F.R.S., F.S.A., Sec. G.S., etc.

(PLATE XVI.)

THE following letter has been forwarded to me with a request to make a few remarks upon the flint-cores mentioned by General Twemlow:—

To the Editor of the Geological Magazine.

Sir,—With reference to the letter of A. B. Wynne, Esq., F.G.S., of the Geological Survey of India, in your number of 1st June, 1866, it may interest him and his colleague, W. T. Blanford, Esq., F.G.S., and perhaps the scientific public generally, if you would undertake to delineate and describe the three remarkable fossils herewith sent.

They have just been brought to me (Overland), sent by my son, Lieut. Edward D'Oyly Twemlow, of the Royal Bombay Engineers, and were found by him "*three feet below the rock in the bed of the river*" (Indus) where he is superintending excavations connected with a canal, near Shikarpoor, in Upper Scinde.

I shall be happy to present the specimens, after they have been described, to the Ethnological Department of the British Museum.

I am, Sir, yours faithfully,

George Twemlow, Major-General, R.A.

Poyle Lodge, Guildford.

The interest attaching to the flint-cores or nuclei, figured on Plate XVI., rests principally on the beautiful regularity of their form, and the circumstances under which they have been discovered. The process by which flakes or knives of flint are produced has been so often described that it is needless here to enter into any of its details. It will be enough to observe that such flakes or knives, being chipped off in succession from a mass of stone, there must in all cases remain, after the process is completed, a block, showing the facets from which the last flakes dislodged have been struck off.

Where the process of chipping off flakes has been carried on successfully all round the block, the resulting core or nucleus will present a polygonal outline, with slight depressions at the upper end of each facet, showing what may be termed the "impressions" of "the bulb of percussion," due to the blow by which each flake was dislodged. In the Plate the cores from the Indus are represented with the upper end, or that at which the blows were administered, downwards, but the "impressions" of the bulbs of percussion are well exhibited in Fig. 3.

To strike off from a large block such a number of successive flakes as to leave merely an elongated polygonal nucleus, it is of course necessary that the material of the block, besides splitting readily from a blow, should be perfectly homogeneous in texture. With ordinary chalk flints this is rarely the case; and even for the gun-flint manufacture, where the form of the flakes is not of so much importance as if they were destined for knives, great care is taken in the selection of the flint, and in keeping it uniformly moist. The best material which has been used for the manufacture of siliceous knives is obsidian, which, so late as the days of Cortes, was used in Mexico for this purpose, and even for razors, two of which, however, were used up in shaving a single person.[1] Some of the obsidian cores from Mexico approximate very closely in form to these from India. One of them may be seen engraved in Tylor's Anahuac, p. 98. The flint from which the specimens now under consideration are formed, is of a light fawn colour, of the same character as that from which the implements from the laterite-beds, described by Messrs. Foote and King, have been fashioned. If, as is not improbable, it partakes more of the nature of a quartzite than of a real flint, its original arenaceous origin may have conduced to that homogeneity which is so essential to uniformity of fracture. In the case of the flint-cores and flakes from the neighbourhood of Jubbulpore, of which I communicated an account to the Society of Antiquaries, the material was principally chalcedony, and the cores, though most symmetrically formed, were much smaller.

The finding of such relics "three feet below the rock in the bed of the river" Indus would, at first sight, point to a great antiquity, even geologically speaking, for them. But further details are necessary as to the character of this rock before any definite conclusions can be safely come to on this point;[2] and certainly, judging from the

[1] In the Mineralogical and Geological Gallery of the British Museum (Room III., Table-case 45) is exhibited a very beautiful and slender Obsidian core from Mexico, agreeing closely in general form with those figured in Plate XVI. It is one of the "Cracherode Collection," and is thus described by the donor:—"Obsidian; Black Volcanic Glass; remarkable for breaking into Prisms; this has 14 sides. From Peru, where they make mirrors of it. Magellan's Cronstedt, p. 917; Kirwan, vol. i. p. 264; Babington, p. 9, sp. 24." [Cracherode Catalogue.] There are besides three flakes and numerous examples of Obsidian in its unwrought state, both from Iceland and Mexico. Many other specimens of cores and flakes in Obsidian and Flint are exhibited in the Ethnological Department of the British Museum.

[2] In a subsequent letter to the Editor, General Twemlow states that neither chalk nor flint are found near the spot where the flint-cores were embedded, and that the rock is a Limestone.—H. W.

form alone, I am inclined to ascribe them to the "neolithic" rather than to the "palæolithic" period of India, whatever value these terms may have when applied to that part of the globe.

EXPLANATION OF PLATE XVI.

Figs. 1–3.—Flint cores, or nuclei, discovered three feet beneath the bed of the river Indus, near Shikarpoor, in Upper Scinde, by Lieut. Edward D'Oyly Twemlow, of the Royal Bombay Engineers. (Two-thirds natural size.)

Figs. 2*a* and 3*a*.—End-views, exhibiting the polygonal form of the nuclei.

II.—Notes on the Physical Geography of East Yorkshire.[1]

By William Topley, F.G.S., Geological Survey of Great Britain.

THE district of Cleveland, long known for the beauty and variety of its scenery, has during the past few years acquired great importance through the discovery of valuable beds of iron ore in the Middle Lias. So much has been written on this district, and in a lesser degree on East Yorkshire generally, that the geological structure of this country must be tolerably well known.[2] My object then is not so much to describe the beds as to give some notes on the physical geography of the country, explaining the relation of its present surface outlines to its internal structure, and to enquire by what means those external features have been produced.

It may appear presumptuous on my part to attempt this after the very able treatment the subject has received from Prof. Phillips in a work devoted, in part, to this question.[3] But I venture to think that the origin of the present scenery of Yorkshire is due, in the main, to subaërial denudation, not to marine action as stated by Prof. Phillips.

The characteristic features of Yorkshire are shown by a glance at its river courses. These run in a general direction from the north and west to the south and east. This is therefore the direction of the general slope of the ground, and corresponds with the *dip* of the beds beneath. The Vale of York, stretching uninterruptedly from the Tees to the Humber, forms a well-marked boundary between the Secondary rocks on the east and the Palæozoic rocks on the

[1] Read before the British Association at Nottingham, August 24th, 1866.

[2] See especially—

Young and Bird, Geological Survey of the Yorkshire Coast, 4to. 1822.
Winch (N. J.) Observations on the Eastern parts of Yorkshire. Geol. Trans. 2nd Series. Vol. V. p. 545.
Phillips (J.) Illustrations of the Geology of Yorkshire. 4to. Vol. I. 1829.
" Geological Map of Yorkshire. 1853.
" Manual of Geology. Ed. 1855.
" Quart. Journ. Geol. Soc. Vol. XIV. (1858) p. 84.
Marley (J.) Trans. N. of Eng. Inst. of Mining Engineers. Vol. V. (1857) p. 165.
Bewick (J.) The Cleveland Ironstone. 8vo. 1860.
Pratt (C.) Geologist for 1861, p. 81.

[3] Rivers, Mountains, and Sea Coast of Yorkshire. 8vo. 1853.

west. It is composed of Permian and New Red strata thickly covered with Boulder-clay and gravel. The secondary beds on the east crop out in a series of escarpments; their scarped edges being presented towards the north and west, while the gentler slope, or "dip slope," falls towards the south and east. The chalk, as the highest secondary bed, occupies the south-eastern corner, and rising as a bold escarpment from the Vale of Pickering (Speeton and Kimmeridge clays), sweeps round to the west and south, overlooking the Vale of York. The Lower Secondary beds rise from beneath the Chalk, their scarped faces likewise facing northwards. These owing to a great unconformity, do not pass south parallel to the Chalk. The escarpment of the Lias however is almost continuous from the Tees to the Humber.

The scarped hills of Cleveland (Lias capped by Inferior Oolite) are highly picturesque. The Oolitic capping weathers into a steep face overlooking a more gentle slope of Lias shale. The bare rugged top of Rosebury Topping and the top of the escarpment seen south-west from Guisboro' are examples of precipitous Oolitic[1] cappings.

These escarpments, in common with all analogous hills in England, have this striking character. The same bed, or its representative, crops out at about the same height of the escarpment all along its course. Thus, in the North Cleveland hills, the "Ironstone and Marlstone series" crop out some way down the side, and the hills are capped by the same bed of Sandstone (Inf. Oolite). In other words, these escarpments *run along the strike* and their scarped sides *face the dip.* Thus, if the beds are dipping to the south the scarped side will face the north, and the escarpment will run east and west. Now, how can this fact be accounted for if these escarpments are old sea cliffs? To learn what a Lias sea cliff is like we have only to examine the present coast line of Cleveland. Here the beds are seen to dip in the cliff section, and therefore the cliff is not formed along the strike. Moreover beds are seen to dip one under the other and disappear, so that a cliff section at one place may give a set of beds quite different from another section taken a few miles off. Thus, 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.[2] Such is never the case with an inland escarpment. This presents the same set of beds throughout its entire length. Now, since "escarpments" run along the strike, whilst the present sea cliffs rarely or never do, it would seem that we must no longer look to marine action as the mode of formation of these escarpments. They are assuredly not "river-cliffs," since rivers by no means always run parallel to them or even near them. There remains then only pure subaërial agencies to account for them. This subject has already been written upon by Mr. Jukes,[3] Prof. Ramsay,[4] Mr. Geikie,[5]

[1] The Inferior Oolite here is a Calcareous Sandstone. ("Dogger.")

[2] This is well shown in the coast section appended to Prof. Phillips' "Geology of Yorkshire." Vol. I.

[3] On the River Valleys of the South of Ireland. Quart. Journ. Geol. Soc. Vol. xviii. (1862.) p. 378.

[4] Phys. Geog. and Geology of Great Britain. 2nd Ed. 1865, p. 81 *et seq.*

[5] Scenery and Geology of Scotland. 1865. p. 138.

and by Dr. Foster and the author.[1] To these various publications I would refer for a fuller discussion of the question, merely noting now the general principles involved.

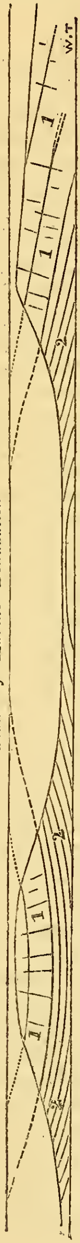
The sea, wherever we now see it at work, exerts a *levelling* power, planing off to a more or less uniform slope the various beds which come within the range of its breakers. This forms what Prof. Ramsay has called a plain of marine denudation.[2] Vast masses of rocks have thus been swept away, often far exceeding in amount those subsequently removed by atmospheric agencies. Now, since we know that the beds have been *unequally upheaved*, proved by their present dip, the action of the breakers would plane off the various beds as they successively came within its range. Hence the resulting plain of denudation would present a succession of beds cropping out along its surface. Of these, some would be hard, some soft: the former resisting atmospheric denudation would stand out as escarpments; the latter would weather into *longitudinal* valleys. The surface drainage of this area would collect into streams joining eventually into main rivers running down the main slope. This will usually be the dip slope, because the line of greatest upheaval will be the line of strike and will determine the direction of the marine plane of denudation. Thus originate the *transverse* valleys which cut across escarpments. These two kinds of valleys can be well studied in the Weald and the bordering chalk country. I think the Humber is a transverse valley of this description; it corresponds to the main channel of the Medway where the latter cuts through the Greensand and Chalk on its way to the Thames. The Ouse with its tributaries the Swale and the Ure, coming from the Vale of York and the Lias hills, correspond to the Eden and its tributaries in Kent. The Derwent, rising far within the Oolitic country and running in a direction opposed to the general dip, corresponds exactly to the tributary of the Medway which rises near Ightham and runs down past Plaxtole and Hadlow into the Weald Clay valley to join the main river. The beautiful valley of Eskdale begins *within* the Oolitic country and runs with the general dip. Its river has excavated a channel through the harder Oolite which forms the steeper part of its slopes down to the Lias below. Eskdale corresponds to such valleys as the Cray and Little Stour in Kent.

If the present valleys were all made by the sea we might expect that they would always drain into the sea by the nearest way. But this is by no means the case. The upper branches of the Derwent rise close to the sea near Filey, and again near Robin Hood's Bay; but they drain *inland*, and after a long course reach the sea by the Humber. Again the river Wiske which rises up in the moors near Osmotherly runs down towards the Tees for about eight miles of its course, and at one place approaches it within 1½ mile, then turning south it runs past Northallerton into the Swale, and finally, after

[1] On the Medway Gravels and Denudation of the Weald. Quart. Journ. Geol. Soc. Vol. xxi. 1865. p. 470.

[2] See a paper on the Physical Features of Cardiganshire. Brit. Assoc. Reports. 1847. Trans. Sects. p. 66; also *Op. cit.* pp. 79 *et seq.*, p. 139.

traversing the whole length of the Vale of York, its waters are carried into the Humber. Many such examples might be given in other districts.[1]



SYNCLINAL HILL AND ESCARPMENT.

Plain of Marine Denudation

1 1. Hard bed (Sandstone or Limestone). 2 2. Soft bed (Clay).

The connection between the internal structure of a district and its physical geography is well illustrated in the case of isolated hills separated from the main mass of a formation. These have very commonly a *synclinal* structure, the beds dipping into the hills on most sides. Every hill of this kind may be considered as an escarpment returning upon itself, constantly changing its direction as the dip changes. The picturesque hills of North Cleveland are synclinals. This is plainly seen when looking south from Redcar at Eston Nab and Upleatham Hill. The Middle Lias is here worked for Ironstone, and the waste heaps on the hill sides shew the dip of the beds. Mr. Marley, in his paper already referred to, gives a section which shows the same arrangement in a transverse direction, so that the beds composing these hills dip on all sides *into* the hill, and the sides are all somewhat steeply scarped.

It is evident that such hills retain their form because of this synclinal dip, in the same manner that an escarpment, with its beds dipping *into* the hill, retains its steep slope. If the beds dipped in the reverse direction the sharply scarped face could not long be retained, as in the process of weathering masses would slip away and slide down with the dip.

This tendency of hills having an inward dip to resist atmospheric degradation and thus preserve their form has been pointed out by Mr. Ruskin in his "Modern Painters,"[2] and by Mr. J. P. Lesley in a little book on "Coal and its Topography."[3] Many examples of synclinal hills and conversely of anticlinal valleys might be given. Thus Mr. Hull, in describing the Physical Geography of the Cotteswold Hills, says,[4] "the anticlinals have produced *lines of weakness*, originating valleys; and the synclinal *lines of strength*, originating headlands." Mr. Geikie has noted similar facts in Scotland. He says,[5] "Ben Lawes is in reality formed of a trough of schists, while the valley

[1] See Ramsay, *Op. Cit.* p. 80.

[2] Vol. IV. "Mountain Beauty." 1856. Chap. xiii., xiv.

[3] 12mo. Philadelphia, 1856. Chap. iii. "Topography as a Science."

[4] Quart. Journ. Geol. Soc. Vol. XI. (1855) p. 483.

[5] Scenery and Geology of Scotland. (1865) p. 96.

of Loch Tay runs along the top of an anticlinal arch. Hence that which in geological structure is a depression, has by denudation become a great mountain, while what is an elevation has been turned into a deep valley." Mr. Whitaker informs me that detached hills in the London Tertiary country have very commonly this inward dip; so too have the Tertiary hills west of Canterbury.

I venture to call the attention of geologists to this generally *basined* or synclinal forms of detached hills. There is no reason, if hills and valleys are due to marine action, why the hills should be synclinals and the valleys sometimes anticlinals, since the sea where we now see it at work pays no regard to dip and strike.

Postscript.—Although not immediately bearing upon the district described in the foregoing paper, I should like to call attention to a work by Mr. William Wallace,[1] in which the structure of the Alston Moor district, and the Tyne valley generally, is described. The author clearly recognises the power of rain and rivers in excavating valleys, and also that marine action had previously, and during the upheaval of the country, largely denuded the beds. I subjoin a few passages from this interesting work (pp. 45, 48): "It is difficult to resist the inference that the bed of the Tyne river above Alston must have been some 200 feet higher than at present." "There are less clear indications of its having occupied still higher positions." "As the river deepened its channel, and the sides of the hills were decomposed and carried away by pluvial agency, all marks of ancient river beds must have been destroyed." ". . . . the sheets of strata, which once stretched from the more elevated sides of the mountain across the valleys far above the bed of the present stream, were gradually removed by the action of the waves and currents of the sea; and further, that previously the strata had been thrown out of their original horizontal position, the erosion being regulated by those portions which were most elevated, as the range of the Pennine mountains, and by the anticlinal axis stretching from the summit of Cross Fell to the sources of the Tyne, and from there north-eastwards to Kilhope Law. The exact point, however, where breaker action ended, and the erosive action of the streams now flowing in the country began, is not, perhaps, determinable."

III.—Notes on the Comparative Structure of Surfaces produced by Subaërial and Marine Denudation.

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

The article by Mr. Mackintosh on "The Cliffs, Gorges, and Valleys of Wales," in the September number of the Geological Magazine, raises so many questions in opposition to the views I endeavoured to support in the previous number, that I venture to offer

[1] "The Laws which regulate the deposition of Lead Ore in Veins." 8vo. 1861 Chap. ii. "Elevation of the Strata and Denudation of the country."

a few further observations on some of the more salient points in which Mr. Mackintosh differs from the advocates of subaërial denudation. Let me, however, in the first place, admit with him the full belief by subaërialists in the existence of numerous evidences of the coast action of the sea over the land surface. The most superficial observer must at once detect in the drift-covered surface and terraced outlines of much of the dry land, the existence of former progressive coast lines of sea erosion over almost the entire surface; indeed, it is this very palpable evidence of the tooth of the sea on the land and its strongly marked character, by which the advocates of subaërial denudation believe they can distinguish between the work of the sea and the denudation performed by rains and rivers, and that the surface erosion performed by the sea has been so trifling as to scarcely interfere with the general structure of surface brought about by subaërial agency.

Valley Excavation produced by Marine Currents directly assailing the Coast (?).—The assumption that coast indentations and valleys may be the result of marine currents directly assailing the coast, though easily disprovable in principle, is also capable of being tested by the facts of the cases brought forward in illustration. The advocates of subaërial denudation hold that marine inlets and valleys running up from the coast are the result of the submergence of land previously moulded by rain and river action, and believe that small local currents, having the power to perform the work attributed to them, and the persistency to perform it on a particular spot, could never have existed. In long narrow channels, such as the fjords of Norway, it is not unusual to find two narrow inlets opening out of the main channel exactly opposite each other, implying on the marine theory of excavation, the existence of currents striking from the same point in exactly opposite directions. A glance at the map will at once show that the Norwegian inlets are merely the seaward prolongation of valleys that have their origin close to the Scandinavian watershed. If, as I shall presently endeavour to show, the sea does no material work below the tidal range, and that the excavation must therefore have been done on its coast outline, how are we to account for the persistency of points of resistance and points of erosion (and these quite independent of the structure of the rock) on the line of the fjords and their valley prolongations through such an immense range of altitude? Is it not obvious that the complete change of coast outline involved in such an oscillation of level must have repeatedly changed and disarranged the course of such assumed local currents? It is a very suggestive fact that this singularly indented coast is now undergoing a change of level—may it not be recovering itself from a submergence which caused the sea to run up the valleys that were cut out by subaërial action on a land surface of greater elevation than the present?

Along the indented west coast of Ireland it is well known that currents do not directly assail the coast, but that the Gulf Stream here takes a grand sweep to the N.E. almost parallel with it.

In the case of the Aber valley, cited by Mr. Mackintosh as an example of marine excavation, the eroding current must have been perfectly constant in its exact location and direction during a range of coast elevation or depression of at least 1200 feet, and you must assume that there were five or six such independent currents within as many miles to form the other similar indentations along the neighbouring coast. In connection with this locality another grave difficulty presents itself: you are not in the open sea, but the valleys opening into the coast deböuch into the mouth of the Menai Straits, up and down which a strong tidal current is constantly running transversely. The Isle of Anglesea rises opposite within a few miles to a height of more than three hundred feet, and must always have formed a barrier against the sea directly assailing the point now occupied by the Aber valley, to, at least, the extent of its present height. Now, even if the possibility is admitted of a current assailing the coast at Aber, when Anglesea was beneath the sea, how are we to account for the excavation of the valley to the extent of two or three hundred feet below the level of the top of the opposite island-barrier? These are only a few of the many local instances in which the theory of marine currents is easily shown to be inapplicable, but the whole assumption that currents, whether of wind or water, can move up and take effect at the extremity of a *cul de sac* is fallacious; you may as consistently assume a power to make the smoke pass up a chimney with the top closed; *there can be no motion without a thoroughfare.* This may be familiarly illustrated by the impotence of the wind to enter an open window when the door of the room is closed, but only make an outlet for the wind and its power through the room is at once asserted.

On the Diversion of Watershed Lines and River Channels.—In connection with the existence of transverse gorges, and the passage of river channels through high land and mountain chains, it is important to bear in mind the *extreme antiquity of the general structure of the present hill and valley system;* on the first emergence of a sedimentary deposit from the sea under which it was formed, the subaërial waterflow begins to take up a definite position, and this may in the first place be determined by the most trifling inequalities of surface. The slightest elevation will throw off the rain, and river channels will begin to be formed in the faintest depressions; the water *must* find an escape and it will leave the higher and find the lower ground, however trifling the difference in height may be. We must thus look for the initiation of the present watershed and waterflow systems in the very earliest history of the emergence of the new-made land, and when once formed they will maintain, under uniform circumstances, their original positions.

The want of correspondence between river channels and the general valley contour of a country, although not unfrequent, must be looked upon as purely exceptional, and attributable to special circumstances that have supervened since the land surface received its first impress of watershed and valley systems. Among the causes tending to the diversion of river channels may be enumerated, fracture or the opening of rents, drift accumulations, damming up valleys and diverting the waterflow, and the alteration of the lie of the ground through local dislocations, upheavals, and depressions, the whole of the causes may have been going on in every variety of degree, working in unison or conflict, ever since the land surface received its first impress of hill and valley contour, and may have produced a variety of exceptions to that regularly graduated contour resulting from the accumulative waterflow over the land surface. May not also some connecting gorges and transverse valleys possibly be the fragmentary remnants of sets of watersheds and valleys that were first initiated on other surfaces than that on which the prevailing hill and valley system had its origin ?

It is impossible to limit the persistency of a set of valleys and watersheds that have never been interrupted by the diverting causes before referred to, or that have not been covered up by superincumbent formations; let us, however, consider the case of an old land surface diversified with watershed ranges and river valleys buried beneath an overlying deposit. The deeper depressions of the buried surface would, as shown in Figure 1, to a certain extent reproduce

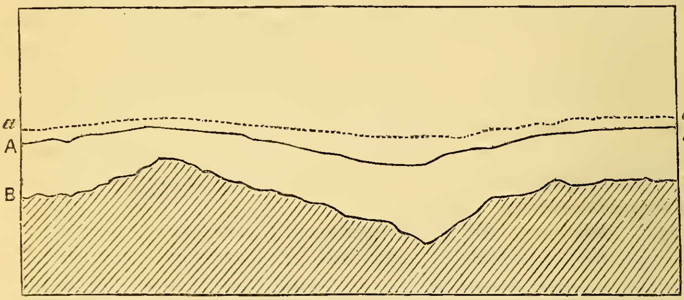


Fig. 1.—Exhibiting partial conformity of New Deposit to the sujbacent Ancient Contour.

themselves on the contour of the new deposit *a a*, and the consolidation and subsidence[1] (represented by the space between the line A A and the dotted line *a a*) of the thicker parts of the new deposit being greater than that in the thinner parts over the higher ground, would still further cause the contour of the ancient surface to be

[1] From observations I have made on the contraction of clays and other materials in drying, it appears probable that strata newly deposited passing from the degree of wetness whilst submerged to a comparative state of dryness on emergence, would contract about as follows :—

Clayey strata from 8 to 10 per cent. of original bulk;
Sandy „ 3 to 6 „ „

Even supposing that the new superimposed deposit was completed with a perfectly level surface, and did not follow in any degree the irregularities of the subjacent contour, the thicker parts over the deep valleys would have a greater amount of contraction than the shallow parts over the higher ground, and thus tend to the reproduction of the general form of the old ground (though with less strongly marked irregularities of outline), and the principal lines of old waterflow and watershed on the new surface.

roughly reproduced on the surface of the overlying deposit. This following of the irregular basement line, in superimposed beds, is well shown in Figure 2, representing a section on the Bristol and

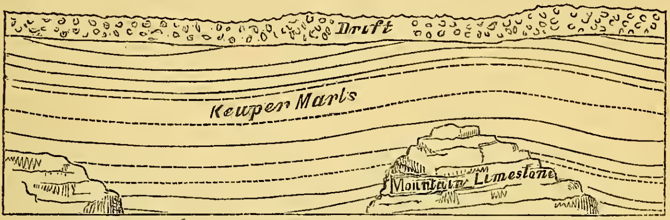


FIG. 2.—SECTION NEAR THE BOURTON STATION ON THE BRISTOL AND EXETER RAILWAY.

Exeter Railway, near the Bourton station, six miles from Bristol, where the Keuper Marls dip away in each direction at an angle of from 4° to 6° from the bosses of Mountain Limestone over which they were deposited. It seems probable that the main valleys and lines of waterflow of the ancient buried surface would impress their outline through a considerable thickness of superincumbent deposits and thus determine the direction of the principal watercourses on the new surface; occasionally the new watercourses would be diverted from the ancient buried lines of waterflow by adventitious irregularities of surface, especially in the case of the shallower valleys, *and it is in these that many of the cross cut valleys and transverse gorges appear to have been initiated.*

Referring to Figures 3, 4, and 5, representing a series of valleys

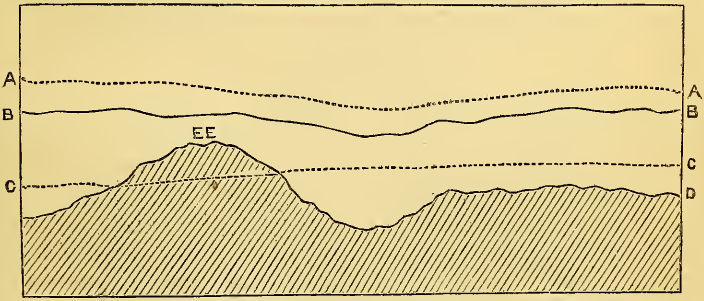


FIG. 3.—TRANSVERSE SECTION OF ANCIENT VALLEY SYSTEM. LONGITUDINAL SECTION OF SUPERIMPOSED SYSTEM.

superimposed *in part uncomformably* over an ancient buried series, let us suppose the superincumbent deposit A A to be gradually denuded by subaërial agency, the main lines of waterflow will simply re-excavate and perhaps somewhat alter the old buried valleys over which they are conformable, *but wherever the upper system of valleys* C C *runs transversely* (as in Fig. 3) to the buried system the separating ridges, as at EE, Fig. 3, or CC, Fig. 4, will be cut through; denudation may proceed over ridge and valley, and gradually lower the entire surface to F F, after having removed the whole of the newer deposit, *and will impress on the old deposit a contour partaking of that of both*

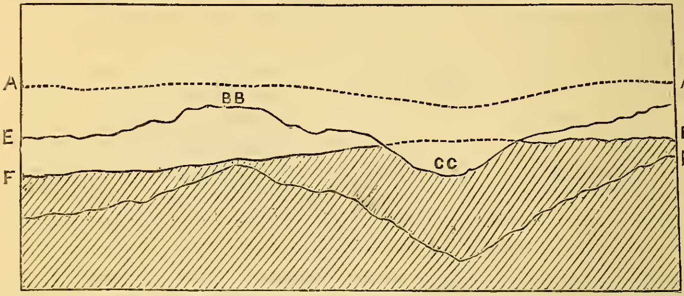


FIG. 4.—LONGITUDINAL SECTION OF ANCIENT VALLEY SYSTEM. TRANSVERSE SECTION OF SUPERIMPOSED SYSTEM.

the old and new surfaces, the association of the general system of valleys with transverse gorges having had their origin on different surfaces and which could not be accounted for on any single simple system of waterflow.

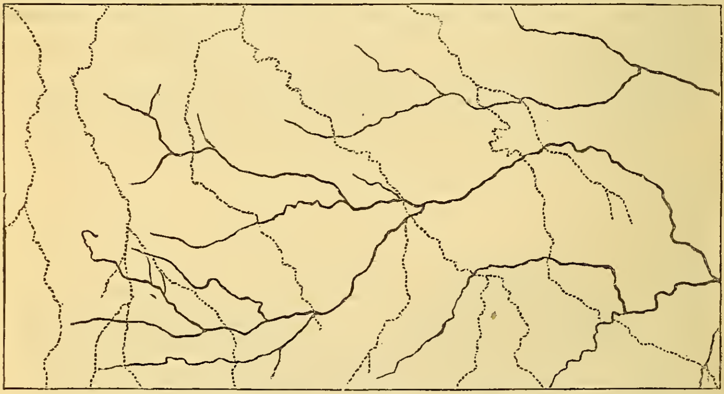


FIG. 5.—The dotted line represents the ancient buried Watercourses, and the dark lines those on the new overlying surface.

The unequal resistance of old and new deposits may also introduce complicated systems of contour; for instance, in the case of the valleys in the softer upper deposit (CC, Figs. 4) running transversely to the ridges of the older underlying formation, the transverse ridges would be gradually cut through, and, as the level of the older valleys was approached, an outlet would be formed for the progressive excavation of the softer deposit filling them up, and the old valleys would be restored, connected by the transverse gorge which played so important a part in their re-excavation. If a progressive series of land contours superimposed on new surfaces of deposit are enabled to faintly transmit, *in part,* their structure upwards (see Figs. 1 and 2) to succeeding surfaces, each surface differing in its details from that which precedes it, a complex structure of surface would be gradually accumulated, the individual changes of surface being lost in the denudation of surface through the superimposed strata, and the accumulated result impressed on the single fresh denuded surface (F F), of the older formation.

"V"-*shaped Gullies and Vertical Gorges.*—The sudden transition that frequently takes place between the form of the immediate water channel and that of the main valley containing it, is I think capable of a satisfactory explanation compatible with a common cause. In

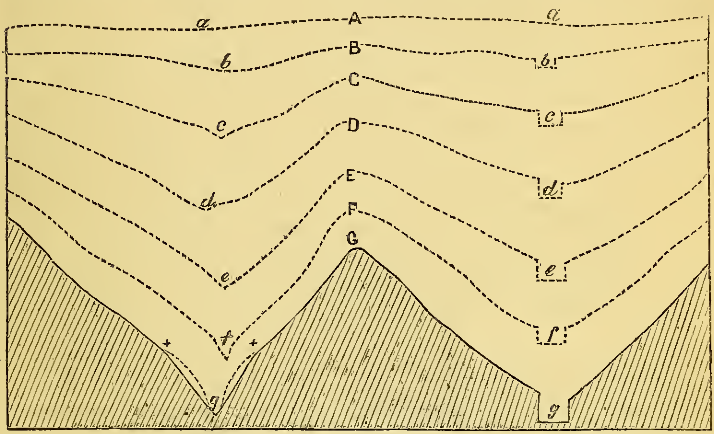


Fig. 6.

nearly all the mountainous valleys of Wales the immediate water-channels are bounded by either vertical cliff-sides (as in the Aber valley, and by the way, here you have a fine example of cliffs produced by river action) or by steep sides having a regular and uniform slope, and in both cases joining into the general contour of the valley by a hard and well-defined outline. It must be borne in mind that on the theory of subaërial denudation as illustrated in Fig. 6, not only the amount, but the rate of excavation is greater towards the bottom, than the confines of a valley towards the watershed; near the watershed you have nothing but the rain that falls on the spot, but as you proceed downwards a progressive concentration of water and consequent power of excavation takes place, and in the actual water-channel at its base there is a kind of force in its erosive intensity which is unlike in its effect that of water distributed over the surface. The progressive modification of the contour will be represented by the succession of dotted lines in Fig. 6. The waterflow depression being lowered at a greater rate than the watershed, the tendency towards the vertical will first commence at its very bottom.

Now nearly all materials have what is called an angle of repose, and will fracture or slip off as soon as their inclination attains to within a given number of degrees of the perpendicular. Some very solid rocks will we know stand with almost vertical sides, and in such rocks running water will scoop out a vertical trough as indicated on the right hand side of Fig. 6, and of this structure examples occur on the Rhone a few miles below Geneva, on the Rhine in its passage through the Via Mala, and on a smaller scale in the Aber valley; but in the great majority of cases softer strata and rocks abounding in a variety of lines of jointing, cleavage, and bedding will find an angle of repose like any loose material, though at a steeper pitch; *the sides at the very bottom of the valley, especially where there is quick running water, will first exceed in their slope the angle of repose of the rock,* and the result will be the breaking down and sliding off of the sides up to a hard angle, as at * on the left hand side of Fig. 6. At first this may be to no great extent, but as the stream deepens its course downwards the confines of the slipping sides will proportionably recede upwards, and a large V-shaped valley be produced, having apparently no harmony or community of origin with the more rounded outline of the valley in which it is placed. The mountains of Wales afford an almost endless number of illustrations of the variety of effect produced by the different degrees of concentration of the waterflow, and the various combinations of the several kinds of outline brought about by subaërial denudation. In some localities the V-shaped gully is but a subordinate feature in the general rounded outline of the valley. In other places the angle of repose will run up to the crest of the watershed, producing a steep gorge with straight sloping sides, and here and there the vertical cliff will, from variation in the structure of the rock, boldly stand out from the straight slope of repose.

The Aber Valley.—In the earlier part of the article I have endeavoured to point out the difficulties that the *position* of this steep valley present to its having been excavated by a marine current directly assailing the coast, and there are certain points in its structure that also militate against the possibility of its marine origin, the most obvious being that it is a complete *cul de sac* affording no thoroughfare for the passage of a current. At about three-quarters of a mile from its mouth the valley splits up, and on the face of the headland separating the two divergent branches which above all other parts would have received the full force of the sea, there is no appearance of any escapement, indeed the sides of the valley throughout, except at its very end, exhibit that graduated contour which appears to be characteristic of subaërial denudation. At the extremity of the left hand fork of the right hand branch below the waterfall a delta like mass of drift occurs, partly filling up the valley; it is evident that its deposition could not have been contemporaneous with the excavation of the valley, as denudation and deposition cannot go on simultaneously on the same spot. The general disposition of the mass appears as though it was deposited when the valley was partly submerged, the debris having been brought down by the stream above the waterfall, and through this delta-like heap the stream has cut a deep winding channel since the emergence of the land. At the end of this main branch of the valley, a little below the waterfall, the stream divides, each of the branches of which flow from a short *cul de sac*, the main branch to the left over a boss of Porphyry with a steep cliff-like front; it is, however, not a true cliff produced from below, but a very steep sloping mass resisting the cutting power of the stream, the level of which above and below it represent the relative rate of degradations of the Porphyry and Silurian rocks, the Porphyry appears to be metamorphic, and graduates into the slates and shales, with which gradation of material the relative steepness of the valley sides exactly correspond, the portion bounded by the Porphyry being the steeper of the two; the small branch of the valley on the right hand side just misses the Porphyry and here the cliff-like form is lost, and the little *cul de sac* graduates upwards to the watershed like the remainder of the valley. Now if the cliff-like contour of the left hand branch had been produced from below by the erosive action of the sea, would not the softer Silurian strata have been the more easily assailed? and why has not the whole valley that cliff-girt outline which we know the sea produces? There is nothing in the nature of the rock to prevent it standing in the form of a cliff, for the immediate channel of the stream consists of a gorge with vertical sides from 30 to 50 feet deep, the whole valley (except the immediate river channel), although rather steep in its conformation, has a graduated sloping contour, and there is no reason why the sea should have singled out high up the valley a little spot to leave its characteristic mark upon, whilst the more salient parts were left untouched.

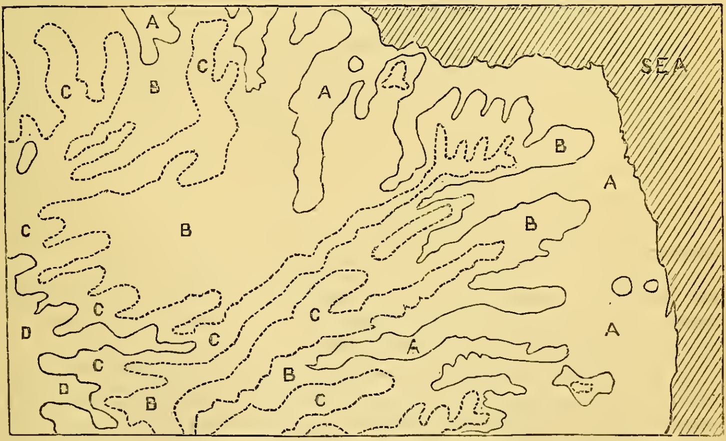


Fig. 7.—Part of the Coast of South America, showing the want of Correspondence between the Direction of the Coast-line and the Lines of equal height on the Land.

The tendency of Marine Coast to be straight.—In my former paper

I pointed out the general tendency of the eroding coast line to be straight, in contrast with the sinuous course of lines of equal height on the land surface. Fig. 7 represents part of the coast of South America, on which I have endeavoured to roughly show the disposition of the adjacent land-lines of equal height as indicated by the disposition of mountain chains and river courses. The belt of the land marked A may be taken to represent a range of altitude from the sea level to 200 feet, B from 200 to 400 feet, C from 400 to 600 feet, and D land over 600 feet in height. One of the most striking features here indicated is, that whilst the various land lines have a certain parallelism and concentric disposition with each other, they show no kind of relation to the direction of the coast line. If the prevailing land contour has been brought about by the same agency as the coast line, how is it that they do not exhibit some kind of affinity? Why should the sea have carved a particular kind of outline on the present coast and not have followed the same principle of erosion (as indicated in Fig. 8) when at a higher level on the present land surface? A comparison of Fig. 7 representing the *actual* land contour, and Fig. 8 representing the lines of equal

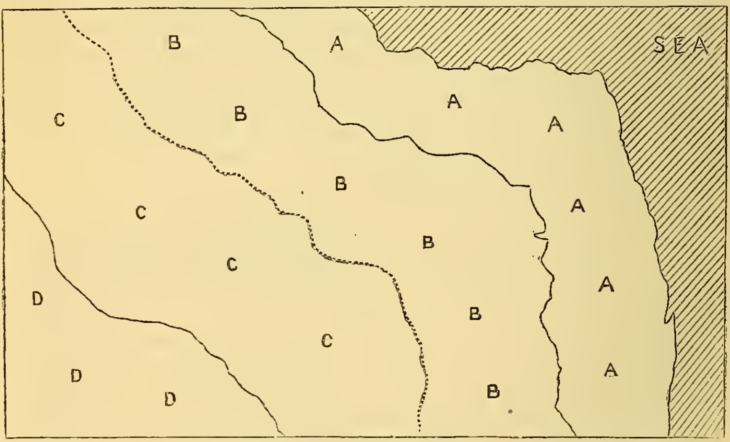


Fig. 8.—Hypothetical Land Contour on the principle of Coast Erosion.

height, had the coast contour been applied to its surface, will readily exhibit the essential difference in structure between the result of subaërial denudation and marine erosion.

If we for the present pass over the case of irregular coast lines resulting from unequal power of resistance in the rocks, the general tendency to be straight seems easily capable of explanation. In the first place, the ordinary wave-action along a coast is tolerably equal, and there are no *primâ facie* reasons why, under similar circumstances, it should produce an irregular result, or why it should persist at one particular point in eroding at a greater rate than at another. The action of the waves within an inlet, be it ever so straight and exposed, must always be less than against a headland; a headland is more or less assailable from three quarters, whilst an inlet can only receive the first force of the direct waves. Waves running along the shore can take little effect upon its recesses; in short, the projections of a coast, be they from whatever cause, must always be more open to assault than its indentations, and in this a compensating equivalent exists for any exceptional tendency towards an irregular outline. With respect to the assumed erosive action of currents, even if any large proportion played directly against the coast, they would be unable to make a deep inlet, for motion cannot take place up a *cul de sac*—a "cushion of still water" would fill the recess, deflecting the current at its mouth, and thus neutralize its excavating power; furthermore, all the persistent currents of the ocean are on a scale altogether disproportionate to the details of coast outline, and for the most part take grand sweeps parallel with the coasts.

On the Levelling Action of the Sea.—If we examine the sea bed between high and low water mark, on any cliff-girt shore, it is impossible not to be struck with the singularly level disposition of the reef surfaces extending seaward, which once formed the foundations of the old cliffs. Their general height will be a trifle above that of low tide, and any irregularities of surface will not exceed one or two feet. This well-marked lower limit to the erosive action of the sea is not confined to hard rocky coasts, but will be found to hold good in the softest strata. The fragile Wealden Sandstones to the east of Hastings stretch out to seaward for many hundred feet as level reefs just appearing above low water; and even the soft London-clay spreads out on the Suffolk coast as a level plateau exposed at low tide. There can be no stronger evidence of the impotence of the sea to do much in the way of erosion below the tidal range; and if a uniform level of land is maintained, it seems practically impossible that anything but a level surface can be the result. In the case of a coast being emerged or submerged, the progressive action of the tidal range would, of course, produce a steep or gentle inclination of surface according to the relative rates of erosion and change of level; but such inequalities must tend to be parallel with the shore (as indicated in Fig. 8), and similar variations of surface, trending in an opposite direction, could only be produced by sea erosion from local differences in the oscillation of level; but these, we know, do not take place within the narrow limits of hill and valley undulations. Furthermore, although you might get a single *incline* parallel to the sea by its action, it is obvious this could not be repeated in reverse so as to produce an *undulation*, and still less possible would it be for the sea to produce that intricate series of undulations skirting river valleys opposed in their direction to the eroding sea line. It may be perfectly true that marine terraces occasionally follow the sinuosities of the land contours, but these are evidently the effect of sea erosion superadded on previous contours produced by subaërial denudation.

On the Formation of Plains.—In Mr. Mackintosh's paragraph, entitled "Valleys Excavated by Streams" (p. 389), he appears to consider himself at issue with subaërialists in attributing to the sea the planing down of flat table lands. The discussion commenced "On the Formation of Hills and Valleys," and there has been no point more strongly insisted on by those who attribute the sculpturing of the land to subaërial agency, than the contrast between the work of the sea, as expressed in the level surfaces of flat-topped ranges and elevated plains, and the work of rains and rivers in excavating the intersecting valleys. Professor Ramsay, in the concluding paragraph (p. 237) of his "Geology of North Wales," says—"To the eye of one who appreciates the physical features of a country there is, indeed, on ascending a height, nothing more striking than the average flatness of the tops of many of the hills, especially when the rocks composing them are of tolerably uniform texture—a flatness, be it remembered, not connected with anything like a horizontal position of the beds, for everywhere they are contorted and often stand on end. All Wales shows this feature from the Towey to the slaty hills that flank Cader Idris and the Arans on the south and east, and even in the mountain land, from Cader Idris to the Menai Straits, traces of a similar approximate uniformity in height are plain to the experienced eye,—showing the relics of an old form of ground in which deep valleys have been not rent but scooped out. In lower ground, the features of Denbighshire, east of the vale of Clwyd, in a remarkable manner agree with these principles. There, in an average table land, *the result of quiet marine denudation* of disturbed strata, innumerable valleys have been cut out of the solid mass, the accumulated draining of which forms streams of tolerable size, which, *from higher to lower levels*, have gradually cut through an unfaulted escarpment of Carboniferous Limestone on their way to join the Clwyd. Such principles, I am convinced, give, when well considered, the true key to the meaning of the present outlines of the country; and few subjects in physical geology would promise greater interest than a complete account of the denudations by which, after the disturbance of the strata, Wales assumed its present form."

Striking examples of these level platforms also occur in the uniform outline of the surface of the Mountain Limestone, Durdham Down, near Bristol, at an average height of 280 feet above the sea, and the level top of the headland of Devonian Limestone bounding Babbicombe Bay, east of Torquay, given by Mr. Chambers in his "Ancient Sea Margins" (page 246) as 278 feet high. Of another similar platform on the south-west side of Tor Bay, Mr. Chambers remarks: "The one which forms the south side of Tor Bay dividing it from the valley of the Dart, has a remarkable appearance from Hope's-nose, the opposite promontory, for its flatness is like that which we should make in a drawing with a ruler, and it perseveres for many miles inland." The absolute identity of height between the Bristol platform, and that at Babbicombe Bay is remarkable; Berry Head, though supposed to be less by Mr. Chambers, is, I believe, identical in height, and it seems highly probable that these uniformly flat surfaces were all contemporaneously ploughed down by the sea.

The whole tendency of the sea appears to be to work on as straight a line as possible, whether it be on the vertical cliff face, the straight lines of coast, or the level surfaces of sea coast reefs. As regards vertical cliffs, the action of running water in river channels will occasionally produce similar results to the sea, but in all other respects the effect of subaërial denudation seems to be the production of a sinuous outline and a rounded undulating surface. Now as the straight element in the form of the ground is altogether subordinate to its rounded contour, it seems impossible to resist the conclusion, that rains and rivers have been the all powerful agents in modelling the land; indeed, the distinctive features of marine and subaërial denudation seem almost unconsciously recognized when the advocates of marine denudation point to the exceptional cases of terrace-structure in proof of the former action of the sea, and thus unwittingly admit some other agency to account for the almost universally rounded form of the land surface, and the sinuous disposition of its lines of equal height.

NOTE.—It has been suggested to me that in the paper "On Watersheds," in the GEOLOGICAL MAGAZINE of August, I used the term Watershed in rather too general a sense. I wish to explain that, in speaking of *watershed areas*, I merely referred to the individual tracts defined by the lines of watershed. I may also have inadvertently fallen into the use of the word as descriptive of an area, instead of a line, from the idea that was before me of the watershed line structure, branching *downwards* from the main line of watershed and ramifying over the whole area it includes, in the same sense that the ramifications of the waterflow branch *upwards* over the whole area to the watershed.

IV.—NOTE ON THE MIMOSA-DALE CHALYBEATE, UITENHAGE, SOUTH AFRICA.

By A. H. CHURCH, M.A., F.C.S., R. A. College, Cirencester.

A SMALL quantity of a highly ferruginous water was lately given to me for analysis by my friend and former colleague, Dr. John Bayldon. He had collected the sample himself at the spring in Mimosa-Dale, Uitenhage, South Africa, where also he had obtained specimens of the iron-salts which are freely deposited by the chalybeate waters.

The incrustation consisted of a crystalline ferrosoferric sulphate containing a good deal of water. In chemical and physical characters it approached Misy, but its occurrence as an abundant natural deposit covering the ground about the spring for a considerable space is of peculiar interest. Misy, it is well known, occurs in the waters of the Rammelsberg mine, near Goslar, in the Hartz, but neither in the abundance nor under the conditions of the Mimosa Dale deposit.

The water was found to contain 63.49 grains of solid matter per imperial gallon. It had a strong acid reaction, and a most decided styptic taste. By means of a direct iron determination, by the permanganate process, in the original water, together with an estimation of the total iron present in the water after it had been treated with zinc so as to reduce the ferric salts present to the state of proto-salts, or ferrous salts, it was found that more than half the iron was in the ferrous condition. It is, however, certain that the water at the spring contains still more of its iron in this state.

With the limited supply of this chalybeate water at my disposal, the following are the only results which I was able to obtain :—

	In the gallon.
Total solid matter	63.49 grains.
Iron as ferric oxide (Fe_2O_3)	19.45 ,,
Sulphuric acid (SO_3)	28.64 ,,

So that out of 63.49 grains of various salts contained in the imperial gallon, no less than 48.09 grains consisted of sulphuric acid and oxide of iron, leaving only 15.40 grains to represent the lime and other ingredients of the water.

V.—Inquiry into the Relative Antiquity of Stone and Metallic Weapons.

By the Rev. Anthony Cumby, M.A.

THE Flint and Stone implements sometimes found in this and other countries seem to form a sort of connecting link between geological and human antiquity; they are certainly the work of man, and they may possibly be older than the invention of metallurgy, and nearly coeval with the human race: it becomes therefore a matter of some interest to determine whether and to what extent the use of stone implements may have been contemporary with that of metals; and the references below given will, it is hoped, assist in elucidating this question.

I. The Jews from the time of Moses downwards have used stone knives for circumcision; see the Vulgate and Septuagint in Exod. iv. 25; Josh. v. 2, 3; also in Josh. xxiv. 30, after mentioning the burial of Joshua, the LXX. add that "they buried with him in his tomb the stone knives with which the Children of Israel had been circumcised in Gilgal after they had come out of Egypt and arrived in Canaan, and there they are unto this very day." This addition to the sacred text is said to exist in the Vatican MS., and therefore may be presumed to be as old as the time of Ptolemy Philadelphus (B.C. 284). We might be tempted to conjecture that flint knives had been found in a sepulchral tumulus, supposed to be that of Joshua, and thus had given rise to the story.

The Phrygian priests of Cybele used flint knives for a somewhat similar purpose (see Catull. lxiii. 5), and the Egyptian embalmers gave the first cut in the body of the deceased with a knife made of Ethiopic stone (Herod. ii. 86; Diod. Sic. i. 91), one of these is engraved by Sir Gardner Wilkinson, in his work on the "Manners and Customs of the Ancient Egyptians," vol. iii. p. 262.

In the time of Xerxes (B.C. 480) the Ethiopians in his army used arrows pointed with a hard stone used in seal engraving; they had also spears pointed with horn; also the Libyans in the same army used spears whose point was merely the end of the shaft hardened in the fire (Herod. vii. 69, 71); to these we may add that the Massagetæ had only gold and brass, but neither iron nor silver, and their weapons and horse furniture were made of the two former metals (Herod. i. 215); and a tribe of Ethiopians had not even brass, but only gold (Herod. iii. 23). It is clear therefore that distant and barbarous tribes used flint and even wooden weapons when brass and iron had been in use for thousands of years among more civilised nations; it appears also that even commerce with these remote barbarians was almost an impossibility.

II. The flint implements most frequently met with are arrowheads:—the bow is perhaps the oldest known weapon, and was used especially by the Scythians, a name given to all the nations that dwelt north of the Danube and the Phasis; for the Scythian bow see Herod. iv. 9, 10, 64; vii. 64; Strab. ii. 125; Plin. N. H. vii. 201; for Scythian metals, Herod. iv. 5, 62, 71; from whence we might infer that with them the use of gold and iron was older than that of silver and brass; yet their arrow heads were of brass (Herod. iv. 81), and also Plin. N. H. vii. 197). The relative antiquity of iron and brass is neither easy to determine nor absolutely necessary to the question we have in hand. According to Hesiod Op. and D. 150, iron was not used in the brazen age; but the Idæi Dactyli, who invented iron, flourished before or early in the brazen age (Strab. x. 473; Clem. Alex. Strom. i. p. 401; Schol. Ap. Rhod. i. 1131; Plin. N. H. vii. 197; Marm. Arund. Epoch. 11.); and the still earlier weapon mentioned (Hes. Theog. 162, 175, 179 *et seq.*; Apollod. Bibl. i. 1, 4), and said to have been made of adamant (whether this be stone or iron) is of a form wholly unsuited to stone (see Schol. Hes. Op. and D. 145; Schol. Ap. Rhod. ii. 231; Schol. Theocr. ii. 34; Hesych. *s.v.* *ἀδάμας*: see especially Strab. xiv. 654). The term adamant was perhaps given to iron from the extreme difficulty of smelting the ore (see Hes. Theog. 864).

III. The old Assyrian arrow had no barbs (Layard's Nineveh, vol. i. p. 336; ii. p. 350, 402; Nineveh and Babylon, p. 150). The Egyptians used both the barbed head and that of a lozenge or leaf-like form (See Sir Gardner Wilkinson's work above cited, vol. i. p. 310).

The Greeks of the Heroic period used iron for agricultural purposes (Il. ψ. 834, Procl. in Hes. Op. and D. 142), and for arrowheads (Il δ. 123). Their other weapons and even table knives were of brass (Il. λ. 640, also Il. *α*. 236, Od. ϵ. 235), their arrowheads had barbs (Il. δ. 151, 214, Od. φ. 61, and Scholl., also Apoll. Lex. *s.v.* *ὄγκους*. Eustath. 457, 30, 1899, 1 seq.; Hesych. *s.v.* *ἀγκίον. ὀγκίον.* and seq. Et. Mag. *s.v.* *ὀγκίον.* Poll. i. 137, vii. 158, x. 165). Here the name given to the barbs resembles the Latin word *uncus*: words common to both the Greek and Latin languages are clearly very ancient, and the antiquity of the name furnishes some presumption of the antiquity of the thing. The trident of Neptune also had barbs (see Gerhard's Greek Vases, Plates 8, 10, 13, 48, and elsewhere frequent), and this weapon is of extreme antiquity and represents a very early kind of fish-spear (Il. μ. 27, Od. δ. 506, ε. 292, Apollod. Bibl. i. 2, 1, Æsch. Septheb. 132, Phurnut. de Nat. Deor. 22, p. 194).

IV. For the use of metals among the Gaulish, German, and British tribes of the Roman period. See Cæs. B. G. v. 12, 42, and iv. 33; Tac. Germ. 6; Agric. 12 (cf. Cic. Ep. ad Att. iv. 15), 36; Ann. i. 64, ii. 14; Liv. vii. 10, xxxviii. 21; Solin. 22; Luc. Phars. vi. 259; Polyb. ii. 29, 30, 33, iii. 115 (cf. Liv. xxii. 46); Plut. Vit. Mar. 420; Strab. iv. 190, 196, 197, 199, 200; Diod. Sic. v. 20–22, 27, 30, 38; Dio Cass. xxxviii. 49, 50, lvi. 21.

Similar places might be multiplied, but the above are sufficient to show (1) that these nations used arms of their own fashion, and therefore of their own manufacture; (2) that the contradictory statements of the writers above cited may be reconciled on the supposition that the scarcity and high value of iron and brass caused great difference between the armature of the chiefs and wealthy men and that of their poorer followers, and also between that of the earlier period and that of the time subsequent to Cæsar and Agricola; (3) that originally neither Gauls nor Germans used any defensive armour except the shield; and that the principal weapon of the Germans was the spear, while the Gauls and Britons used a long sword.

A steel helmet, perhaps such as those described by Plutarch and Diodorus, is engraved by Spon. Miscel. p. 254, it had been gilt, and to this probably owed its preservation.

To the above we may add that stone weapons are found in the tombs of ancient Germany, and that bronze implements and armour were used very generally till the end of the Roman period; see the Ribchester helmet, the Brough caldron, etc., etc.

V. We may observe that in the places above cited the bow is scarcely mentioned as a military weapon, but they are said to have been fond of hunting and fowling, and would probably use it for this purpose. Flint arrowheads have been always found in great numbers in England and Scotland, and hence the superstition respecting elf-arrows. (See the Gentle Shepherd, Act iii. Sc. 3, "When Brawny elf-shot never mair came hame," and a few lines lower he speaks of "Bawsey shot to dead upon the green." Here Brawney is a man and perhaps misprinted for Sawney: Bawsey is a bassened (*i.e.* brindled) cow, see Jamieson's Dictionary, *s.v. Bawsand, Elf-shot*, see also Captain Grose's Popular Superstitions, p. 31, "Fairies sometimes shoot at cattle with arrows headed with flint stones, these are often found and are called *Elf-shots*. In order to effect the cure of an animal so injured, it is to be touched with one of these elf-shots, or to be made to drink the water in which one has been dipped.") It would seem therefore that flint arrowheads have been found and admired as curiosities, from perhaps the Saxon invasion to the present time, so that the number of them must have been very considerable.

These flint arrowheads are often (perhaps most commonly) barbed; sometimes the barbs may have been broken off: now, in such an implement, the vertical angle must not be too slender—perhaps not less than 30°—and, in this case, the wide span of the barbs would greatly diminish its power of penetrating hide or feathers; this would be still further diminished by the projecting shoulders of the shaft, which must have received the head; the barbs would thus be a hindrance to the effect of the arrow, and it is difficult to account for their use.

When steel is employed the vertical angle may be made very small indeed, and its penetrative power would be thereby increased, but it would all the more easily slip out of the wound, and the animal would be likely to escape; to prevent this barbs were invented.

Barbs, therefore, are a very doubtful improvement to a stone arrowhead, but very necessary to one of iron: does not this suggest a suspicion that the flint weapon was an imitation and cheap substitute for the more costly metal? Our lady-archers sometimes lose their arrows in long grass: what would they do in the ling, whins, and marshes of a British forest? To lose a steel arrowhead for every other grouse they killed would make fowling an expensive amusement, and it remains to be seen whether a hand-bow of ash or horn could send a flint-headed arrow through the hide of a red-deer or a wild bull at the distance within which these animals will allow themselves to be approached. Till this is determined we may conjecture that for large animals—stags, swine, etc.—the aboriginal Britons would hazard the loss of a steel arrow, and shoot smaller game with a less costly weapon: that the flint should remain though the iron has vanished, is no more than the proper consequence of the imperishable nature of the one and the rapid decomposition of the other. It is, therefore, certain that the flint implements and weapons found in Britain and elsewhere do little to prove that those who used them were ignorant of the use of iron; and if they could have proved it, even this would be as far as ever from proving that the Assyrians and Egyptians of the same period were equally ignorant.

Hesiod's fable respecting the metallic ages might seem to imply that the use of metals was coeval with the human race; and this is, perhaps, supported by the Egyptian histories, which make Vulcan the father of Sol. Mosaic history attributes the invention of metallurgy to Tubal-cain, Adam's eighth descendant; and the places above cited, from the LXX. and from Herodotus, corroborate the existence of a stone period, which must, however, be placed very long before the flood.

If we partially adopt Lucretius's conjecture respecting the invention of metals, we might suppose that the flint-breakers had discovered nuggets of gold, and the possibility of using it for vessels. The accidental burning of woods and smelting of ore on mountain sides had, perhaps, some foundation in truth, and opened the way to the discovery of other metals more capable of taking an edge or a point; but, in whatever way the discovery was made, we shall still find it difficult to distinguish flint implements older than the invention of metals from those of later and, perhaps, even of Roman times. Careful examination of the implements themselves, and classification of their forms and apparent uses, the place and part of the country where each sort are found, and the other remains found along with each, may throw some light on the subject; and those who have the means of doing this will, we trust, give the matter their best consideration.

NOTICES OF MEMOIRS.

I.—Notes for a Comparison of the Glaciation of the West of Scotland, with that of Arctic Norway.

By Archibald Geikie, F.R.S., etc.

[Proc. Roy. Soc., Edin., Jan. 15, 1866].

In June, 1865, the author, accompanied by two of his associates in the Geological Survey, Mr. W. Whitaker and Mr. James Geikie, made an excursion to Norway, for the purpose of examining the glacial phenomena of that country, and to search for any facts that might help to throw light upon the history of the glacial period in the British Isles.

The close resemblance between the general outline of Scotland and Scandinavia is well known, and this depends upon a close similarity in the geological structure of the rocks, and a coincidence in the geological history of the surface of the two regions. Norway from south to north, is almost wholly made up of metamorphic rocks, not all of the same age, yet possessing a general similarity of character. In like manner, the west of Scotland, from the Mull of Cantyre to Cape Wrath, is, in great measure, built up of gneiss, schist, slate, quartz-rock, granite, and other metamorphic rocks, quite comparable with these of Norway.

Besides the external resemblance due to the lithological nature of the rocks, beneath there is a still further likeness dependent upon similarity, partly of geological structure, and partly of denudation. Many of the Scottish sea-lochs have had their trend determined by lines of strike or of anticlinal axis, and the same result seems to have taken place in Norway. In other cases, the lochs and glens of the one country, and the fjords and valleys of the other, cannot be traced to any determining geological structure, but must be referred to the great process of denudation which has brought the surface to its present form.

No one can attentively consider the maps of the countries between the headlands of Connaught and the North Cape without being convinced that the endless ramifying sea-lochs and fjords, kyles and sounds, were once land-valleys. Each loch and fjord is the submerged part of a valley, of which we still see the upper portion above water; and the sunken rocks and skerries, islets and islands, are all so many relics of the uneven surface of the old land.

No feature of the Norwegian coast is more striking than the universal smoothing and rounding of the rocks, which is now recognized as the result of the abrading power of ice. Every skerry and islet, among the countless thousands of that coast-line, is either one smooth boss of rock, like the back of a whale or dolphin, or a succession of such bosses rising and sinking in gentle undulations into each other. Such too is the nature of the rocky shore of every fjord; the smoothed surface growing gradually rougher, as it is traced upward from the sea-level, yet continuing to show itself, until at a height of many hundred feet, it merges into the broken, scarped outlines of the higher mountain sides and summits. In short, the whole surface of the country, for many hundred feet above the sea, has been ground down and smoothed by ice.

An excursion was made, by the author and his friends, to the glaciers of Svartisen; starting from the island of Melo (a steamboat station), which lies a little to the north of the Arctic Circle, the party proceeded up Holands Fjord to Fordalen. This hamlet stands at the mouth of a deep narrow valley, on the line of the terrace, which here runs along the crest of a steep bank of rubbish covered with enormous blocks of rock—an old moraine thrown across the end of the valley. At the head of the valley a small glacier descends from the snowfields of Svartisen. There could be no better locality for studying the gradual diminution of the glaciers, and for learning that it was land-ice that filled the Norwegian fjords, over-rode the lower hills and mountains, and went out boldly into the Atlantic and Arctic Seas.

Leaving Holands Fjord, the party took the steamer at Melovaer, and proceeded northwards, halting at the island of Skjaervö (lat. 70°), in order to make an excursion across the Krenangen Fjord, and up the Jökuls fjord, to see the glacier which reaches the level of the sea. The sides of the Fjord are icemoulded and striated, in the direction of the inlets, and its islands are only large *roches moutonnées.*

Several other fjords were visited by the party. In fine, the excursion into this northern part of Scandinavia furnished abundant proofs that the glaciation of the west of Norway was produced by a mass of land-ice, of which the present glaciers are the representatives It likewise confirmed, in a most impressive way, the conclusion which has gained ground so rapidly within the last few years, that the glaciation of the Scottish Highlands, as well as of the rest of the British Isles, is in the main the work, not of floating bergs, but of land-ice.

II.—Report on the Auriferous Drifts and Quartz-Reefs of Victoria.—Observations on the Probable Age of the "Lower Gold Drifts."

By Alfred R. C. Selwyn, Director of the Geological Survey of Victoria.

THE attention of the Geological Survey has latterly been directed to the very important question of the age, and probable auriferous or non-auriferous character of what are called the "Lower drifts of Victoria," and from the facts observed, the following conclusions have been arrived at:—

First.—That these particular drifts are clearly antecedent in date to the upper and middle marine Miocene beds, under which they have now been traced, and, therefore, that they are far older than the lowest Pliocene gravels, to which age the deep-lead gravels of Ballaarat, the White Hills of Bendigo, and other similar rich gold-bearing gravels have been referred.

Second.—That they do not probably contain gold in paying quantity, because, as I believe, they are derived from the abrasion of quartz veins, that themselves contained little or no gold, and that were probably formed by forces in operation as long prior to those which produced the gold-bearing veins, as the denudations, producing the barren Miocene gravels, were prior to those which gave rise to the Pliocene productive ones.

I will now briefly state the facts which have led to these conclusions.

During the progress of the Geological Survey, deposits from a mere capping, to over 300 feet thick, have been met with in several localities, from sea-level to an elevation of 4000 feet. These consist of beds of clay, sand, "cement" or conglomerate, gravel, and large boulders,—the gravel and boulders, much water-worn and rounded, and composed either of quartz, quartz-rock or hard silicious sandstone. They rest on the ordinary slates and sandstones (Silurian) of the gold-fields, and are often in the vicinity of rich gold-bearing quartz-reefs.

Till quite recently I have considered these deposits to be true Older Pliocene gold-drifts, or of the same age as the rich lower drifts of Bendigo, Epsom, Ballaarat, Castle-maine, and other gold-fields, all of which drifts they very closely resemble, both in lithological character and geological position. Holding this opinion, I have hitherto been at a loss to explain why they had in no instance been found to contain gold in paying quantity. Numerous shafts had been sunk and levels driven in them in the most likely places in various localities, both by miners and by the Geological Survey parties, with a view to develop their supposed auriferous contents, but always with the same unsuccessful result.

In the neighbourhood of Steiglitz especially, they occur in close proximity to rich quartz-reefs; and the more recent alluvial deposits near the same reefs are also auriferous, while every attempt, and many have been made, to find paying gold in the older gravels either on the hills or in the valleys, has proved unsuccessful. The connection of these old unproductive Miocene gravels of the Steiglitz gold-fields, with the lower gravels of the Golden Rivers, Tea-tree Creek, the Upper Moorabool, Parwan Creek, Bacchus Marsh, and Ballan, has not yet been fully mapped out; but the preliminary examination recently made has, I believe, clearly established that they all belong to the same Miocene period; and, if so, I venture to predict, they will all prove equally unproductive. At the Tea-tree Creek, and all along the valley of the Moorabool, what I believe to be the true Older Pliocene gold-gravel has been worked, and it rests directly on what I now term the non-auriferous Miocene gravel, without the intervention of the marine beds or of the older basalt, both so well shown lower down the same valley.

The section near the Golden Rivers is:—

1. Upper basalt-rock, about 25 to 30 feet.
2. Pliocene gravel, about 50 to 60 feet.
3. Miocene gravel, etc. ("false bottom of miners"), gravel, sand, clay, and boulders, with fossil-leaves and wood; about 400 feet.
4. Silurian slates, etc.

The section on the Moorabool, west of Steiglitz, is:—

1. Basalt, upper, 49 feet.
2. Sandy Pliocene grit, 10 to 15 feet.
3. Upper coralline limestone (Miocene), 13 feet.
4. Older basalt, enclosing bands of hard compact limestone with fossils (Miocene).
5. Sandy limestone, with fossils, 30 feet (Miocene).
6. Rounded quartz pebble-drift, and hard silicious conglomerate rock, with fossil wood, lower part a gravel and boulder drift, 90 feet.
7. Silurian slate and sandstone with quartz veins.

No. 6 of this section represents No. 3 of the Golden Rivers, 3, 4, and 5 being absent in the latter. The thicknesses given are only approximate, and of course vary in different sections.

In support of the theory I have advanced respecting the non-auriferous character of a set of what I believe to be the older quartz-veins, and from which the Miocene gravels have, probably, in great part, been derived, I would mention a fact well known to all experienced quartz-miners, viz., that in many districts numerous large lines of reef occur that are entirely barren, though in close proximity to others affording handsome returns. These reefs present no peculiar features either in external character, general appearance, or mode of occurrence, that would enable an ordinary observer, unacquainted with the reefs of the district, to distinguish them. They are, however, I believe, recognised without much difficulty by the practical quartz-miner.

Now unless there really is, as I suggest, some marked difference in the time, and also in the conditions under which these different reefs were formed, it is difficult to explain why one reef should be richly auriferous, while another, in close proximity, is entirely barren, if formed at the same time and under similar conditions. In attempting to reconcile these facts, I have arrived at the conclusion, that there must be two, if not more, distinct sets of quartz veins—that the older ones were formed prior to the Miocene period, and are barren; and that the newer ones were formed after the close of the Miocene epoch, and before the Pliocene, and are productive. The former have furnished the material for the barren Miocene gravels; and the latter have furnished the material for the productive Pliocene gravels.

Victoria, *May 4th*, 1866.

REVIEWS.

I.—The Lake Dwellings of Switzerland and other parts of Europe. By Dr. Ferdinand Keller, Pres. Antiq. Soc., Zürich. Translated and arranged by John Edward Lee, F.S.A., F.G.S., etc. 8vo. pp. 418. Illustrated by 97 Plates, and numerous Woodcuts. London: Longman, Green, & Co. 1866.

FEW discoveries relating to the early history of mankind have excited more general interest than that of the Lacustrine villages of Switzerland. To Dr. Ferdinand Keller, the eminent Swiss antiquary, and President of the Society at Zürich, we are indebted for the first announcement of these Lake-dwellings. The later writings of M. Fred. Troyon, Mr. W. M. Wylie, Sir John Lubbock, and Sir Charles Lyell (chiefly derived from Dr. Keller's Reports to the Antiquarian Society at Zürich, 1854 and 1858), have attracted the earnest attention of the scientific public in this country; and all the isolated cases of similar discoveries in Norfolk, Scotland, and Ireland, at once assumed a fresh interest, as affording further evidence in confirmation of the prevalence of such structures; so true is it, that man, placed under analogous circumstances, acts in a similar manner, irrespective of time or space.

In the work before us, Mr. John Edward Lee, an eminent antiquary and geologist, well known as the author of "Isca Silurum," and other works, has not only furnished us with a corrected and revised translation of Dr. Keller's six reports, communicated to the Antiquarian Association of Zürich between the years 1854 and 1866, but he also gives us nearly 100 8vo. plates, one-half of which are actual "transfers" of plates from Dr. Keller's work; the others are either drawn from the plates, or by the translator from the objects themselves. Some idea may be formed of the labour of this undertaking, when it is stated that the objects figured in the plates exceed 1500, besides views of the pile-works in about fifteen different settlements, with plans of their construction and topographical sketches of their relative positions.

The following is a list of the settlements recorded:—

1	Lake of Constance	1	settlement		16	,,	Neuchâtel	50	settlements
2	,, Ueberlinger-see	8	,,		17	,,	Morat	16	,,
3	,, Unter-see	14	,,		18	,,	Geneva	24	,,
4	,, Nussbaumen	1	,,		19	,,	Luissel, near Bex,	1	,,
5	,, Pfaeffikon	5	,,		20	,,	Annecy	2	,,
6	,, Greiffen-see	1	,,		21	,,	Bourget, Savoy,	5	,,
7	,, Zürich	2	,,		22	,,	Mercurago	1	,,
8	,, Zug	6	,,		23	,,	Borgo Ticino	1	,,
9	,, Baldegg	5	,,		24	,,	Varese	6	,,
10	Lake of Sempach	6	,,		25	,,	Garda	6	,,
11	,, Wauwyl	5	,,		26	,,	Fimon	2	,,
12	,, Mauensee	1	,,				Total		193
13	,, Inkwyl	1	,,						
14	,, Moosseedorf	2	,,						
15	,, Bienne	21	,,						

It will be observed that the largest number of settlements have been discovered in the lake of Neuchatel. This and the lakes of Bienne and Morat have been especially investigated by Colonel Frederick Schwab, of Bienne, and it is in a great measure due to his exertions that so many settlements have been discovered; these three lakes alone containing 87, or nearly half the entire number known.

Dr. Keller's several reports are here entirely re-arranged, so as to form one complete work. Commencing with an account of the general form of Pile-dwellings, Fascine-dwellings, and Crannoges, or Wooden Islands, Mr. Lee proceeds to show us the methods and apparatus employed in collecting the antiquities of the Lake-dwellings. This fishing up of remains from among the ancient pile-works of the Swiss lakes is exceedingly interesting, and sufficiently difficult to render its pursuit almost as exciting as that of picking up the lost end of the Atlantic cable.

We cannot omit to quote here Dr. Keller's important "REMARKS ON THE AGES OF STONE, BRONZE, AND IRON" (p. 12):—

"It is well known that many antiquaries divide bygone ages into the stone, the bronze, and the iron periods; and attribute any burials or settlements to one of these divisions, according to the exclusive or prevailing presence of implements of any one of the three materials which are the groundwork of this classification. This division, according to the grade of civilization, is in general clear and convenient; but in determining isolated cases, it leads to many false conclusions and errors.

"In the first place, it has throughout only a relative value; for instance, if we grant that the civilization of man actually ran its course through these periods, just as they are mentioned above, yet it is certain that the bronze period of northern Europe by no means agrees in time with that of the middle and southern parts of this continent. Again, the bronze age of Greece and Italy may be separated by centuries from that of Egypt, which we may consider as the cradle of civilization. We may safely conclude, as the Danish antiquaries themselves allow, that in the Scandinavian countries, stone implements were for a length of time continued in use, while the bronze period was in full activity in the more southern lands; and that Egpyt, whose oldest monuments indicate very clearly the use of iron, and also Greece, had both advanced to the iron period when middle Europe was in the bronze age. If, therefore, according to the testimony of ancient authors and monuments, bronze and iron were used in the earliest ages in the countries round the Mediterranean, the commencement of these periods in the inland and northern parts of Europe was regulated entirely by the greater or less amount of intercourse between these countries and those to whom we are indebted for a knowledge of these materials, so essential to civilization. We may, even at the present day, observe a similar irregularity in the distribution of the products of higher civilization and art.

"In the second place, this kind of division gives us no positive certainty; for in very few of the burial places, still less in the regular settlements, are the remains found so purely distinctive as to enable us conclusively to attribute them to any one of the three periods. The materials on which this division is based are mixed to such a degree, that in nine cases out of ten the antiquary remains undecided as to what period of civilization he should assign a grave or a settlement. An object very commonly both in form and material bears the character of different periods: or it may be a specimen useless in deciding the age, being found in settlements of all the three periods. Thus the stone celt is an unsafe guide in determining the period of civilization, though it strictly represents the stone period, because it occurs in all stages of the bronze age, and is not unfrequently found associated with iron weapons and instruments.

"It is very certain that, at least in Switzerland, there was no hard line of demarcation between the three periods, but that the new materials were spread abroad like any other article of trade, and that the more useful tools gradually superseded those of less value."

Dr. Keller admits, however, the convenience of using these divisions, when rightly understood, but he does not enforce them in a very definite and rigid manner.

The work contains a careful account of all the principal settlements, their peculiarities of construction, and illustrations of the most interesting remains found in each (1 to pp. 88).

Dr. Keller then offers some general remarks as to the people of the Pile-works, and their mode of life. He considers that the lake-dwellings were all built by the descendants of the inhabitants of the earlier dwellings, and not by successive peoples; the better construction of the later erections being due to the possession of better tools.

A description is given of their woven fabrics; of the plants and seeds (by Dr. O. Heer); of the animal remains (by Professor Rütimeyer); and of the neighbouring mainland-settlements of Ebersberg and three other places.

An account is also given of other lake-dwellings not in Switzerland, and the Appendix contains some remarks on M. Troyon's "Habitations Lacustres," and a notice of the latest discoveries in the Swiss lakes.

No review, however complimentary, can do proper justice to so laborious a work, both by Author and Translator—it must be seen and read to be properly appreciated.

II.—Reliquiæ Aquitanicæ: being Contributions to the Archæology and Palæontology of Perigord and the Adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Part I., December, 1865; Part II., March; and Part III., August, 1866. 18 Tinted Plates, and 80 pp. 4to. London: H. Baillière.

[2nd Notice].

We gave a brief notice of this valuable work at page 76 of our present volume, and we propose now to draw attention to its subsequent progress.

If anything were wanting to add interest to this book, in the estimation of English readers, it is to be found in the fact that the wonderful collection accumulated with so much pains and labour by the late Mr. Henry Christy, and which finally cost him his life, are now secured to the nation by his will, and as soon as suitable exhibition accommodation can be provided, will form a part of the treasures in the British Museum.

The text of the several parts of the Reliquiæ Aquitanicæ is two-fold, the principal portion or narrative being paged separately from the description of the plates, which latter is, however, a history of itself, being illustrated, where needed, with explanatory woodcuts of modern weapons used by the Esquimaux, etc., at the present day.

The plates are also in two series, A., Pl. I. to XII. being imple-plements of stone, whilst B., Plate I. to VI., are weapons of bone and horn, carved antlers of reindeer, and ornaments formed of shells and teeth of animals, etc.

We find illustrations given in B., Plate V., Part III., of several shells which show clearly, by their having been perforated, that they had been worn either as ornaments or charms by the aborigines who inhabited the cavern of La Madelaine. The custom of using shells, etc., as necklaces, or other personal decorations, is common, not only among savages, but even among *civilized* races at the present day, and might therefore be passed over without special remark; but in this case the shells have been obtained, not *from sea or river*, but from the Faluns of Touraine or Bordeaux, deposits of Miocene age, rich in fossil marine shells, many of which are so well preserved as to retain the glazed surface seen in recent specimens. Dr. Fischer, of Paris, (p. 43,) has determined as many as five species in the caverns of Perigord.

It is interesting to record that, in the cavern of Bruniquel, Dep. Tarne et Garonne, an Oolitic Belemnite, having its sides squared by grinding, was found among the *débris*: also an Ammonite and a *Gryphæa*, probably introduced by children as toys. Perforated recent marine shells were likewise numerous. These relics are preserved in the British Museum.[1]

We called attention, in our former notice, to the fine series of fish-harpoons cut from reindeer horn (B., Plate I.), and also to drawings on horn and bone of animals (B., Plate II.). In Part II. at B., Plate III. et IV., are given illustrations of some magnificent weapons made of reindeer-horn, perforated and carved in various patterns according to the skill and ingenuity of the possessor. In B., Plate VI., Part III., is given a second series of fish-harpoons, less well preserved than those in B., Plate I.; and also some small bone pins; the use of those and of the harpoons is clearly explained by the help of the figures given in Part III. pp. 50 and 51. These consist of a series of weapons principally in use among the Esquimaux, for angling, and spearing fish, the double-pointed bone pin forming the hook.

If we examine the harpoon heads figured on B., Plate I., and B.,

[1] For an account of this cave see Geol. Mag., Vol. 1, p. 137.

Plate VI. (all these being of reindeer horn from Dordogne), and Fig. 9, p. 50, which is from Bruniquel, we shall be at once struck with their great superiority in workmanship over the ruder weapon of the modern Esquimaux (Figs. 5 and 6), or Fuegian (Fig. 7), or the harpoon of the Ancient Dane (Fig. 8), or North American (Fig. 12). Even the bone harpoon (Fig. 10), from the alluvium of the River Lacque, near Calais, appears to have belonged to an older, and probably a ruder tribe. But time is not the only agent to be taken into account in considering the progress of the human race. Other influences, such as change of climate, the abundance or scarcity of food, the freedom from or liability to attacks from neighbouring races—these are often more potent in affecting the advancement or deterioration of a race, both socially and physically, than even centuries would be.

The cave-dwellers of France appear to have suffered less from severity of climate than the Esquimaux of the present day; their food was more abundant and varied—consisting of venison, horse-flesh, wild oxen, salmon, swans, grouse and other game; their caves afforded more safe retreats from hostile attacks, whether from beasts of prey, or from man; and this state of existence must have continued for a very long period of time until the race was probably driven northwards by a more powerful and better armed tribe who invaded the hunting-grounds of Aquitania.

Much more has yet to be recorded of this ancient people, and we look forward with interest to the appearance of the future parts of this grand work.

III.—Illustrated Charts of Natural History.

Engraved by J. W. Lowry, F.R.G.S.

BOTANY AND ZOOLOGY.

I. The Vegetable Kingdom. II. Recent Shells. III. Worms, Crustacea, Spiders, Scorpions, etc. IV. Insects. V. Fishes. VI. Reptiles. VII. Birds. (VIII. Mammalia, just ready). London: Society for Promoting Christian Knowledge.

GEOLOGY AND PALÆONTOLOGY.

I. Characteristic British Fossils, stratigraphically arranged. II. Chart of Fossil Crustacea (with descriptive Catalogue.) III. Chart of Characteristic British Tertiary Fossils, stratigraphically arranged. London: J. Tennant, 149, Strand.

THERE are few men who have done more to promote a taste for Natural History—especially among young people—than Mr. J. W. Lowry. His Natural History Charts, though designed and engraved by himself, have all been carried out under the direction of able naturalists, in the several branches of which they treat, among these may be named such men as the late Mr. Henfrey and Dr. S. P. Woodward, Mr. Adam White, Dr. Baird, Mr. Gosse, and Mr. George Gray.

Visual education is not only the first form of training by which the attention of youth is attracted, but it is also that which remains longest impressed upon our mental retina. These charts are calculated, however, to afford education of a still higher character, and to pupils of all ages: they are, therefore, not only fitted for the school and class-room, but every lecturer on Natural History should possess a copy of each, and no museum can be complete without these admirable and instructive guide-maps.

In recent Natural History, Mr. Lowry's task is drawing to completion, the last of his charts—that to contain the *Mammalia*—being announced to appear this year.

In Palæontology a good deal more it is hoped will be done; but we wish especially to allude to his latest labour.

The Chart of British Fossils is, as it were, a general outline of British organic remains, arranged according to the strata.

The Chart of Fossil Crustacea, by Messrs. J. W. Salter and H. Woodward, gives a conspectus of a single class, arranged not only in stratigraphical series, but in zoological order. It contains nearly 500 figures, and is, moreover, accompanied by a short descriptive catalogue.[1]

That of *Characteristic British Tertiary Fossils* is an elaborated view of the topmost or newest section of the Chart of British Fossils, and holds the same relation to it which a map of Europe does to a map of the World. It contains upwards of 800 figures of characteristic shells and other organisms found in the series of formations of Cainozoic or Tertiary age, which have been engraved by Mr. Lowry expressly for this work, and selected by him with great care, assisted by Messrs. Robt. Etheridge, Searles V. Wood, Fred. E. Edwards, and other geologists of eminence, and contains a mass of information never before collected in so compact a form for reference. Every specimen is not only named, but has its natural size indicated against it, if it be enlarged or reduced. Those Crag species which occur in more than one bed are also marked by the initial letter of the beds in which they have been found, thus giving the range of each. Very much interest is now taken in Tertiary geology, because we see that the fauna and flora of our present earth is really only a modified remnant of the previous age, and that, both on land and in the sea, there exist numerous descendants of all the lower forms of life which are found fossil in these later formations; but instead of their all now living on our shores, some have gone further south, whilst others have retreated in a more northerly direction according to their arctic or tropical tendencies, thus revealing to us a wonderful history of alternations of climate, further confirmed by the presence of scratched boulders and Glacial Drift, telling of glaciers and icebergs over all the land, but which are now happily melted.

We strongly recommend these charts to all lovers of Natural History, but would especially call the attention of geologists to this new and interesting CHART OF CHARACTERISTIC BRITISH TERTIARY FOSSILS.

[1] For a full description of this Chart of Fossil Crustacea, see British Association Reports, Sections C. and D. Birmingham, 1865; and GEOLOGICAL MAGAZINE, Vol. II., p. 468.

IV.—Biblical Studies. By William Robinson. Longmans, 1866.

Our concern with this volume extends merely to a note respecting the novel geological theory propounded by the writer on the baffling subject of the Mosaic account of the creation.

The author affirms that the burden of proof, in an examination of the Mosaic narrative, lies on the objector. "Suppose there can be presented a theory of creation, scientifically admissible, which is in harmony with the Biblical record; then, unless it can be shown by evidence that the world was not formed according to that theory, the voice of the objector is silenced."

As the Bible is commonly received amongst us we acquiesce in this as a rule of the contest.

He then claims for his theory the place not of a dogmatic assertion, but of a mere suggestion.

Thus properly introduced we are in the presence of his argument, which we give in his own words:—

"Seven thousand years ago this earth may have been shaped as the moon is thought to be, and may have moved in relation to the sun, as the moon does in relation to the earth. [This is without rotating on its axis.] If such were the case, one hemisphere of the world was a chaos; the other a deep, and dark: our present division of day and night had no existence; the firmament in which the clouds now float, was not; neither were the signs of the sky, as now presented by sun, moon, and stars; all which differences between the past and present state of the world, are either affirmed or implied in the Scriptural record of creation." pp. 8, 9. "Scientific men assume that this earth rotated before the Adamic era, as it does now. *That postulate requires proof.* The earth may have been formerly as the moon is supposed to be now. No man has the right to say it was not so. Therefore no man has the right to say that the first chapter of the Bible cannot be history." p. 9.

If the worthy author had wandered from his door at Cambridge as far away as the noble Woodwardian Museum there, he could hardly have written thus. He would hardly have consigned to darkness the whole organisms of that glorious collection. The argument scarcely needs serious consideration, save for the motive which induced its publication. It is refuted, first, by the structure of all organic remains, which are framed and fitted for optical conditions like the present; secondly, by the actual physical condition of the earth's crust, which in southern as well as in northern latitudes shews alternations of land and water during all the past; thirdly, by the dynamical conditions of the solar system, which are fatal to the supposition in question.

We therefore feel ourselves relieved from the task of following the illustrations and corroborative evidences adduced in support of a proposition which is obviously untenable. But we protest against the author's statement that the first chapters of Genesis are the keystone of the Bible. The fundamental facts of the latter are not to be thus summarily disposed of. As to the exact course of creation, either it belongs not to things revealed, or we have not the revelation, or cannot yet correlate it.

V.—The Intellectual Observer, for September,

CONTAINS, among other articles of general interest, one which has so important a geological bearing, that we cannot neglect to call attention to it here.

The article is by Mr. Henry M. Jenkins, F.G.S., the Assistant Secretary to the Geological Society of London, and is entitled "*Hypothetical Continents.*" The author, after explaining the nature of the two prevalent theories respecting the origin of organic beings, 1, that of their having been *created* in the several areas they are found to occupy; and, 2, the derivative origin of every group by descent with modification from some pre-existing group, assumes as a postulate the truth of the latter theory. He does not adduce facts and arguments in its favour; but only mentions that compulsory wandering, or "migration," as it is termed, is one of them, and the one that most concerns the subject of his article.

Bearing these two points in view, the palæontologist can frequently infer the progenitors of any particular assemblage of animals or plants, and the route by which their ancestors travelled from their own habitation to that of their more recent descendants. But Mr. Jenkins admits that in tracing the origin of terrestrial life the palæontologist meets with some serious difficulties; but it is generally as to the route which the ancestors of the species have taken. The author points out, that in past time the same laws of climate, and hydrographical and physical conditions produced corresponding changes in the faunas and floras of the regions affected by them, as at the present day.

Hypothetical continents have been invoked to account for the relationship which exists between the recent or fossil faunas, or floras of distant regions. For instance, the Atlantis theory was framed to account for the preponderance of American types in the Miocene flora of Europe, which it sought to explain by the supposition that there existed during the Miocene period a great island-continent over which the American flora extended to Europe. This theory has received the support of some able naturalists, but has been assailed by others, chiefly on the grounds that it does not explain the presence of a large number of Japanese and other types in the European Miocene flora; and that there is no physical evidence of the existence of an Atlantic continent at so recent a period.

Mr. Jenkins, after giving a resumé of the characters of the Swiss Miocene flora, proceeds to state his objections to the Atlantis theory as hitherto enunciated, and then propounds a modification of it which he conceives more in accordance with the facts to be explained, and not obnoxious to the physical objection urged against the Atlantic theory of Professor Unger. He believes that the Swiss Miocene plants were derived from America during the Eocene period, by way of an Atlantis which existed during the early Tertiary epoch, and that they migrated at the close of the Miocene period towards America by way of Northern Asia and Japan, that is to say, along the route suggested by Professor Asa Gray. This theory is borne out palæontologically by the fact that the flora of America seems to have undergone little or no change in facies since the Cretaceous period, and geologically by the evidence brought forward by Mr. Searles Wood, jun., in support of his view of a great Post-cretaceous east and west Atlantic continent (see Phil. Mag., 4th Ser., Vol. xxiii. p. 277).

Another hypothetical continent is the one proposed by Dr. Sclater to account for the affinity of some of the mammals of Madagascar to some living in Hindostan, and of other animals to certain West Indian forms, as well as the difference of the Madagascarian fauna from the African. This continent was supposed to stretch from Hindostan through Madagascar to the West Indies, and to include only a small portion of what now constitutes the continent of Africa; and it received from its proposer the name of Lemuria.

In opposition to this view, Mr. Jenkins states that there is no physical evidence in support of it, and that it is quite possible to explain all the facts by the aid of palæontology without having recourse to it, although our ignorance of the palæontology of Madagascar renders somewhat difficult what more perfect knowledge will doubtless very much simplify. The chief facts adduced are the affinity of the European Eocene Mammals to existing South American forms, the absence of New World monkeys from the Tertiary deposits of the Eastern Continent, and the commencement of the prevalence of Old World types at a later period than the Eocene. Mr. Jenkins therefore infers that the West Indian species represented in Madagascar may have travelled by way of the Eocene Atlantis to Europe, and have migrated thence to Madagascar at a later period. The absence of New World monkeys from the Miocene deposits of Europe supplies him with an additional argument in favour of the Atlantis having existed in early Tertiary times. Had it been of Miocene age, it seems improbable that New World monkeys should not have migrated to Europe in company with the American plants; but as we have no trace of them in Eocene deposits, their absence from Europe may be explained by the fact of their non-existence at that period.

One element of uncertainty in these inquiries is "the probability of a great Pacific continent having formerly united the Old and New Worlds on that side, for we know that that great region is even now an area of depression;" but Mr. Jenkins thinks that this consideration "would more nearly affect the relation which formerly existed between Australia and South America than the regions which now concern us."

The following are the conclusions at which Mr. Jenkins has arrived :—

1. That hypothetical continents belong to two categories; namely, first, those supported by physical evidence; and, secondly, those unsupported in that respect.

2. That while the Miocene Atlantis and Lemuria come into the second category, the Eocene Atlantis and the possible Pacific continent come into the first.

3. That the theory of a Miocene Atlantis and that of Lemuria each explains only one portion of the palæontological facts that call for elucidation; while the theory of an Eocene Atlantis explains the whole of the facts of both cases.

4. That for these reasons it is probable that the Miocene fauna and flora of Europe came from America during the Eocene period by way of the Eocene Atlantis; and that since the Miocene period they spread over Asia and Africa, and the eastern seas, and that a part of the flora returned to America by way of Northern and Central Asia and Japan.

5. That the fact of American Cretaceous and Eocene plants uniformly occurring in older deposits than a European palæontologist would, *à priori*, consider possible, is of itself a most remarkable confirmation of two theories; namely, (1), that organisms have migrated from west to east (*e.g.*, from America to Europe in Eocene times); and (2), that deposits in the Old and New Worlds should be treated as homotaxeous and not as contemporaneous.

REPORTS AND PROCEEDINGS.

British Association for the Advancement of Science, Nottingham, 1866.

SECTION C.—GEOLOGY.

President: Professor A. C. Ramsay, LL.D., F.R.S., V.P.G.S.

List of Papers read before the Geological Section:—

H. Hicks and J. W. Salter—Second Report on the Geology of St. David's, Pembrokeshire.

H. Woodward—Second Report on the Fossil Crustacea.

W. S. Mitchell—Report of the Committee appointed to investigate the Alum Bay Leaf-bed.

J. Gwyn Jeffreys—Report on Dredging among the Hebrides, with regard to Geological considerations.

Dr. Leith Adams—Second Report on the Maltese Caves.

Professor Hitchcock—On the Geological Distribution of Petroleum in North America.

W. Pengelly—On Raised Beaches.

C. Spence Bate—An attempt to approximate the date of the Flint Flakes of Devon and Cornwall.

Rev. P. B. Brodie—On the Correlation of the Lower Lias at Barrow-on-Soar, Leicestershire, with the same strata in Warwick-, Worcester-, and Gloucester-shires; and on the occurrence of the remains of Insects at Barrow.

H. A. Nicholson—On Fossils from the Graptolite Shales of Dumfriesshire.

W. Pengelly—Second Report of the Committee for exploring Kent's Cavern, Devonshire.

W. Topley—On the Physical Geography of E. Yorkshire.

A. B. Wynne—Notes on the Physical Features of the Land as connected with Denudation.

Prof. Ansted—On Intermittent Discharges of Petroleum and large deposits of Bitumen in the valley of Pescara, Italy.

Prof. Ansted—On a Salse or Mud Volcano on the flanks of Etna, commencing to erupt in the month of January last.

Edward Hedley—On the Sinking of Annesley Colliery.

J. F. Walker—On the Lower Greensand of Bedfordshire.

R. A. Peacock—On a case of gradual change of form and position of land at the south end of the Isle of Walney.

Dr. W. H. Ransom—On the occurrence of *Felis lynx* as a British Fossil.

James Oldham—On the Discovery of Ancient Trees below the Surface of the Land, at the Western Dock now being constructed at Hull.

F. M. Burton—On the occurrence of Rhætic Beds, etc., near Gainsborough.

Sir R. I. Murchison—On the Various Tracts of England and Wales in which no Productive Beds of Coal can reasonably be looked for.

Mons. Pierre de Tchihatchef—Eight Years' Researches in Asia Minor.

H. Govier Seeley—On some Characters of the Brain and Skull in *Plesiosaurus.*

H. Govier Seeley—On the Aspect and Habits of the Cambridge Pterodactyle.

Dr. C. Le Neve Foster—On a curious Lode or Mineral Vein in New-Rosewarne Mine, Gwinear, Cornwall.

E. Brown—On the Drift Deposits of the Weaver Hills.

H. Govier Seeley—On the Characters of *Dolichosaurus*, a Lizard-like Serpent of the Chalk.

James Oakes—On a Peculiar Denudation of a Coal Seam in Coates' Park Colliery.

Dr. Beke—On the Island of St. John in the Red Sea. (The Ophiodes of Strabo).

Prof. Oswald Heer—On the Miocene Flora of North Greenland.

J. E. Taylor—On the Relations of the Upper and Lower Crags, near Norwich.

C. W. Peach—Observations on, and additions to, the lists of Fossils found in the Boulder-clay of Caithness, N. B.

Rev. John Gunn—On the Anglo-Belgian basin of the Forest-bed of Norfolk and Suffolk, and the Union of England with the Continent during the Glacial period.

Report of the Committee appointed to Investigate the Alum Bay Leaf-bed.

By W. Stephen Mitchell, LL.B., F.G.S., Caius College, Cambridge.

The bed known to geologists as the "Leaf-bed," or "Pipe clay-bed," of Alum Bay, is the band of white clay which occurs in the lower Bagshot beds, in Alum Bay, about 200 feet from their base. It is about six feet thick, but one portion only, a few inches in thickness, contains the plant remains. No other organic remains whatever have been noticed.

The occurrence of these plant-remains was first observed by the Geological Survey in 1853.

Dr. P. de la Harpe, of Lausanne, examined these, and gave a notice of several species in a paper on the "Flora tertiaire de l'Angleterre," which appeared in the "Bulletin de la Societe Vaudoise des Sciences Naturelles" for June, 1856. In Dec. 1860, in conjunction with Mr. J. W. Salter, F.G.S., he prepared the list which is published in the memoir of the Geological Survey of the Isle of Wight.

This list includes the collections from "the same strata worked at Bournemouth and Corfe Castle, in Purbeck, Dorset;" yet for the compilation of it the total number of specimens that could then be brought together from the three localities was but about 300.

It is therefore no matter of surprise that in larger collections since made many fresh form are met with.

I went down to Alum Bay last September with Mr. Keeping, and remained there during the working to note the appearance of the leaves when first turned up.

In the majority of instances, not only the outline, but the venation, even the most delicate, is at first clearly visible, though a few hours' exposure to the air almost obliterates the more delicate marks. A washing with a solution of isinglass often preserves them, indeed in some instances it brings them out even more sharply, but unfortunately it often fails. There are some specimens on which I partly traced the venation with pencil as soon as they were exposed. Now, after an interval of ten months they are so faded that the part not pencilled is hardly, if at all, to be made out. It is much to be regretted that there is a difficulty in preserving the specimens, and we shall be very glad to receive suggestions for their treatment. All our specimens have had the usual isinglass wash, though I fancy it somewhat obscures the character of the surface of the leaves. I cannot speak with certainty on this point, for, as I had not anticipated such a result, I did not record the character of the surfaces among the notes I made on the spot. Still, from comparing the recollection I have of the appearance of the leaves when first turned up with their appearance now, I am almost certain this is the case. This I the more regret as the character of the surface of the leaf is often a useful help in determining its genus. I hope to have an opportunity of again examining this bed, and I shall endeavour to take both drawings and complete descriptions of the leaves before the air and light have in any way injured them.

After a fortnight, bad weather put a stop to our work. We had, however, succeeded in obtaining a good collection, numbering altogether some 470 specimens. The leaves are, on the whole, well preserved, but the bed in one part yielded forms so indistinctly marked as to be almost worthless.

I decline to attempt to fix the number of new species, or even genera, we are able to add to the list in the Survey Memoir, for not only is the determination of fossil leaves at all times very unsatisfactory, but that list was not intended for a monograph, and has neither drawings (except a few) nor the exactness of description requisite for identification. Then, too, the nomenclature of fossil leaves is very unsatisfactory, the same fragment of a leaf having often half-a-dozen different names.

With regard to the species of fossil leaves, I believe the word "form" might often with advantage be used where "species" is now universally employed. "Species" is applicable only to the entire plant; "form" is applicable to individual leaves. When we consider the variation in leaves often met with growing on the same tree, I think we see reason for great caution in determining what "forms" represent the existence of distinct "species."

Dr. MITCHELL exhibited photographs and drawings of some of the larger and more striking leaves. Among them we noticed some fine compound leaves formerly only supposed to occur from isolated leaflets found; also some fine *Aralias*, *Dryandras* [or *Myricas*], *Taxites. Ficus, Laurus,* etc., and two curious forms supposed to be cones, with other new leaves. Professor Ramsay asked if any of these were identical with the remains found at Bovey Tracey. Dr. Mitchell replied that certainly some were, but the majority were not.

In conclusion Professor Ramsay said he wished to point out a moral. We have here from the Eocene of Alum Bay, some forms identical with those from the Miocene of Bovey Tracey. This should be a caution not to consider beds to be of identical age merely from the identity of a few of their fossils.

WARWICKSHIRE NATURALISTS' FIELD-CLUB.—The third meeting was held at Bredon Hill, in Worcestershire, on the 10th of August. Arriving by early train at Ashton-under-hill, where this club joined the Worcestershire Field-club, the party gradually ascended the hill and stopped for a little time to examine some Lias Marlstone quarries, abounding in fossils, though not in a good state of preservation. Here, at the request of the Vice-President of the Worcestershire Club, the Rev. P. B. Brodie delivered a short address on the Geology of the district, which presents many features of geological interest, commencing with the Great Oolite, of the more distant Cottswold chain of hills, to the Lower and very ancient Oleni shales on the south-west flank of the Malverns. This includes a wide extent of geological formations of different ages, and each characterised by peculiar and distinctive fossils. The faulted condition of the Inferior

Oolite on Bredon Hill was also noticed. A magnificent view was obtained from the summit, and the day being showery the far distant Welsh Mountains were readily distinguished. The party next visited the Roman camp and the singular Bambury Stone, supposed to be a Druidical monument, where Mr. Lees read a paper on its history. In the descent, Elmley Castle, of which the trenches now only remain, and the well-restored church were inspected. The united clubs dined together at the Crown Hotel, Evesham, at 5 o'clock. —The Rev. W. Lea, President of the Worcestershire Club, exhibited some charred remains of the lake-dwelling period from Switzerland, and the Rev. G. Faussett, Oolitic fossils of the neighbourhood. Few spots could be better adapted for a scientific meeting, as it abounds in points of great interest to the geologist, botanist, and conchologist.

P. B. B.

CORRESPONDENCE.

THE SO-CALLED LOWER NEW RED SANDSTONE OF PLUMPTON, YORKSHIRE.

To the Editor of the Geological Magazine.

Dear Sir,—In the "Reader" of this week is a report of Sir R. I. Murchison's Paper, read at the late meeting of the British Association at Nottingham, "On the vast areas in England and Wales in which no Productive Coal-beds can reasonably be looked for." The learned author is made to say, "On the banks of the Tees, west of Darlington, wherever the Magnesian Limestone forms the upper stratum, as at Coniscliffe, it is at once underlain by unproductive millstone grit, which, on the west, lies upon Mountain Limestone, the productive Coal-measures between the Millstone-grit and the Permian rocks being entirely wanting, owing, he presumed, to an ancient elevation of the tract during the lower Carboniferous period, so that no valuable vegetable or coal matter had ever had an existence in the tract extending from Barnard Castle, on the Tees, to the south of Harrogate. At the latter place, the Plumpton rocks and conglomerates, underlying the Magnesian Limestone, and forming the base of the Permian system, are seen to repose directly on unproductive Millstone-grit, which, in its turn, rests upon the great Mountain Limestone region of the western dales of Yorkshire." It is not my intention, at present, to discuss the point as to whether profitable Coal-measures ever covered the Millstone-grits of Yorkshire, but I do demur even to so great an authority as Sir Roderick, founder of the kingdom of *Permia*, as well as *Siluria*, claiming the Plumpton rocks and conglomerates as forming the base of the Permian system, and thus a portion of his first-named realm. These rocks I showed in a paper printed by you in your Magazine a few months since were most probably Upper Millstone-grit, or "rough rock." Since that time I have been confirmed in my opinion by local geologists, so that I have now no doubt upon the matter. The same reasoning which proves that the Magnesian Limestone, forming the base of the Permian system, reposes directly on unproductive Millstone-grit from Barnard Castle to Harrogate, shows exactly a like sequence of rocks through Knaresborough, Plumpton, and Bramham Park, the only difference being that the coarse millstone at Plumpton is coloured red by peroxide of iron, certainly no sufficient reason in my judgment for claiming it as Permian. I should not have troubled you with this letter had not I deemed it right to lose no time in warning people from searching for coal in the Millstone-grit of Plumpton, which is not a locality where there is any fair probability of finding a profitable seam of coal, but a place where no productive coal-beds can reasonably be looked for.

I remain, yours truly,

E. W. Binney.

Ravenscliffe, Douglas, Isle of Man,
Sept. 10th, 1866.

RIVER-DENUDATION OF VALLEYS.

To the Editor of the Geological Magazine.

Sir,—Those who are acquainted with the region of the Lower Carboniferous Rocks on the borders of Lancashire and Yorkshire—forming the great anticlinal ridge between the coal-fields of these two counties—cannot fail to have been struck with the characteristic features of its valleys. They consist for the most part of narrow winding channels—bounded by steep sides, or cliffs of grit or shale—intersecting flat-topped or gently sloping moorlands of Millstone grit. These valleys generally contain rapid brooks and torrents—which are often swollen by heavy rains—and in their course carry away large quantities of material from the bottom and sides of their channels. It is, in fact, one of those districts where it might be supposed the theory of the sub-aërial or river-denudation of valleys could be most satisfactorily illustrated. This is certainly true in the great majority of instances. When the valleys contain brooks—*having some relationship to the size* of these valleys themselves—the process of scooping the ravines is palpable to every observer; but that the theory is not capable of universal application seems to me equally clear from the fact that some parts of the deepest and most sharply sculptured valleys contain no streams whatever, owing to their crossing watersheds. I shall briefly notice a few examples, illustrated by cross-sections, of which the outlines have been drawn to natural scale for the contour lines on the Ordnance Maps. They are therefore true to nature, and are consequently less striking than when actually seen on the spot and *fore-shortened.* But their real proportions would be more evident did space admit of the lateral extension of their sides.

1. Vale of Todmorden (Fig. 1). This is one of the most remarkable valleys in this part of England. It is entered from the south at the village of Littleborough, near Rochdale, and extends northwards in a slightly winding course to Todmorden, a distance of

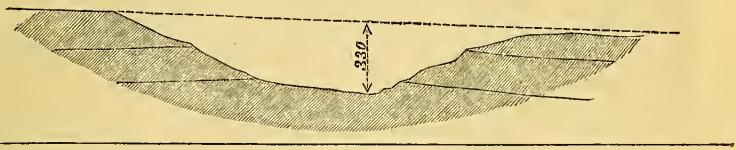


FIG. 1.—VALE OF TODMORDEN, NEAR DEAN HEAD.

five miles—when it divides into two arms: one stretching to the north-east in the direction of Burnley—the other, eastward into Yorkshire. Throughout its course to Todmorden it is bounded by lofty banks, maintaining a nearly uniform distance from each other; but in many places cut through by branching ravines. If restored (to use a favourite term) it would present the appearance of a huge canal trough, as the bottom is smooth and slopes almost imperceptibly. To the eye it presents the appearance emphatically of a "river valley." Yet, at a point distant one-third of the way between Littleborough and Todmorden, it is crossed by the watershed, and consequently contains no stream whatever. It might be supposed that, at this point, the valley becomes narrower and shallower than further down on both sides where the rivers are flowing; but, in reality, there is scarcely any appreciable difference between this and the other parts of the valley; and for some distance on either side of the watershed the brooks are so insignificant that they cannot be considered as having modified the form of—much less of having been the agents in hollowing out—this deep furrow in the Pennine Hills. At the point where the watershed crosses—as shown in the woodcut—the valley is 330 feet in depth.

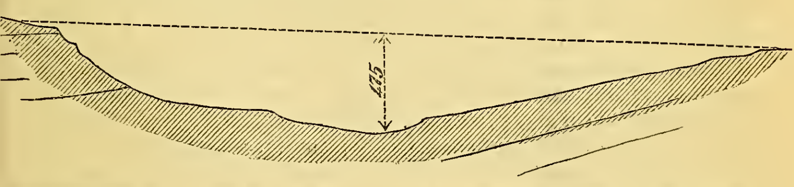


FIG. 2.—VALLEY OF CLIVIGER, AT CALDER HEAD.

2. The Valley of Cliviger (or Portsmouth) is another illustration. This valley is the one alluded to above as branching in a north-westerly direction from that of Todmorden. It is also a very well marked and deep valley, opening in the opposite direction into the wide basin of Burnley. At Calder Head—a distance of nearly four miles from Todmorden—it crosses the watershed; and the streams which issue forth from springs, at this point, flow in opposite

directions. At this point the valley is 475 feet in depth, measuring from its steepest portions, but is much deeper if measured from a line joining the tops of the moorlands on opposite sides. It should also be remarked that the relative steepness of the sides have an evident connection with their geological constitution. The valley is in the line of a large fault, along which the Millstone-grit is upheaved on the south-west side, and forms, in some places, a wall of precipitous rock.

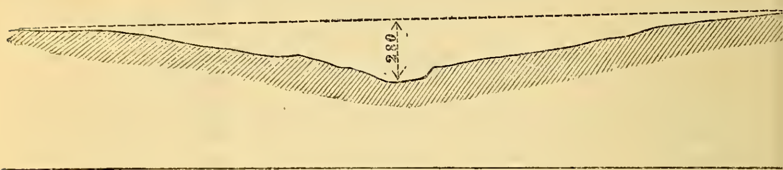


Fig. 3.—Whitworth Valley, South of Bacup.

3. The third instance (Fig. 3) is that of Whitworth Valley, between Rochdale and Bacup. Almost two miles south of the latter town it crosses the watershed. It is less striking than the other two cases just cited, but is worthy of notice from the fact that, at the point where there is no brook, the sides of the valley are very sharply cut. The hills on either side rise much higher than is shown in the figure.

4. The last example to which I shall especially refer is the Valley of Sabden—at the eastern base of Pendle Hill. This is a truly remarkable channel from its evident connection with the strike (or direction) of the beds of Millstone-grit. It commences at the valley of the Calder, near Whalley, and thence ranges in a nearly straight line for a distance of seven miles in a north-easterly direction. The ridge which bounds it on the south-east side is composed of hard grit, and is sharply defined—that on the opposite side is more broken, but is in some parts very steep. Not having the six-inch Ordnance Maps at hand, I cannot give the exact depth of this valley where the brooks rise; but, judging by the eye, it seems not less than 400 feet, and is probably more. The watershed crosses near the village of Newchurch, in Pendle, about two-thirds of the distance from the south-western entrance to the valley; and it is a curious fact that a branch of the river Calder crosses the opposite entrance on the north-east.

There are, doubtless, many other illustrations of the same kind throughout the Northern uplands; but the cases I have cited are sufficient for my purpose, which is to show that there are valleys—with all the appearances of "river valleys"—which have no connection whatever with, at least, the present streams. It may be replied that these were once river-valleys, but that in consequence of the changes in the relative levels of the different parts of the country, the streams have been diverted. This may be so, but I should like to have some evidence of it in the presence, for example, of some old river-terraces, of which, however, there are no examples as far as I have observed. On the other hand—from the elevation attained by the Drift, and erratic blocks on these hills—it is beyond question that at the Post-pliocene period nearly the whole country was submerged; and it is less incredible (to say the least of it) to assume the agency of the sea in the formation of these valleys (or parts of them), which we know *was* there, than that of a stream of which there is no trace.

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, or valleys within valleys, the smaller being alone due to river denudation. This is a subject, however, on which I have more fully stated my views in the pages of a contemporary,[1] and shall not further allude to at present; but before the enthusiastic advocates of sub-aërial denudation *for all valleys* can expect their views to meet with general acceptance, they must explain the origin of valleys without rivers such as those of the uplands of Yorkshire and Lancashire.

I remain, your obedient servant,

EDWARD HULL.

GEOLOGICAL SURVEY OF GREAT BRITAIN,
Manchester, 11*th Sept.*, 1866.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—Permit me through the medium of your Magazine to direct attention to some remarks made by Mr. J. W. Salter in the Appendix to the Memoirs of the Geological Survey of Great Britain, Volume III., lately published.

In reviewing the group of *Cystideans* (page 284), which had been so ably and philosophically handled in the preceding volume of the Memoirs, by the late Professor Edward Forbes, then Palæontologist to the Survey, Mr. Salter takes upon himself the responsibility of expunging the identification Professor Forbes believed he had correctly made, of specimens collected by the Survey from Rhiwlas, and Sholes Hook, in Wales, with *Echinosphærites* (*Sphæronites*) *aurantium*, describing them as a new species under the name of *Sphæronites stelluliferus;* the figures to illustrate this and the other fossils on Plate 20 being transferred from the very fine engraving by Mr. Lowry, originally made for Professor Forbes' article in vol. ii. part 2.

As to the correctness of Mr. Salter's views with regard to the structure of this singular group of Silurian Echinoderms, wherein he differs from Professor Forbes, I do not at present intend to enter; I cannot, however, allow the remarks on some of these species to remain unrefuted as I consider them unjust to the memory of one so universally admired for the strict probity and correct scientific observation, so characteristic of our late highly esteemed friend.

The following are the passages I especially allude to (the italics

[1] The forthcoming number of the Popular Science Review.

except where used for the scientific names are my own); at page 287 under *Sphæronites stelluliferus* "Pl. 20, fig. 6 (6*a wrongly figured*)."

S. aurantium, Forbes, Mem. Geol. Survey, vol. ii., pt. 2, pl. 22, figs. 1, *a*, *b*.

"It was not a bad idea to put these species among the multiplied varieties of *E. aurantium*, for it really is allied to it; yet it differs in nearly all its characters. What is regarded (Forbes, *supra* fig. 1*a*) as the base is really the epauletted apex, *and assuredly the external ornament* (here fig. 6a) *has been much exaggerated* to suit *the view taken of its affinities*. It is far too much radiated; and I only give it in the hope of calling attention to the fact that the common northern species, *E. aurantium*, has never been found in Britain unless "*Ech. granulatus* M'Coy be, as Forbes suspected, the same species: it is very much like it."

Again, lower down on the same page are these expressions: "Fig. 6*a* represents the outer surface, but, as above said, *highly exaggerated as to the radiation. Nor is the central tubercle conspicuous, and I cannot help believing that Forbes had allowed his artist to figure a portion of the true foreign aurantium to make up for deficiences in the British specimens supposed identical. Such mingling of figures, however, must be condemned as tending to create confusion. It is introduced here to call attention to it and prevent future mistakes*."

As I am the "*artist*" alluded to in the above extract, and "*Forbes*" (Professor Forbes) is the author of this assumed misrepresentation of facts, I beg to state my firm belief to be that the figure was correctly drawn by me, from *Welsh* specimens, as clearly described in the explanation of the original plates accompanying Professor Forbes' articles (Mem. Geol. Surv., vol. ii., part ii., p. 537,) as follows:

"Plate XXII.—*Sphæronites aurantium*.—*a*. specimen showing the base; *b*. cast, showing the plates; *c*. external structure of the plates: *all from Wales*, and in the collections of the Geological Survey;" and that it is highly improbable Professor Forbes would have "allowed" me to copy the markings upon a foreign specimen of the species he wished to identify it with, without, at least, stating such to be the fact.

I remain, sir, very truly yours,

Wm. Hellier Baily.

Belleville, 135, Rathgar Road, Dublin.
Sept. 15, 1866.

MISCELLANEOUS.

Figures of Characteristic British Fossils.—Mr. William Hellier Baily, F.G.S., F.L.S. (Belleville, 135, Rathgar Road, Dublin), Acting Palæontologist to the Geological Survey of Ireland, announces that he is about to publish, uniform in size with Professor

Morris's "Catalogue of British Fossils," a series of Lithographed Plates (tinted), containing figures of species characteristic of the principal groups of British Fossiliferous Strata. The desirability of such a series of figures as an important aid in the identification of strata will appear obvious to those engaged in the study of geology, and in mining operations. Mr. Baily proposes to issue these plates, consisting of faithful representations of the most remarkable fossils (original, as far as possible), at short intervals, in numbers, without descriptions, but with an explanation of each plate. Each wrapper, to include ten plates, price 5*s*. Such a work will be extremely useful and we heartily wish Mr. Baily's publication the success it deserves; the labour, however, will be immense.

Important Discovery.—After the patient and costly labour of four years, coal has at length been struck in the New Stafford pits, near Priors-lee, on the line of railway between Wellington and Shiffnal. The coal is of the description known as the double coal, the seam is six feet three inches in thickness, and, lying perfectly horizontal, promises a rich field. At present, the men are working through the yellowstone, ironstone, and yard coal; and from the geological characteristics of the district it is confidently expected that the blue and white flat ironstone, the flint coal, the pennystone, the sulphur, and other mineral strata of great value will succeed in due course. The distance at which this coal has been struck is only 620 feet, but the cost of working the mine has, nevertheless, been considerable, from the unusually hard nature of the rock through which it has been reached. The works have been carried on under the direction of the Lilleshall Company, but it is understood that Lord Granville and the Duke of Sutherland are principally interested in the discovery. The pit is one of the most easterly in the Shropshire coal-field, and is sunk just where the Coal-measures are overlapped by the Permian beds. Another sinking, about three and a half miles to the south of the new Stafford pits, is being carried on by the Madeley Wood Company, in the parish of Kemberton, where Permian red marls and sandstones, from sixty to eighty yards thick, overlie the Coal-measures, the upper part of which has been penetrated to a considerable depth. These two pits will be of the greatest value in helping to determine the easterly extension of the Shropshire coal-field, and, when completed, will probably lead to sinkings being made further to the east through the red beds separating the Shropshire and Staffordshire coal-fields.—G. M.

Earthquake Shock in Paris.—At about 5.15 yesterday morning a shock of an earthquake was felt in parts of Paris and its neighbourhood, especially in the direction of Versailles, in which town persons say that when awakened by the motion they heard a cracking of the walls and floors, and that the first shock was followed by several others. Persons in Paris have told me they awoke about the time the shock took place, but went to sleep again without being aware of what had occurred. It appears that it was also felt in the departments, chiefly, as far as is yet known, in the west, centre, and south-west of France. The shocks are estimated to have taken eight or ten seconds. At Limoges it seems to have been severe and accompanied by a noise compared to that of trains passing through a tunnel, and in the houses, according to letters received, the beds moved, the crockery and glass clattered, the bells rang, and the inhabitants were all on foot. In the neighbourhood of Paris I know of persons who got out of bed in alarm, thoroughly roused by the first shock. Earthquakes are complete novelties in nearly all the districts where we know of this one having been felt. At Niort there was a slight shock a fortnight ago.—*Times*, Sept. 17th.

OBITUARY.

Death of M. Louis Sæmann, Memb. Instit., etc.

During the Meeting of the British Association at Nottingham, the Editor received the following sad announcement:—

To the Editor of the Geological Magazine.

Sir,—I have the sad duty to advise you of the death of my friend Louis Sæmann. He died the 23rd instant, in Paris, of congestion of the lungs, at the age of 44. It is a loss to science and his numerous friends, and particularly to your Magazine, for which he wrote a pamphlet "On Meteorites,"[1] in course of publication, and which he had not the satisfaction to see in print before his decease.

I am, sir, very truly yours,

Jules Marcou.

Paris: 44, Rue Madame, 26 *August*, 1866.

Charles Maclaren, Esq., F.R.S.E., F.G.S., died at his residence, Moreland Cottage, Grange, Edinburgh, on Monday, September 10th, at the advanced age of 84. He was born in 1782. In 1817, when holding a subaltern office in the Customs, he established, in connection with the late Mr. W. Ritchie, the *Scotsman* newspaper, and acted as its anonymous editor for four or five months. Circumstances rendering it inconvenient for him to appear as editor, he relinquished that post to the late Mr. J. R. M'Cullock. He resumed it, however, after an interval of two years, and continued to exercise the editorial functions until compelled by ill-health to resign them in 1847; still, however, writing occasionally for the paper, when placed under the management of Mr. A. Russell. He was the author of "A Treatise on the Topography of Troy." (1822), of which, after visiting the district, he published an improved and illustrated edition in 1863, under the title of "The Plain of Troy Described." He also wrote "The Geology of Fife and the Lothians" (1839); some articles in the *Cyclopædia Britannica*, and contributed many scientific papers to the *Edinburgh Philosophical Journal*. Mr. Maclaren was one of the chief promoters of the Edinburgh Geological Society, and was elected President in 1865, which office he held until the time of his death, though unable to deliver the annual address, which was supplied by Mr. David Page, and entitled "Geology and Modern Thought."

[1] See the Geological Magazine for August, p. 362, and September, p. 414.

THE

GEOLOGICAL MAGAZINE.

No. XXIX.—NOVEMBER, 1866.

ORIGINAL ARTICLES.

I.—On the Australian Tertiary Species of *Trigonia*.

By Frederick M'Coy, F.G.S.

Professor of Natural Sciences in the Melbourne University; Director of the National Museum of Victoria; Palæontologist to the Geological Survey, etc., etc.

As I have prepared descriptions of nearly all the fossils of Victoria collected by the Geological Survey under Mr. Selwyn for some years, I have been urged to make a preliminary publication in the Geological Magazine of some of the more remarkable forms, and I now forward my descriptive note of the two Tertiary *Trigoniæ*, on account of Mr. Jenkins' paper in the May number of this Journal, in which one of them is referred to the recent *T. Lamarckii*. I feel assured that if Mr. Jenkins will look at the edge along the ribs, towards the beak of a recent specimen of *T. Lamarckii* and my *T. acuticostata* from the Tertiary beds, he will at once appreciate the distinctive form of the ribs which I point out and figure in the annexed woodcut.

1. 

2. 

Fig. 1.—*Trigonia acuticostata*, M'Coy. Older Pliocene, &c., Victoria, South Australia.

Fig. 2.—*Trigonia Lamarckii*, Mathn. Recent Australian Seas.

Description of New Species.

1. *Trigonia semiundulata* (M'Coy).

Sp. Ch. Rotundato oblong, little longer than deep, moderately convex, anterior and ventral margins broadly rounded, posterior margin nearly straight, abruptly truncated, forming an angle of 120° with the hinge line; posterior slope flattened and radiated with about ten or eleven strong obtusely rounded ridges, separated by rather wider flattened spaces, and crossed by lines of growth near the margin, closer and spinulose near the beak, and followed on the lunule close to the hinge-line by six or seven much smaller spinulose ridges; middle and anterior portions of the valves covered with narrow rounded, slightly undulating ridges, nearly parallel with the ventral margin, crossed, except on the anterior portions, by rather faint impressed sulci radiating from the beak to the ventral margin, nearly the same distance apart as the ridges of the posterior slope. Length of longest specimen, two inches; proportional width from beak to ventral margin $\frac{80}{100}$; length of anterior side $\frac{25}{100}$; length of hinge line $\frac{60}{100}$; of truncated posterior margin $\frac{50}{100}$; depth of one valve $\frac{25}{100}$; average length $1\frac{1}{4}$ inches.

I sent labelled specimens of this species to the second Great Exhibition in London. Mr. Jenkins gives a figure of it in the "Quarterly Journal of Science," in which the transverse ridges are not sufficiently thin, numerous, or undulated.

It is easily distinguished from any known recent or Tertiary species by the rippled appearance produced by the undulated concentric ridging of the anterior two-thirds of the valves; the posterior slope is abruptly marked by the ridges being only radiating. The transverse ridging, though common in the Mesozoic *Trigoniæ,* is not found in the recent species.

Very abundant in the sandy beds of Bird-rock Bluff Ad. 22 and Ad. 24.

2. *Trigonia acuticostata* (M'Coy).

Syn. *T. Lamarckii,* Jenkins, GEOL. MAG., Vol. III. p. 201, Plate X., fig 3–7 (not of Mathn.)

Sp. Ch. Rotundato rhombic moderately convex; posterior slope flattened; anterior and ventral margins rounded; posterior margin obliquely subtruncate nearly straight; respiratory angle obtusely rounded; anal angle about 130°; surface radiated with about thirty-two acutely angular ribs, about thirteen of which are on the posterior slope; the intervening spaces seem wider than the ribs from the sides of each rib gradually converging to an acutely angular line closely set with numerous small thorny tubercles (about seven in. three lines, at six lines from the beak); intervening spaces coarsely striated and wrinkled at right angles to the length from anterior to posterior end 1 in. three lines; proportionate width from beak to opposite point of ventral margin $\frac{90}{100}$; depth of one valve $\frac{30}{100}$; length of anterior side $\frac{20}{100}$; length of hinge line $\frac{52}{100}$; of truncated posterior margin $\frac{55}{100}$.

This species is easily distinguished, even as a fragment, from the *T. Lamarckii, T. pectinata,* and other recent species, by the character indicated in the specific name, *i.e.* the remarkable compression of the ribs into acute angular ridges, Woodcut Fig. 1; and from the same cause the spinous tubercles do not form the broad, blunt, transverse tubercles which they do in the recent species, in which the ridges form broad, obtusely flattened, almost square ribs, when viewed from the margin in a position in which those of the present species form a series of acute angles.

Not uncommon in the older Pliocene beds of Mordialloc in Hobson's Bay. Rare in the Upper Miocene beds of Muddy Creek.

The specimens above referred to were collected by the Geological Survey, and are deposited in the National Museum of Melbourne.

II.—On the probable Glacial Origin of certain Phenomena of Denudation.

By the Rev. O. Fisher, M.A., F.G.S.

The pages of the Geological Magazine have lately contained some interesting articles on denudation. I wish to add some further remarks on the subject, which I think will, if duly considered, add important elements to the discussion of that problem.

In my paper "On the Denudation of Soft Strata," read before the Geological Society in 1861, I combated the view then generally held, that the present contour of the country was due to the ordinary action of the sea, as the land was slowly elevated above the waters. At that time I had perceived that the denuding agent must have flowed from higher to lower levels, and I suggested the flowing off of water owing to a sudden elevation of the land. I am not prepared entirely to recant those views, for I believe we shall err in this, as we are liable to do in all physical problems, by summarily excluding any possible explanation of the phenomena.

Messrs. Foster and Topley did me the honour to quote my argument against the possibility of escarpments being Old Sea Cliffs, in their paper "On the Denudation of the Weald;"[1] and Mr. Topley has repeated the argument in the last number of this Magazine.[2] His explanation of the formation of escarpments in that article is very good, and, in general, I believe the true one, in as far as he has shown how a denuding agent has worked to cut out the valleys and leave the escarpments. But the point I wish to discuss at present is what that denuding agent has been.

Rain and rivers are the agents now chiefly relied upon. They have, no doubt, done much, and are still at work: so that we can judge of their past labours by their present effects. But I believe I have succeeded in proving in my paper "On the Warp," in the forthcoming number of the Journal of the Geological Society, that the present surface of this country has been eroded into channels by a plastic mud or gravel derived from higher grounds, and forcibly indented into the surface. The materials in these furrows (and sometimes we have extensive coverings of it, not mere furrows[3]) I have called "trail." The junction of the trail with the subjacent bed, where that is clay, is constantly marked with "slickenside;" and my own impression is, that pebbles near the surface of junction are somewhat polished. I do not believe it possible that any theory of denudation can be of the least value which ignores the existence of this almost universal coating of the surface. It is necessarily the

[1] Quart. Jour. Geol. Soc., Vol. xxi. p. 463. [2] Geol. Mag. Vol. III. p. 435.

[3] An excellent exhibition of the trail, under this aspect, will be found in the brick-pit at Uphall, near Ilford, the same pit from which came the head and tusks of *Elephas primigenius* in the British Museum. Here I saw from the trail an angular block of grey weather sandstone, weighing about twenty-five pounds.

key to the *last* denuding agent. The unstratified character of this trail, the large blocks of stone which it sometimes contains, while the subjacent bed perhaps contains none, the unscattered condition of lumps of clay, crag, and sand, which sometimes occur in it, the force which evidently acted to push it forward, all point to *land-ice* as the moving agent.

We need not be surprised at the existence of land-ice at comparatively recent geological periods, even in the south of England, for Mr. Jukes has described Glacial Striæ in Devonshire,[1] and in the south-west of Ireland;[2] and the Hon. W. O. Stanley informs me that Anglesea, which is not high ground, is generally ice-marked. The reason why such markings are rare in the south of England is probably that the surfaces are so often of materials liable to disintegration and solution. This is exceedingly well illustrated by Mr. Green's remarks, "On the Bloody Stone in Derbyshire,"[3] where scratches are preserved on chert, but usually effaced on the containing limestone.

Thus far, then, we see that the general covering of the surface indicates ice-action, and that it is probable, from other independent indications, that land-ice has lately covered the existing surface. The next point is to balance the probable efficacy of ice, as compared with water, to mould the surface to its existing form.

Conceive the actually existing surface of any district, which consists of soft strata, to be intersected by a nearly horizontal plane. The curves of intersection will be full of cusps or sharp angles, running up into the secondary (or tributary) valleys. It seems self-evident that a river gradually deepening its bed (which in the case supposed would be represented by the gradual lowering of the horizontal plane) could not excavate a level area of such a configuration.

Frequently one meets with evident instances of the erosion which a stream has produced, and I never saw a case in which it was not possible to distinguish readily the work of the stream upon the previous configuration of the surface which had been left by the more general ancient denuding agency. Messrs. Foster and Topley rely much, in their paper "On the Denudation of the Weald," upon a river gravel at an elevation of 300 feet. I do not know the locality; but does it follow that because the river has once flowed at a higher level, therefore the subsequent degradation of the surface is the work of the river?

Mr. Maw, at p. 445 of the last number of the Magazine, very justly distinguishes between the excavation by a river at the bottom of a valley, and the denudation of the valley itself. But upon comparing the absolute quantity of material abraded by the river, with that removed from the valley sides by some other cause, we see how much larger the latter is; and on the supposition that the

[1] Geological Magazine, Vol. II., p. 473.
[2] Juke's School Manual (1863), p. 326.
[3] Geological Magazine, Vol. II., p. 440.

work has been effected, simultaneously from its commencement, by atmospheric causes on the sides and river action at the bottom, we arrive at the conclusion that the abrading power of the atmosphere far exceeds that of the river, which, when once the sides have reached the angle of repose, seems very improbable.

Sir Roderick Murchison, in his address to the geological section at the last meeting but one of the British Association, said: "I do not believe that the wear and tear due to atmospheric subaërial erosive agency could, even after operating for countless ages, have originated and deepened any of the valleys and gorges which occur in countries as flat as the tract in which we are now assembled" (which was the neighbourhood of Birmingham). In this sentence the argument rests upon the *flatness* of the surface. It is impossible to conceive a very rapid flow of water caused by rain upon a moderately flat surface of upland. A current of water of a given velocity cannot move an ordinary pebble which is above a given size. A current which can just move a given pebble can, roughly speaking, move any smaller pebble of the same or less specific gravity. Yet, in a mixed gravel, pebbles too large for the flow of water to move will, nevertheless, progress by the washing away of smaller stuff in front of them. A temporary inclined plane is thus formed, down which the pebble rolls partly by its own weight. Thus it happens that where the stream is too slow to move the larger pebbles, if there be sufficient fall in the ground they nevertheless slowly progress, but the small stuff moves off faster, and the pebbles accumulate behind. Thus the gravelly bottoms of rivers are formed. If then, the degradation of gravelly strata has been produced by rain wash, we ought to have most of the larger pebbles corresponding to the denuded material left behind. This is certainly not the case. A still more obvious difficulty is the removal of large blocks from escarpments. Take, for instance, such blocks as those which form the upper portion of the Greensand in Dorsetshire, which are notably seen at Eggerdon-hill and Bincombe-down. What has become of those which must have fallen as the hills were cut back? We see a few lying about on one side of Eggerdon, where a landslip has occurred, but those which must have fallen as the Chalk was degraded, if by atmospheric agency, ought to cover the spurs of the hill and the bottoms of the valleys.

Let us now suppose the land to have been covered with a sheet of ice, what would be the character of the denudation? I endeavoured to explain, in a letter to the "Reader,"[1] what I conceived to be the *modus operandi* of ice in the particular case of excavating a lake basin, and Mr. Jamieson has very well illustrated the nature of the motion of a sheet of ice by that of a quantity of corn heaped up upon a floor.[2] As its height is increased the grains in contact with the floor move outwards from the centre. Provided, then, that a sufficient thickness of snow were supplied, the ice would always move outwards from some central region towards the sea.

[1] Reader, April 25, 1865. [2] Quart. Journ. Geol. Soc., Vol. xxi., p. 166.

In the first place, then, the smallness of the inclination of a surface would not prevent motion, and consequent friction and denudation. Secondly, there would be no selection made of the materials carried away, while a certain quantity of *till* containing all the ingredients of the surface derived from an area in rear, would be interposed between the ice and the land. The remains of this I suppose to constitute what I have ventured to call the trail. The softer strata would be worn away most quickly, and, in general, each successive outcrop would be maintained at a uniform level depending upon its hardness.[1] I should expect that, when a soft rock had been denuded to a certain depth in proportion to the thickness of the ice-sheet, a fissure would be formed, causing an ice-fall, which would excavate a steep escarpment at the junction of a harder with a softer stratum. We know that it is the tendency of an ice-sheet to "descend towards the sea in successive steps, leading up to as many icy-platforms, the ridges and valleys (of the land) being levelled up to one uniform plane, and concealed by these tabular masses of ice." (See Sir C. Lyell's account of the continental ice of Greenland: "Antiquity of Man," p. 235, ed. 1863.) The thicker the ice-sheet the more uniform its action upon the surface would be, and the less it would tend to form minor features. But as the climate gradually became milder, and the ice-sheet thinner, features would be formed on a smaller scale, and it would be these which we should now see.

As far as I have had opportunities of examining the furrows that I have described, I have noticed that they are largest and most numerous in the neighbourhood of valleys, and are either parallel or inclined at a small angle to them.[2] This is what we should expect: for, according to the theory, the valleys represent the directions in which the ice flowed off during the later periods of its existence; and since the sheet would partake of a similar motion for some distance on both sides of the line of maximum flow, we should find the surface scored, in a minor degree, nearly in the same direction as the valley.

Finally, the sheet would be confined to the higher grounds with glaciers descending towards the plains.

To seek for the beds of extinct glaciers among Chalk downs might be thought fruitless. Nevertheless, I have noticed combs in the Wiltshire downs which have much that appearance. There is one in particular above the village of Heddington, near Calne, up which the footpath to Devizes runs. Its sides are steep walls of Lower Chalk, and in general form and inclination it most closely resembles

[1] An excellent illustration of the effect of the comparative hardness of material, in determining the form of the ground, may be noticed in the neighbourhood of Cromer. The landscape suddenly changes from one of a rather monotonous character to one of rapidly varying hill and dale, on account of the extremely irregular collocation of masses of clay, chalk, and gravel, among the glacial deposits of that district.

[2] The workmen at Ilford told me that the furrows all ran nearly in the same direction, which was one inclined at an angle of about 45° to the River-valley adjoining.

a small glacier bed. In the same down there are also some very singular combs just beneath Oliver's Camp, which have all the appearance of glacier beds. At their lower end, a dry bed of a former torrent suddenly commences, as if it were the seat of the old glacial river.

About Tollard Royal, in the Chalk downs north of Tisbury, some of the combs are very deep, and their sides steeper than will allow the Chalk, as it disintegrates, to lie upon them. It forms a talus at the bottom. This points to an agency which has left nearly perpendicular walls upon the sides of the combs, an effect which glaciers would produce.

Agreeing, as I do, with Professor Ramsay in his theory of the erosion of lake basins by ice, I look to that agent for the formation of such basins as the Broads, of Norfolk;[1] and I think that many of the basins in other districts now occupied by lacustrine deposits may have been formed in a similar manner. Indeed, on any other theory, it is hard to account for peat bogs and lacustrine deposits in certain situations.

It is obvious that the view I have taken of the mode of denudation is not in any way inconsistent with those phenomena which have been attributed to the effects of solution, such as pipes in Chalk and Limestone strata, or with the formation of caverns by solution of the rock. A constant supply of water to the surface would be afforded by the liquefaction of the lower surface of the ice.

After the disappearance of the ice, the surface of the country would become gradually covered with vegetation, while the work of rain and rivers and frost would commence to modify the form and condition of the surface. But the grand general features, which, to my apprehension, are not attributable to the last-named agents, would have been already impressed upon it.

We have geological evidence of constantly alternating conditions of an arctic and a temperate climate in these latitudes, at least, since the period of the Norwich Crag.

But I am much mistaken if, in the eastern plain of England, any part of the configuration of the surface dates further back than the great submergence which deposited the Boulder-clay containing so much Chalk and Oolitic *debris*—the "Upper-drift" of Mr. S. V. Wood, Jun. Since that period the surface has been under constantly varying conditions; the glacial periods having in all probability become less and less severe. The present contour of the surface is the accumulated result of these varied conditions throughout long ages. My object in this article has been to suggest that the glacial periods have been those to which the form of surface is chiefly due.

[1] Possibly Norfolk, from its situation, may have been colder than other parts of England, being in the neighbourhood of an arctic current; and its valleys may have been filled by ice while, in other places, alluvial beds were in course of formation.

III.—On some Fossils from the Graptolitic Shales of Dumfriesshire.[1]

By Henry Alleyne Nicholson, B.Sc.

(PLATE XVII.)

THE Upper Llandeilo Rocks of the South of Scotland have long been known to yield graptolites in great profusion, few other forms of animal life being recognised as occurring in them. Having, this summer, had an opportunity of examining the graptolite-shales of Garple Linn, near Moffat, I was struck with the occurrence in them of numerous bodies, differing from the graptolites in form, though resembling them in mineral texture.

These bodies present themselves as glistening pyritous stains, scattered in considerable numbers among the graptolites upon the surface of the shale. In their most perfect condition (Plate XVII. Fig. 1, 2) they appear to be bell-shaped bodies, averaging three-tenths of an inch in length, and two-tenths in breadth, and provided at one extremity with a prominent spine or mucro, the other terminating in a gently curved or nearly straight margin. When compressed from above downwards, a condition in which they not seldom occur (Fig. 4, 5), they appear as oval, or rounded patches, often very definite in their outline, and presenting somewhere within their margin an elevated point, surrounded by several concentric, elliptical, or circular rings, disposed with more or less regularity. The elevated point marks the position of the mucro, and the concentric ridges are merely due to vertical compression. In this state they are not unlike orbicular brachiopods in appearance.

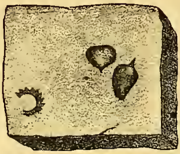
The texture of these bodies appears to have been corneous, like that of the graptolites themselves, but they show no traces of structure beyond the presence of the mucro, from which, in some well-preserved specimens, a filiform border is prolonged along the free margin of the body. The mucro appears to have constituted the most solid portion, standing up as a marked elevation, when obtained in relief, and leaving an evident hollow in the cast. In most cases these bodies are free and independent, but they occasionally occur in such close juxtaposition with the stipe of a graptolite, as to justify the belief that the connexion was organic and not simply accidental. The only case in which I have observed this is in *Graptolites Sedgwickii* (Fig. 3, 3 *a*), the form in which it might most reasonably be expected, as the cellules are separated from one another by a conspicuous interval till close to their bases. In this case the body appears to spring from the common canal, or cœnosarc, of the graptolite, and the mucro appears to have been situated at the free extremity, and therefore to have constituted a point of dehiscence rather than one of attachment.

The occurrence of these bodies in shales crowded with graptolites and graptolitic germs, and their close connexion in some cases with the graptolites themselves, would seem to warrant the conclusion

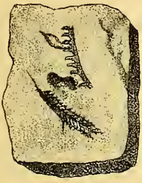
[1] Read before Section *C.* British Association, Nottingham.

1

1a

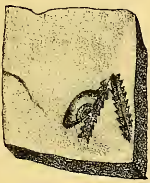


2



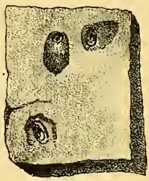
3

3a



4

4a



5

FOSSILS FROM THE GRAPTOLITE SHALES OF DUMFRIESSHIRE.

1. Ovarian Vesicle of Graptolite (?) or "Graptogonophore" half natural size.
1a. The same magnified.
2. Ovarian Vesicles of Graptolites (?) half natural size.
3. Graptolites Sedgwickii, with Ovarian Vesicle (?) half natural size.
3a. The same magnified.
4. "Graptogonophore" vertically compressed. 4-a. Ditto magnified.
5. "Graptogonophores" vertically compressed. half natural size.

H.A. Nicholson del. *F. Dangerfield lith.*

that they may be "gonophores," or "ovarian vesicles," at first attached to the parent stem, but finally becoming free-swimming "zooids." Bodies somewhat similar to these have been described by Prof. James Hall (Decade II. of the Geological Survey of Canada), as occurring in the Quebec shales, in connexion with the stipe of *Graptolites Whitfieldi*, a diprionidian form; and these are regarded by him as reproductive cells.

If this conjecture as to the nature of these curious bodies (to which the term "grapto-gonophores" might be applied) be correct, then the *Graptolitidæ* would have to be finally referred to the *Hydrozoa*, and would find their nearest analogues in the *Sertularidæ*, from which, however, they would always be separated by sufficiently distinctive and definite characters.

The facts, that no traces of a central axis have been preserved in these bodies, and that they are not yet known to occur in other localities, where graptolites abound, would militate somewhat against this hypothesis; but the first may be due to the soft nature of such an axis, and the second may be referable to the attention of geologists not having been directed to them.

Since the above was written, I have examined the graptolitic shales of Dobb's Linn, Glenkiln, and Duffkinnel Burn in Dumfriesshire, and I have found similar bodies present in all these localities, though not in such plenty, nor so well preserved.

EXPLANATION OF PLATE XVII.

Fig. 1. Ovarian vesicle or "graptogonophore of Graptolite (?)," half natural size.
1*a*. the same magnified.
2. Ovarian vesicles of graptolites (?), half natural size.
3. *Graptolites Sedgwickii* with ovarian vesicle (?), half natural size.
3*a*. the same magnified.
4. "Graptogonophore" vertically compressed, half natural size.
4*a*. The same magnified.
5. "Graptogonophores" vertically compressed, half natural size.

IV.—On the Formation of the "Rock-basin" of Lough Corrib, County Galway.

By G. H. Kinahan, F.R.G.S.I., of the Geological Survey of Ireland.

(With two Lithographic Maps. Plates XVIII. and XIX.)

LOUGH CORRIB is a long irregular lake of various widths, but having a general bearing of about N.W. and S.E. Its N.W. portion is in a granite and metamorphic rock country, while the rest of it overlies Carboniferous rocks, principally limestone. The northern portion is deep, the southern shallow, and through the whole of it are scattered numerous islands which, in the former part, are generally composed of Boulder-clay, while those in the latter portion are nearly always rock. Its known natural outlets are two, one being over the barrier of metamorphic rocks at Galway (U on Map, Pl. XIX),[1] and the other a subterranean passage south of Castle-

[1] The accompanying Map (Pl. XVIII. and XIX.) is copied from the Index Ordnance Map of the county Galway, and on it, copied from the Chart of Lough Corrib, are the

gar (T on Map, Pl. XIX).[1] On all sides of the lake are rocks extending under it, or, to use Professor Ramsay's term, it lies in a "Rock-basin." What excavated this Rock-basin? I propose in this paper to consider.

It does not seem to have been formed by faults or displacements of any kind, as in different localities peculiar beds of rocks are either traceable across it, or will be found opposite one another on each side. One of these localities is half-way between Oughterard (K on Map, Pl. XVIII.) and the Ferry of Knock (O on Map, Pl. XIX.), where a remarkable set of cherty limestones can be traced in the islands across it. Another is between the mouth of the Owenriff or Owenfough (L on Map, Pl. XVIII.), the river that flows by Oughterard, and Ballycurren (M on Map, Pl. XIX.), where dolomite beds extend across the lake, and others are farther north, where peculiar beds of rocks are found opposite one another on each side. Neither does it seem to have been made by marine denudation, for though I believe it was that force which formed the main features of the neighbouring mountains, and during that time the rush of tide out of the narrow valley of Maum (A on Map, Pl. XVIII.) might have scooped a depression opposite the mouth of the valley; yet it seems hardly possible that marine denudation could have excavated out the entire "Rock-basin" now occupied by Lough Corrib.

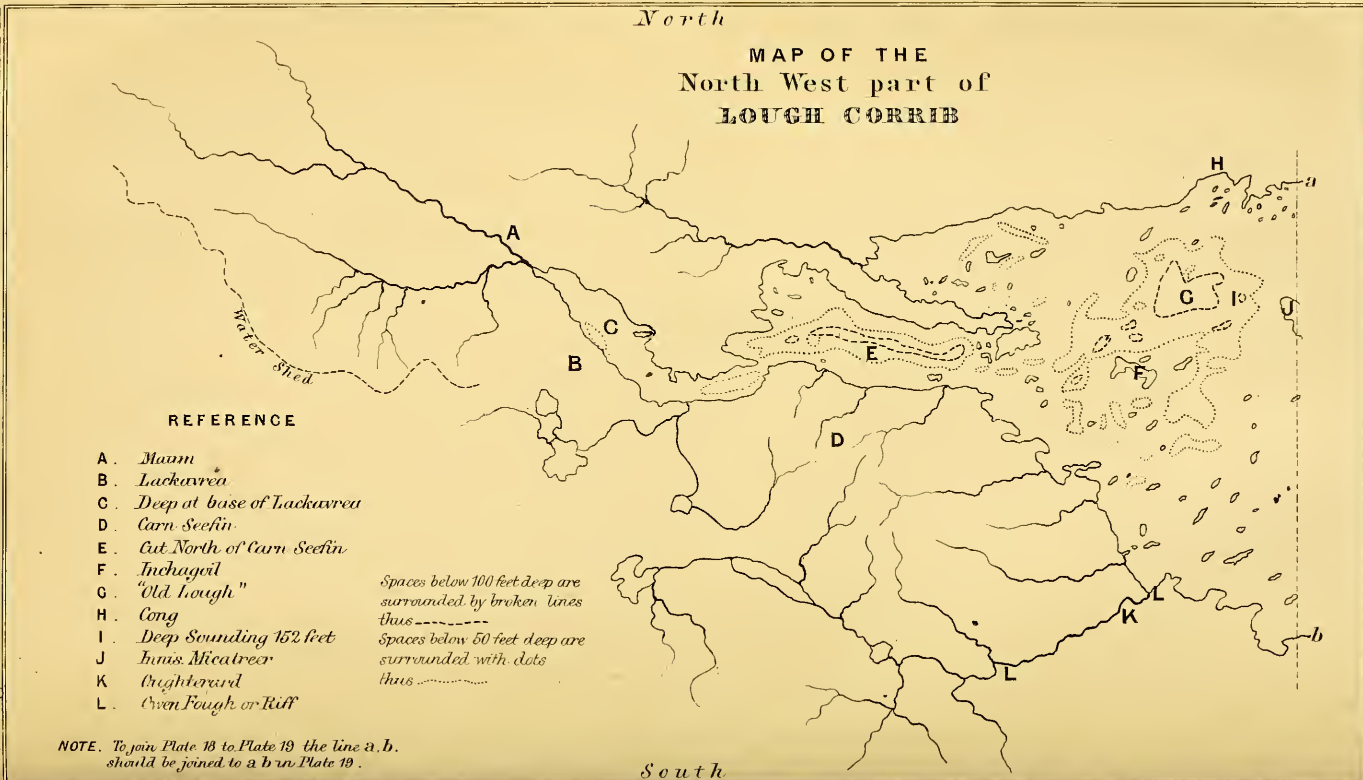
If the "Rock-basin" were not caused by faults, or excavated by marine denudation, could it have been formed by either running or solid water (*Ice*), or corroded out by the waters of the lake? The facts in connection with the corroding powers of the waters of the lake will first be considered.

The works carried on, about fifteen years ago, to improve the drainage of the neighbouring country, and to make the lake navigable from Galway upwards, have lowered the Lough about three feet, and made patent the following facts, to which my attention was first directed by Professor King, of the Queen's College, Galway. These seem to prove, as will immediately be seen, Col. Greenwood's remark in "Rain and Rivers," "that water by itself has very little power on rocks."

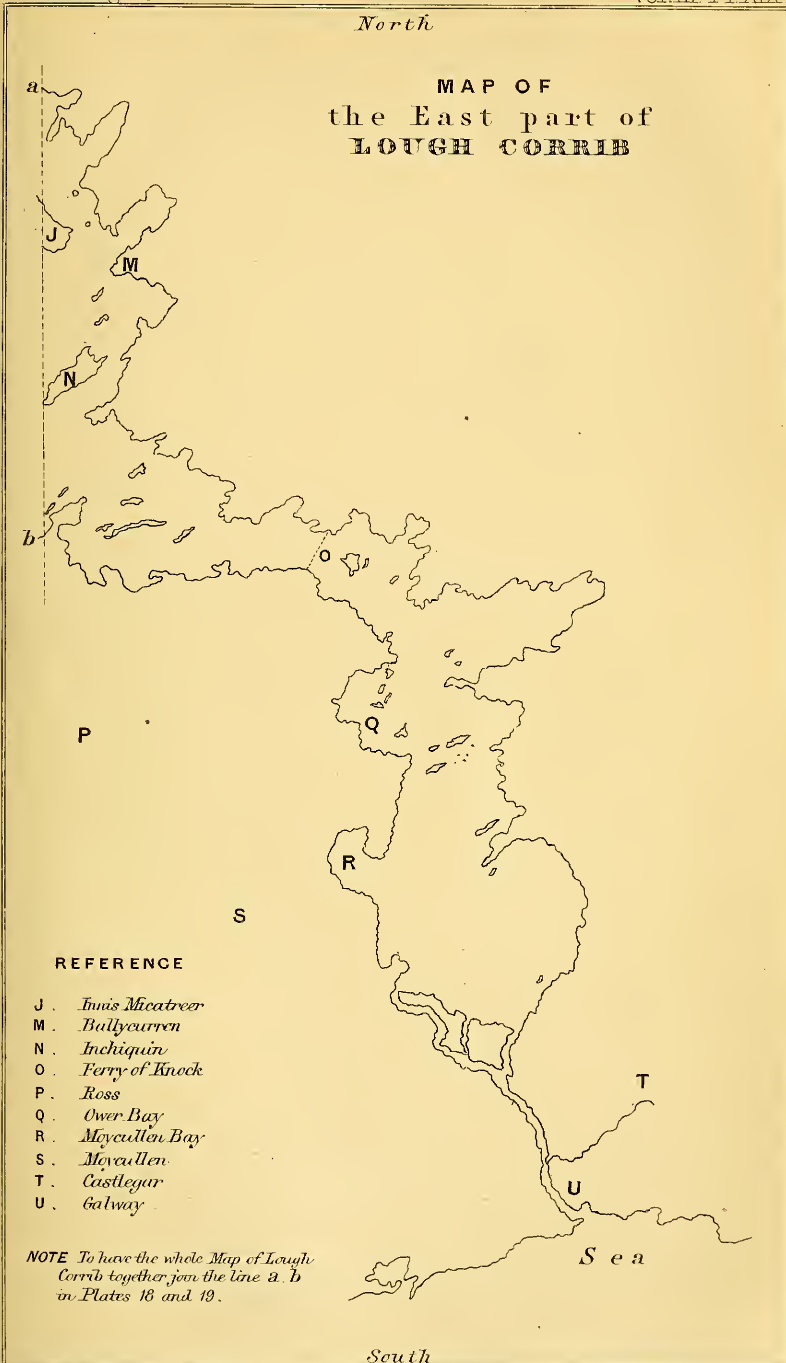
The limestones that are exposed to the dash of the water during the winter gales, and at other times to wind and weather, are rapidly corroding away; next to them the limestones, which, previous to the lowering of the lake, were exposed during the summer months; while the rocks that are now exposed during the summer months are only beginning to weather, and the rocks that are below the summer level and always covered with water, seem scarcely, if at all, weathered. Moreover, if the water of the lake corroded away the rocks and formed the "Rock-basin," it

parts of the lake that are respectively below the 100 and 50 feet contour lines; the former being surrounded with a broken line, and the latter by dots. Not to crowd the map, all the places that are referred to in this paper are marked by letters, while other names are left out.

[1] The passage to the Castlegar outlet was closed about fifteen years ago by the Board of Works, to facilitate the navigation of the Lough.



F. Dangerfield lith.



F. Dangerfield lith:

ought to have acted more on the soft limestones than on the hard metamorphic rocks. This seems to be contrary to facts, as most of the portion over the latter is deep, while nearly all the shallow part of the lake is cut out of the limestone. That the waters have scarcely affected the metamorphic rocks since the glacial period seems proved by those rocks—so far as can be seen under the water when the lake is at its lowest summer level—being ice scratched, rounded, and in places polished.

If the water of the lake did not corrode away the rocks, could they have been worn away by running water and the other subaërial agencies? This at first seems to be impossible, as the barrier of metamorphic rocks, across the lake's outlet at Galway, is even now higher than most of the bottom of the lake.[1] However, if water and the other subærial agencies have the power of wearing away rock, it might not have been impossible here; for from the "Rock-basin," part of it being in a limestone country, there may have been subterranean passages through which the drainage could escape. There was one at Castlegar that carried off part of the water, and why might there not have been others? In the Annals of the Four Masters, A.D. 1178, and in O'Flaherty's History of H-iar Connaught,[2] we find four times during the historic period, namely A.D. 1178, 1190, 1647, and 1683, "that the river at Galway suddenly went dry. and remained so for a few hours during very low tides." Might not this point to old subterranean passages? If these did exist, they would have been outlets from the lake, while the land was higher than now, but would cease to act when the land sank, and the surface of the lake was only a few feet above the level of the sea. Moreover, they would be liable to be choked up by the sand, etc., swept into them by the waves, as the water could not flow through them except when the tide was very low, and it may have been during four of these very low tides that the phenomena, recorded by the Four Masters and O'Flaherty, occurred. For if the entrance to one of these passages was left dry for a few hours, or with only a small depth of water over it, the weight of the water in the lake might force out the sand, etc., that filled the passage, and so find a vent through which to flow instead of down the open river at Galway, until the returning tide dammed up the water, and as the tide did not for years recede so far, the passage would again be choked up.

Let what seems in favour of subterranean passages now be considered. On examining the chart of the lake it will be observed that north of a N.E. and S.W. line, drawn from Oughterard (K on Map, Pl. XVIII.) to the south point of Inchiquin (N on Map, Pl. XIX.) the lake is generally deep, while, southward of it, it is shallow, and that none of the latter, excepting the narrow passage at the Ferry of Knock, is over 29 feet deep;[3] also that S.E. of this line it is shallowest toward

[1] This barrier was lowered considerably during the navigation and drainage works previously mentioned.

[2] History of H-iar Connaught, by Roderic O'Flaherty, Esq. Edited by James Hardiman, M.R.T.A. Pages 28 and 29.

[3] The depths given are those on the chart, which was made before the drainage and navigation works; now the lake is a little shallower.

the south end, while it gradually deepens toward the north, and on the north of the line the soundings still gradually become deeper until they reach a tract over 100 feet deep (G on Map, Pl. XVIII.), which lies about two miles south of Cong (H on Map, Pl. XVIII.). That a little east of this pond is a deep isolated hole, 152 feet (I on Map, Pl. XVIII.); also between this pond and Innis Micatreer (J on Map, Plates XVIII. and XIX.) there is a long deep patch that bears about N.E. and S.W.; and S.W. of the pond there are four long deeps which have similar bearings; while, surrounding these deep places, there is a tract that also has a similar general bearing, over 50 feet in depth. This area, over 50 feet deep, including the deep patches, is called by the fishermen on the lake "The Old Lough."

At Inchagoil (F on Map, Pl. XVIII.) there are limestones *in situ*, and also at Cong; it may therefore be safely concluded that part at least of "The Old Lough" is in a limestone country, and as these limestones are cavernous, which is proved by the subterranean passages and caves between Loughs, Mask and Corrib, there may also have been an underground passage from "the Old Lough." If this was the case there would be from one of the lowest parts of the lake—the part to where all the southern portion has a gradual fall—a passage, into which the drainage of the "Rock-basin" would flow. These streams, combined with the other subaërial agencies, might, even though in the smallest degree, have helped in excavating that basin.[1]

That large tracts of country are drained through subterranean rivers is a well-known fact. In Ireland there are many such river systems; one of the largest being at Gort, county Galway, where miles of country drain into Coole Lough, and from thence through subterranean passages, five miles long, into the sea at Kinvarra. The subterranean river from "The Old Lough" would have been at the least 18 miles long.

The foregoing theory might account for the formation of a portion of the "Rock-basin," but there is still the bay that leads up to Maum, where, near its entrance and due north of Carn Seefin (D on Map, Pl. XVIII), there is another "deep" that consists of a long narrow gut, over 100 feet, surrounded by a margin over 50 feet deep, (E on Map, Pl. XVIII). This deep could scarcely be accounted for in a similar manner to that just now mentioned in connection with "The Old Lough;" for while part at least of the latter may be in limestone and excavated as suggested, the whole of this gut must have been denuded out of the hard metamorphic rocks; and as caverns or subterranean passages are rare in them, there could scarcely be an underground passage from this place; and if there was not, subaërial action would have no power to excavate it.[5] Neither is it

[1] Any one who can look so far back may bring in this name—"The Old Lough"—as evidence in favour of this theory, as the place may be so called from a tradition handed down from the Pre-glacial men "of the time when the lake did not exceed these limits."

[2] Full particulars about the Coole Lough water-basin are given in the Mem. Geol. Survey of Ireland, Ex. sheets 115 and 116 p. 7.

[3] What might be considered in favour of a subterranean passage out of this gut is,

likely that it was ever joined to "The Old Lough" as a rock island and a shallow channel with a rocky bottom intervene.

If this gut could not have been excavated by subaërial agencies, was it formed by ice? and was ice the principal agent that denuded out the "Rock-basin" of Lough Corrib?

It has before been mentioned that the rocks are dressed and striated under the water of low summer level; this of itself is a fact in favour of ice action. Of the striæ there are various systems. the oldest bearing about N.W. and S.E.; a newer running with the lie of the Rock-basin of Lough Corrib, and the newest following different lines according to the direction of the transverse valleys that open into Lough Corrib. These may respectively be called the primary striæ, the secondary striæ of Lough Corrib, and the secondary striæ of the transverse valleys.[1] The primary striæ are very general on the Carboniferous Limestone ground; the secondary striæ of Lough Corrib have various bearings according to the turnings of the valley, and coming down into them are the secondary striæ of the transverse valleys. From this it will be seen that three sets of striæ may occur in the valley of Lough Corrib. This is well marked east of Oughterard, for thereabouts are found—the primary striæ bearing N. 40 E.; the secondary striæ of Lough Corrib bearing N. 30 W.; and those of the Owenfough valley bearing N. 80 E.

If ice can scoop out rock, "The Old Lough" may have been principally formed at the same time as the primary striæ (as the general bearing (about N.E. and S.W.) of both is the same), by the sheet or *nappes* of ice that is supposed at one time to have covered Ireland. If the movement of this sheet of ice was from the N.E. it would have plunged over the high ground at Cong and scooped out a hole, having a much greater power if, previous to the ice period, a lake, as before suggested, existed hereabouts. On looking at the map (Pl. XVIII.) it will be seen that "the deep" forks on either side of Inchagoil, and that there are three small spaces in "The Old Lough" which are less than 50 feet deep. These would seem to be in favour of hills and hollows existing here previous to the action of the ice.

The previously mentioned deep gut on the north of Carn Seefin would lie in the course of the glacier that came down the Maum valley. At the west end of this gut there is a barrier of rocks across the valley. If this barrier once extended farther east than it now does, and if ice has a similar or greater power of cutting back a

that in one place there is a hole exactly the same depth as the isolated hole in "The Old Lough," viz., 152 feet; and also that in the metamorphic rocks there are beds of limestone, one of which might possibly be so placed that it joined into the Carboniferous Limestone, and through it the passage ran. However, against it is the fact that in the neighbouring hills no subterranean passages occur, and the boundary between the metamorphic rocks, and the Carboniferous Limestones can be traced by the streams that flow down the hills, taking the ground as soon as they come on the latter.

[1] For particulars about primary and secondary striæ, see Paper by the author—"Notes on some of the Drift in Ireland"—read before the R.G.S.I. "Dublin Quarterly Journal of Science," Oct., 1866.

fall than running water, it might have excavated the gut; for the ice would first have slid over a fall near the east end of the gut and scooped out a hole, and, as the fall was cut back, the hole would become longer and longer till at last the gut we now find was formed.

Lackavrea (B on Map, Pl. XVIII.) is a high steep hill close to the lake; and if ice, sliding down a steep slope, can cut into a rock, there ought to be a hollow at its base. On looking at the chart this is found to be the case, as the soundings suddenly change from about 20 to from 60 to 80 feet; this deep is marked C on Map, Pl. XVIII. The hills, N. and N.W. of Carn Seefin, approach close to the margin of the lake, and at their base there is also a deep. In a similar manner the deeps N.W. of "The Old Lough" would be formed by the ice from the hills on the north, and the deeps, S.W. and S. of Inchagoil, by the ice plunging over the hills that now appear as either islands or shoals.

In the valley of the Owenfough, the rocks have the appearance as if a large glacier once flowed out of that valley into the valley of Lough Corrib, and Lough Corrib extends in an elbow-shaped bay towards it.[1]

Might not this elbow be due to the Owenfough valley glacier plunging over the bar of rock, on which Oughterard now stands and cutting out the rock. In a similar manner the glaciers, coming down the E. and W. valley north of Knockaleeky, which lies a little west of Ross (P on Map, Pl. XIX.), would cut out Ower Bay (Q on Map, Pl. XIX.); and the glaciers out of the valley at Moycullen (S on Map, Pl. XIX.) Moycullen Bay (R on Map, Pl. XIX).

On the east side of the Lough similarly circumstanced bays occur, but they could not be pointed out except on a geological map, being now filled with bog or alluvium. Another fact in favour of the Lough Corrib Valley, being an ice-scooped rock basin, is, that in the north-west portion of the lake, which is nearly surrounded by hills, and where the primary striæ must be deflected considerably by the different mountains, the islands are scattered irregularly about, while in the rest of the lake, which is open to the N.E., nearly all the islands have a similar bearing to the primary striæ: as if their nucleus were originally "Tors" or "Roches Moutonnée" in the ice stream.[2]

I have now laid before my readers the facts remarked in connection with the "Rock basin" of Lough Corrib, and which seem to suggest the following conclusions:—That the extent of the lake in the limestone country has increased in those places where the water and the atmospheric agencies combined could act on the limestone;[3] but

[1] This would be much more marked on a geological map, on which the bog and alluvium were coloured, as then the original dimensions of this part of the lake could be seen.

[2] The lie of the islands can be better seen on a larger map.

[3] Although its superficial extent has increased in some places, it really has been greatly curtailed, for many of the large bays, as previously mentioned, are filled up by bog and alluvium. These could not be defined until the geological maps surrounding the lake are published.

that its depth seems not to have increased, as the lake waters by themselves have little or no denuding powers. That after the general features of the country had been formed by marine denudation, and previous to the Glacial period, subaërial agencies may have excavated part of the Rock-basin; the drainage at that time finding an exit through one or more subterranean passages; but that the greater part of the "Rock-basin" was cut out by ice; first, by the movement of the ice-field that once covered Ireland, and afterwards by the local glaciers, those of the valley of Lough Corrib and Maum, and the transverse valleys.

That the subaërial denudation was not since the end of the Glacial period seems evident, for as before mentioned, all the rocks that can be seen under the water are ice-rounded and scratched; also the last movement of this part of Ireland appears to have been upward, not downward:[1] it might possibly have taken place in the Glacial age, that is, after the ice-field ceased to move in one general direction, but while glaciers flowed down the different valleys and slopes.

V.—Theoretical Remarks on the Gravel and Drift of the Fenlands.

By Harry G. Seeley, F.G.S.
Of the Woodwardian Museum in the University of Cambridge.

1. *Boulder-clay.*

The cliffs of the Norfolk coast give conclusive evidence that, before the denudation which formed the drifts had begun, the level of Eastern England was not lower than it is now. On that coast, at Weybourne, is seen the western end of a shell-bed which holds the place of the Norwich Crag. But along to Hunstanton, up the Wash, over the flat lands of Cambridgeshire, so little above the sea-level, there is no trace of Crag, and no evidence that it was ever there. At Norwich, and south and north, the Crag is covered with thick gravels, which do not appear to affect its preservation. And hence it may be inferred that the absence of Crag in the Fenlands is, probably, due to something more than "moving accidents by flood and field" The way in which the Forest-bed extends down to the water side, and the bones dredged from it out at sea; the nature of the lacustrine deposit over it, and the fluviatile strata at Mundesley, seem to show that before the Drift age came on, that part of Norfolk extended further north. If the Crag was not formed in the Fens or on the adjacent coast, it could only have been because the sea had not access. What little is known of the laws of elevation and subsidence of land does not favour a gratuitous assumption that

[1] In places on the north shore of Galway Bay, peat with the roots of trees is found below high water mark; however, this does not prove that the land has sunk, because, at the present day, about two miles west of Galway, between Blackrock and Blake's Hill, there is a morass in which peat and trees are growing. This latter is divided from the sea by a barrier of sand and gravel, and in the places where peat is now found below high water mark, similar barriers may once have existed.

an elevation affected Western Norfolk. But were it so or not, at Hunstanton there terminates a cliff which reappears over the Wash at Wainfleet with the same rocks; and were these cliffs connected, a Cretaceous barrier would dam out the sea, and no Crag could be formed in the Fens. And as there is no evidence that it could have been exposed to the sea during the Tertiary periods, I am prepared to suggest that, before the Drift began, this barrier was not broken through.

At the close of the Crag age, as the island was subsiding, every part of it must have come successively under the action of the breakers; and the result—denudation. But of the detritus the traces are not clear. For when the Boulder-clay appears, so far as may be judged from included fragments, it is not to any extent a drift of local detritus, but came sweeping down from the land of Plutonic and old-life rocks, whose hills seem to have been sawn and grated with ice. It may be that, during this earliest Drift age,—

Ice, mast-high, came floating by,
As green as emerald,—

but I have not found in this locality a vestige of iceberg action. Of glacier action the deposits of the Fenlands offer no traces, unless the fragments of northern rocks be held to prove that one great glacier stretched from the Tweed to the Thames, of which there may be as much likelihood as that the ice of the Caucasus excavated the Black Sea. This may have been a long, slow period, for under the Norfolk drift are shells; in the Boulder-clay are shells; and marine shells are met with at every elevation up to the top of Moel Tryfaen Some may have come with the drifted material; but whether living near where found, or brought from afar, they equally indicate a continuous sea shore changing so slowly that the life of the margin followed it.

In the typical section at Hasborough, in Norfolk, Boulder-clay covers the laminated beds, and is overlaid by the contorted drift; above this is an Upper Boulder-clay, and finally gravels. The Boulder-clay of Muswell Hill, near London, that of Ely, and the Lower Boulder-clay of Norfolk, contain the same rocks, and present substantially the same characters. The Hunstanton Red Rock occurs at Muswell Hill, at Ely, and on the Norfolk coast. The Ely Boulder-clay contains thick specimens of Tellina, exactly like those so characteristic of the Norfolk Boulder-clay. This, to me, suggests that the Ely deposit is as old as the old Boulder-clay of the Eastern Counties. I am, moreover, led to believe that it is the oldest drift of the Cambridge district, from the fact that it rests on beds which have since been removed from the country round, and that it would almost have disappeared but for the fault letting down a wedge of it into the Roswell pit, where it is at least some 60 feet thick. And measurements show that, at the date of the fault, Ely Hill must have been from 100 to 200, or more, feet higher than it is now.

The regular character of the Boulder-clay on the Norfolk coast would lead to the conclusion that it was somewhat uniformly spread over the country, and originally did not merely cap hills or fill valleys as it does now—at least, in this district. If this is assumed, it is difficult to explain what has become of all the solid substances which would be contained in a regular stratum of even 20 feet of drift, or whence such a deposit could have come. And I should rather be prepared to believe that the Boulder-clay was only partially spread than that its solid rocks and fossils could melt into thin air. In many cases what is now the higher land may have arrested the passage of the drifting ice, and the melting would thicken the Boulder-clay.

I am far from asserting that all the Boulder-clay was formed during this period of subsidence; or, in this manner, some at least was constructed during the subsequent age of uprising.

There can be no doubt that the gravels of Hunstanton came from the Yorkshire area. The presence of a sandy variety of the Hunstanton Rock, rounded into water-worn boulders, would seem to indicate a similar origin for the coarse gravel of the Gog-magogs. The brown Boulder-clay of Elsworth, where it rests on the stratified beds, has a large per centage of Oxford and Kimmeridge clay fossils with some of the Lias. Bluntisham abounds in Liassic fossils, with a few from Upper Chalk. This too may indicate a northern origin. Fossils from the clay at March are more local. At Bourn and Longstow, with many local forms, there is a large proportion which may have come from the northern oolites. So that the contents tend to show that much of the material of Fenland Boulder-clay came from the Yorkshire area. Against this is the fact that on all the hills in the Fens and its borders the drift and coarse gravels are found only on the south and south-east slopes, which, however, shows that by subsequent denudation they were removed from the sides facing the old sea.

2. *Coarse Gravel.*

The Fenlands offer few memorials of what happened during the succeeding age of elevation. There is no contorted drift as in Norfolk and Suffolk.

In this area Boulder-clay is rarely overlaid by gravel. One instance may be seen in the Ely Clay pit; others on the Hog's Back, going to St. Neots; others on the Gog-magogs. All are cases of gravel on hills. The gravel of Ely is partly a fine deposit, and shows abundant evidence of having been regularly arranged in water. It does not cover the Boulder-clay, but only fills a cavity in it; and from its small extent looks as though denuded: it is largely made up of flints.

In the gravels are found, only more sparingly, all the rocks which compose the Boulder-clay. But there is something more, for in this district, where the hills are of Chalk, the mass, especially of the low land gravels, consists of flint. At Peterborough, where the high land is oolite, the gravel consists, to some extent, of rounded calcareous pebbles. At Hunstanton it is chiefly sand.

I do not suppose that the existence of coarse gravels on hills, like the Gog-magog, Harston, and Stapleford, indicates that before the gravel was deposited these hills were a continuous table-land. But as the rocks making the gravels are the same as those of the old Boulder-clay, and, as in the case of the Gog-magog, the Boulder-clay itself can be seen a little further down the hill, these seem rather to be examples of reconstructed Boulder-clay, washed of its mud, and converted into gravel. Seeing that these deposits were arranged during upheaval, it may be said as a rule that the oldest beds will be at the higher levels.

As the country arose from out the icy sea, many Upper Chalklands must have come under the power of the moving water. And so flints must have been floated out, and sunk or stranded on the low hills. As the land rose higher, these in their turn would be washed, and this would explain the larger proportion of flints at the lower levels.

Thus by stranding of flints and washing away the mud from Boulder-clay, the coarse gravels may be accounted for. Many considerations show that the Boulder-clay was at this time more widely spread. And while the effect of the upheaval has been to wash the Boulder-clay into gravel at high levels, at low levels it must have been swept into holes and valleys, with the addition of much new mud and many local fossils.

3. *Deposits newer than the Fine Gravel of the Plains.*

Out in the Fen there is little evidence of gravel, except near high places which are built upon; but the black-peat covers the country like a pall, hiding everything. One section indicates, at Drayton, peat under clay, and gravel under peat. Professor Pryme has told me of other similar sections, and Mr. Marshall, of Ely, has communicated one from near by, which, as typical of all, I will here give. First, he found peat eight feet thick, under which is a clay known to the workmen as "Buttery-clay." Under this a yew-tree stood erect, well preserved as high as the clay reached, but rotted off in the peat, which was filled with its branches and splinters. The tree stood on a foot of gravel, below which was Kimmeridge-clay. Two similar sections from near Whittlesea are given by Dr. Porter, in his Geology of Peterborough, in one of which, in place of gravel, was a bed made up of shells of the common edible cockle. But the mammalian remains are chiefly found at the top of the lower bed of peat, and the marine ones in the Buttery-clay, in which are also found *Ostreæ Cardium Scrobiculariæ,* etc. The Marl-bed described by Mr. Hamilton between the upper and lower peats, appears to be a freshwater condition of the Buttery-clay. Half a mile nearer St. Ives than Drayton Gate House, was a section,

Earth	1 foot.
Blue-black Clay	1 foot.
Peat	3 feet.

Below which was black gravel, from which, at eight feet from the surface, was obtained part of the antler of a red deer. And at

Wisbeach St. Mary's, three miles west of the town, in a clayey bed at a depth of fifteen feet, were found—

Tellina obliqua,
Cardium edule,
Scrobicularia piperita,

examples of which are preserved in the Wisbeach Museum. The mammals of this clay are the Walrus and Grampus, and a large Whale. The *upper* bed of peat is long anterior in date to the formation of Whittlesea Mere, seeing that it exists on the site of the Mere, capped with two feet of gravel. The gravel and shell bed below the lower peat are clearly marine. The Buttery-clay and shells above that layer are also marine, while the erect position of the trees show that the peat was not drifted, but clearly an old land surface. Thus there is evidence of several alternations of level and different conditions of the country since the gravel. In the upper peat Mr. Carter found a Bos primigenius slain with a large chipped flint (of late aspect) which was driven into the brain.

Nor would the fauna approximate the old peat period to the present time.

Bos frontosus,
Bos primigenius,
Cervus megaceros,

are old peat species now extinct, which also belong to the gravel and cave deposits.

Canis lupus.	*Castor Europeus,*	*Sus scrofa,*
Cervus elaphus,	*Cervus capreolus,*	*Lutra vulgaris,*

are Fen Fossils, which also occur in the gravel and caves of other localities, though not near Cambridge.

The only animal in the Fens which does not occur in cave or gravel is *Ursus arctos.*

Other remains, such as teeth of hippopotamus and rhinoceros, may have been washed out of the gravel.

A fauna is found in the uppermost gravel, which in preservation would appear to be no older than this, whilst all the species seem to be now living.

4. *Fine Gravels of the Plains.*

a. Physical considerations throw little light on the relations of these deposits. The top of gravel is often undulated, and nearly every gravel pit shows some indication of this darker layer, out of which so often descend the structures called pipes. The flexures have sometimes been attributed to coast ice, but from numerous sections and observations on ground from which trees have been removed, I believe that they merely mark the site of an ancient forest. The bedding too may deceive. In a section of Potton sands, at Potton, I was able to see the process going on by which the beds were coloured. Between two oblique and comparatively impervious bands of oxide of iron, there was loose sand, and stretching over this in curves were films of colour evidently deposited by percolating water; and where the sand is coarse, there the colour is dark. Hence I would suggest that the gravel may have been coloured, since it was deposited, by waters draining into it.

The comminution and angularity of the flints of course indicates the action of force, but whether of water only, or water and frost, there is nothing to show.

The physical geography demonstrates that the action of water could only have been marine. And it could only have been by a grand extension of the Wash over the Fenland, that the Upper Chalk, and local rocks, and the old Boulder-clay were denuded to form the gravels. A common section of false bedding from Barnwell represents such conditions of currents as are indicated by the shoals of estuaries.

β. In the Cambridge area land and freshwater shells are found in the gravel of most places. At Overton and Whittlesea the shells have a land and brackish water character. At Hunstanton they are marine, and such as now live on our coasts. At March they are not only marine, but have an arctic aspect. At Doddington and Drayton they are also marine. Those of Barnwell occur in the marl-band, which Mr. C. M. Doughty finds to consist largely of Chalk and Upper Greensand foraminifera. This, like the physical geography, suggests a southern and S.E. origin for the Cambridge portion of the gravel. The shells are generally well preserved, but there is no evidence that they lived near where now found. There are sometimes other thin marl beds above the main one. Now this may either indicate that by upheaval the country became fluviatile and lacustrine, or that from some unknown cause—such as silting up, the sea lost its tidal action, and the estuaries only brought down fine mud. Perhaps in some cases the former of these suppositions best explains the sum of the facts; but the other view may also be true. Therefore, though the deposit is in the main marine, the fresh water band shows that the change was gradual, aud that since the period of coarse Gravel the country had become capable of supporting many kinds of life.

The marine shells of Hunstanton by their aspect belong to the close of the Gravel age. Those of March are in gravel, which is contained between Boulder-clays, and obscure in age. Judging from their arctic aspect they might belong to the Boulder-clay age, but the Wash would be a very likely place to cut off and retain a retreating colony. Reconstructed Boulder-clay and gravel may both be results of the same cause, and as those of Doddington are in no way connected with Boulder-clay, their relation to that bed is probably accidental. There is no reason for giving a different age to the sea shells from Drayton; and here, though Boulder-clay is near, gravel is the superficial bed. The aspect of the country, the shells of March, and considerations from the freshwater beds of Cambridge gravels, induce me to regard this as the oldest of the Fen gravels, probably formed between the coarse gravel and the marl beds of the Gravel of the Plains.

Summary.

1. The brown Boulder-clay corresponds with the brown Clay of the Eastern counties, and is oldest.

2. Then the hill gravel, the blue Boulder-clay, and perhaps the shell bed of March corresponds to the contorted drift.

3. As elevation progressed, the Fenlands would become one great fiord, ramifying at the Cambridge end up the southern valleys in the Chalk. First the coarse gravels of low levels were formed, and finally, during a long period—for the flints are wonderfully worn—the fine gravel of the plains. After which the country was elevated, and the sea denuded the superficial beds and retired. This corresponds to the Upper Boulder-clay and coarse gravel of the Norfolk section.

4. Now rivers cut their channels, and there commenced luxuriant vegetable growth, which corresponds with the excavation of the Mundesley river and the Mundesley peat.

5. Then a depression, during which was formed the Buttery-clay of the Fens. This corresponds with the Upper Sands and Gravel of Mundesley.

6. And, finally, comes the second peat and the present state of nature.

I believe this succession is true for a far larger area than the Fenlands, perhaps for all Great Britain.

VI.—On a Bed of Chalk-flints near Spa.

By J. A. Birds, Esq.

The fashionable Belgian watering place, Spa, is situated 1000 feet above the sea, in the centre of a circle of hills called the High Moors (Les Hautes Fauges), a wild and desolate tract covered with peat-bogs and heaths, themselves some 600 to 800 feet above the town. Immediately above Spa, and opposite to it, there are two other distinct hills, of lesser height, the limits of which are definitely marked out by streams or deep valleys, and these, together with the "High Moors" and their rock, constitute the leading geographical features of the immediate neighbourhood.

The chief geological constituents of the district consist of Silurian *Rhenan*, Devonian, and Carboniferous rocks, together with the alluvium of the Wayai,[1] and the diluvium descending to it from the summits of the High-Moors Hills. But, upon the crest of the latter, a little to the right of the road from Spa to the village of Francorchamps, there is a thin bed of chalk flints, of perhaps a mile square in extent, strewed over the peat or embedded in it, forming one of the most interesting geological phenomena in the neighbourhood.

The bed, as far as I am aware, is completely isolated, the nearest cretaceous deposits being those of Maestricht and Aix la Chapelle,

[1] The Wayai is a small stream, having its source in the Moors eastward of Spa, which, after flowing by the town, turns sharply to the north and continues its course in a line parallel with the railway to the Vesdre, a tributary of the Meuse.

the approximating point of which, according to M. Dumont's map, is a little north of Limburg, twenty miles off, the next nearest, the Losnée beds near Namur, and the next at Mons (60-70 miles). The flints are generally of a yellow or brown colour, with a coating of white chalk; a few are purple and red and of different shades, and they vary in size from that of a man's head to the smallest chip; they lie scattered over the cart roads crossing the moor, or cast up upon the ditch banks, or imbedded here and there in their sides.

They appear to contain a considerable variety of fossils, as in a search of three or four hours I found from fifteen to twenty distinct species of shells, echini, etc. They belong, probably, to an age contemporary with the Upper or flinty Chalk of the British Isles.

The most interesting inquiry, however, concerning them is as to their origin in this spot. How did they come there? Are they the relics of the original chalk ocean left *in situ* where they were first formed, and if so, were they once connected by a continuous band, with the larger masses of Maestricht or Losnée, the rest of which has since been swept away? or were they originally a small isolated formation? or did they form a shoal or shingle beach brought by currents from elsewhere? (The fact that, though most of the flints are angular, some are rolled and waterworn might seem to favour the latter hypothesis). Or, lastly, have they been brought to their present position during the Glacial period by icebergs or floating ice. In view of such a solution, one natually looks around for other signs of glacial action, and they are apparently not wanting.

Tho whole northern slope of the hills below the point where the flints occur is covered for a mile or two, down to the bed of the Wayai, with a thick coat of mud, including fragments of rock. It is seamed in different directions by the hill streams, often to a depth of 12 to 14 feet, and a cutting in the new railway to Luxemburg near the river bed, displays a section of nearly 20 feet, without reaching the bottom. A formation of such width and thickness can hardly have been caused by the Wayai, which is an insignificant stream only a few feet wide. It seems much more natural to suppose that it is due to the melting of icebergs or float-ice. One can imagine the frozen seas of the north sending out icebergs and fields of ice over the area now lying between Maestricht and Spa, and if the hills then had the same relative elevation as at present, a berg would clear the summits south of the Vesdre, and then standing upon the hills above Francorchamps and melting there, would leave its deposit of chalk flints and pour down torrents of mud towards the valley of the Wayai.

Such may seem a not impossible origin of the deposit in question, but should any experienced geologist, visiting Spa, think it worth while to examine the locality, he might, perhaps, be able to decide in a very short time whether this or any of the other hypotheses I have suggested is the most natural. If the ice-origin of the flints is correct, the limits of the sea during the Glacial period would have to be extended one or two degrees southward of the line indicated in Sir C. Lyell's map ("Antiquity of Man," p. 276.)

M. D'Omalins D'Halloy's account of the Geology of Belgium appended to his work[1] "Abrégé de Geologie," contains the following notice of the above formation :—

"Le Lambeau entre Spa et Francorchamps a cela de remarquable qu' il se trouve à une altitude de près de 600 mètres, tandis que les autres dépôts crétacés de la Belgique n' atteignent pas 300 métres. Ou ne l'a connu pendant longtemps que par des silex jaunâtres épars sur le sol et dans lesquels M. Dareux avait observé l' *Echinocoris vulgaris*, mais M. Malaise vient d' y découvrir une petite couche de craie blanche contenant la *Belemnitella mucronata*."

In addition to the above-mentioned fossils, I found in a few hours nineteen distinct genera and species of testacea and echinodermata:

Pecten quinquecostatus, and two other species ; *Terebratula* ; two species of *Rhynchonella* ; two species of *Echinoderms*, etc., etc. The great variety of these, contained in so small a space, seems a strong argument in favour of transport from another area of considerably greater extent.

NOTICES OF MEMOIRS

I.—Fossil Medusæ.

PROFESSOR HÆCKEL, of Jena, who, in 1865, called attention to the existence of well-preserved *Medusæ* in the lithographic slates of Eichstadt, belonging to the families *Æquoridæ* and *Trachynemidæ*, has recently published[2] a notice of two other species of *Medusæ* so well preserved, that the family to which they belong can be ascertained without doubt, They are from the same locality, and belong to the *Discophoræ*, and to the family *Rhizostemidæ*. The restoration which Professor Hæckel has been able to make from the specimens in his possession, is quite satisfactory, and the attention of geologists having been called to this subject, we may expect further interesting researches into the ancient history of *Acalephæ*, since it is well known that even at the present time a kind of petrifaction of jelly-fishes, when thrown upon sandy beaches, readily takes place. A. A.

II.—Notes on the Geology of Western Australia.

By the Rev. W. B. Clarke, M.A., F.G.S., etc.

THE following is one of a series of papers, contributed by Mr. Clarke to the Government of Western Australia, on the geology of the country east of the settled districts. It was communicated by the Colonial Secretary to the "Perth Gazette and Western Australia Times," and is now reprinted as containing the

[1] "Abrégé de Geologie," p. 534.

[2] Leonhard und Geinitz's Neus Jahrbuch, 1866, Heft 3, p. 257.

first connected account of the geology of a territory new to science :—[1]

Description of Mr. Hunt's Specimens East of York, W. A., between 31° and 31° 12′ S. Lat. and between 121° 12′ and 121° 22′ E. Long. on the N.W. of Lower Lake Lefroy, collected in 1865.

A.—From Well near Camp 25.

1. Grey soft micaceous clay slate filled with minute white particles ; 12 feet deep.

2. Soft bluish grey glossy slate ; 15 feet.

B.—From surface of the Gully-bed.

3. Brownish-blue ferruginous slate, full of iron and white glossy particles.

4. A gneissiform grey-bedded and jointed foliated but hard rock, with *used* mica, and a small proportion of quartz in a felspathic base, holding numerous cubic crystals of bisulphuret of iron decomposing into hydrated iron, as in the trap rocks of the Harding River.

5. Ironstone-conglomerate, consisting of numerous shining black water-worn rudely crystalline particles of magnetic iron, which in some examples possess *polarity ;* brownish-red hydrated oxide of iron ; small clear crystalline bits of quartz ; opaque quartz, and one or two particles of trap, all cemented by a hard cellular mineral effervescing with hydrochloric acid. Presumed to be of Tertiary or recent origin, arising from a calcareous spring producing tufa and collecting small loose stones from the surface of a water-course.

C.—From Red Hill Gully.

6. Decomposed granite.

7. Decomposed granite, with a slight saline taste.

8. Brownish white coarse deposit.[2]

9. Brown and white bedded deposit; decomposed slate or granite.

10. Ferruginous sandy deposit, probably decomposed granite.

11. White crumbly kaolin-like deposit.

12. Coarser, red and yellow deposit.

13. White soft clay-slate, perhaps the source of some of the preceding five samples.

14. Cavernous ferruginous quartz, part of a vein, probably from granite.

D.—From Stony Hill.

15. Hydrated iron, not magnetic.

16. Semi-opal.

17. Hardened white deposit, hydro-magnesite.

E.—From Tank near Stony Hill ; 4 *feet below surface.*

18. White soft, nearly pure alumina.

F.—From Ridge 8 *miles due East of Saddle Hill.*

19. Drift-pebble of air-and-water-worn *concretionary* rock ; siliceous in composition and probably formed in some soft deposit—or,

[1] From the "Perth Gazette and Western Australia Times," Friday, April 20, 1866.

[2] This word "deposit" explains the sedimentary nature of the substances which are properly "silicates of alumina."

being soft originally, altered by silicification. Although imagination may give an idea of organic form, it is pretty certain that soft mud drying might take and retain just such a structure. Its polished surface implies drifting and exposure.

G.—From While Peaks Lat. 31° 2′ 30″ *S., Long.* 121° 12′ *E.*

20. White silicate of alumina.
21. White [? porcelain] clay. Not sufficiently tested.
22. Pink bedded deposit.
23. Yellow deposit.
24. Fine bluish white deposit with black points of (?) iron, a silicate of alumina.
25. Greyish blue soft deposit, a tolerably good fire clay; a silicate of alumina, with common salt, magnesia and lime in small proportions.
26. White and yellowish sandy aluminous deposit.

H.—From Saddle Hills.

27. Ferruginous black and white quartz.
28. Chalcedonic quartz or agate [? from amygdaloid basalt].
29. Baked red and white fine conglomerate (a variety of so-called quartzite).
30. A drift-portion of a black silicified substance like fossilised wood.
31. Quartz like No. 14.
32. Siliceous deposit, probably a *hot water* product.
33. Jasperized rock, red and black, an altered clay or shale.
34. Common opal, white with black streaks.
35. Red and white sandstone, altered.
36. Hyalite coloured by iron (?).

I.—From Bed of Gully near Red Hill.

37. Fine ferruginous sandstone or grit, apparently a *Tertiary* rock.

Additional Remarks.

In this collection there is no granite; but, by reference to Mr. Hunt's map, it appears that the whole of the country traversed by him (as well as that previously described by Mr. Lefroy) extending to near the meridian of 122° E. exhibits an abundance of granite; and that rocks of that class form the base of the whole region eastward of the Darling Range.

It would be interesting to compare the varieties of granite from this region; since Mr. Lefroy's descriptions lead to the conclusion, that it is not all of like composition, nor of one age.

Whilst admitting this, we cannot however adopt the opinion expressed by the latter gentleman, that the granite is the "primitive crust" laid bare—an opinion which is at variance with the general views of geologists of the present day, and is certainly not supported by some of the facts reported by him. The Protogine which he met with in 30° 20′ S., and 120° 40′ E., as well as the elvan dykes in 31° 27′ S., and 119° 20′ E., clearly imply metamorphisms or eruptions of a period subsequent to the formation of the general mass; and, perhaps, subsequent researches will justify the suggestion, that the occurrence of granite over so wide an area in Western Australia, is due to a boss-like[1] elevation, certainly after the period of the older Palæozoic rocks, the traces of which, though limited in extent, are widely scattered and sufficiently repeated to sustain the conclusion, that they once existed probably over the whole granitic area; and that from the calcareous coating of the granite at King George's Sound and Recherche Archipelago some of it may be even of *Post-tertiary* elevation.

[1] The dome-like or boss-like form of granite is a feature of frequent occurrence. It is of concretionary origin, and distinguishes especially those hornblendic granites which are connected with auriferous deposits. But it occurs also in other granitic regions, as in the mountains of Central Asia. Where the great bosses meet there is generally a depression, which if repeated in a given direction, may give the idea of a fissure; this may also be the case where joints traverse the rock. Mr. Lefroy mentions *intumescences* of granite, a term well describing the nodular or concretionary structure. He also mentions that near the head of drainage to the westward, there is a dip of about 2 feet in the mile to the south-west. Eyre also mentions that nearer the coast the granite has a slope to the south-westward. A slope of 2 feet in a mile could scarcely occur except on the summit of a nearly level mass. That the granite in the region under discussion must have, occasionally at least, a true nodular structure, may be seen on the nearest part of the coast to Mr. Hunt's furthest, viz: *about Esperance Bay*, where the granite exfoliates in decomposition, peeling off in concentric layers like those of concretionary trap. Mr. Lefroy mentions similar features in 32·0 S. and 118° 19′ E. at Burra Kukkin. This particular species of granite is about Esperance Bay full of *garnets*, and garnetiferous granite is well known to be *not* of the most ancient class, and, besides the inferences from this fact, that the rocks must have considerable slopes is to be inferred from the fact that the cliffs of the Australian Bight have, in some places, a vertical thickness of 600 feet, resting on the edges of the granitic base, which begins to crop out on the west side of the great arc of the coast at about 124° E., and on the east side near Fowler's Bay about 132° E., giving to the hollow between the granitic intumescences a breadth of 500 miles. We may, therefore, safely assume that such a hollow is formed by the slopes of the great dome-like masses composing the granite base. That towards the ocean this concretionary or nodular structure may furnish slopes of enormous extent, may be gleaned from a fact stated to me by my friend the late Captain Owen Stanley, R.N., F.R.S., who in H. M. S. *Rattlesnake* obtained soundings when fairly inside the horns of the Bight, at a depth of *four* miles. That this is far from surprising may be considered by reference to the data given for the mass of strata supposed to be denuded, in the preceding remarks. For with a slope of the granite or other rock *not greater than one degree in the mile*, a depth of *more than four miles* would be reached along the versed sine of the Bight at a distance from the cliffs of 234 miles, which is within the chord along the 35th parallel. Deep as is this depression of the sea bottom, it is quite evident that the Tertiary and underlying deposits may obtain their present position without any extraordinary concurrence of circumstances. The great width of the Bay and the depth indicated for the ocean off the cliffs of Bundah, justify the probable opening of the Strait alluded to above. Nor can it be without interest to recollect that Flinders, on his survey of the Bight, stated his belief that the sea would be found behind them (vol. i. p. 97). He distinctly refers to a gradual subsiding of the sea, or sudden convulsion of nature, which, however, can have no bearing on the real facts of the case, and to the cylindrical sandy concretions of Bald Head, which have another and truer explanation than he supposed, and yet which, if interpreted in *his* way, would prove elevation of the coast, which is so far correct. At from 8 to 15 miles from the shore at the head of the Bight, the depth according to D'Entrecasteux and Flinders is from 27 to 30 fathoms English; the depression, therefore, observed by Stanley is much further out, and beyond the base of the Tertiary platform which extends from the head of the Bight on the south-west side to a parallel with the chord of the Bight about 140 miles south. There is room and depth enough to allow for other formations as well as the Tertiary, which, for want of researches, cannot, however, be proved.—W. B. C.

[*To be concluded in our next number.*]

REVIEWS.

THE COAL QUESTION.

I.—Age of the Coal-formation of China.

In two recent numbers of the Geological Magazine (pp. 286 and 370), we have given notices of the coal-mines of China, since which there has appeared in the September number of the American Journal of Science, a short paper on the age of the coal. From specimens of coal plants sent over from China by Mr. R. Pumpelly, the author was enabled to determine the age of the strata from which they were taken, and to prove, rather unexpectedly, that a large part of the great coal-fields of China are of Mesozoic age. This conclusion is based on the entire absence of Carboniferous plants from the collection: and the presence of well-marked cycads—species of *Podozamites* and *Pterozamites*—closely allied to, if not identical with, some heretofore found in Europe and America. There are fragments of a new generic form, probably a cycad, in the collection, and some obscure specimens that may represent other plants new to science, but the *Pecopteris*, *Sphenopteris*, *Podozamites*, *Pterozamites*, etc., have a very familiar look, and in their resemblance to well-known forms give fresh evidence of the monotony of the vegetation of the globe previous to the introduction of the angiospermous forests of the Cretaceous period.

Whether the strata which have furnished these plants should be considered Triassic or Jurassic remains to be determined by future observations, as the fossils yet obtained can hardly be considered sufficient for the solution of that question.

II.—Mr. H. B. Medlicott's Report on the Coal of Assam,

Has been published in the "Memoirs of the Geological Survey of India." It appears that there are two places prominently known in Assam as coal-producing, of which one is in the neighbourhood of Jaipoor, in the Seebsaugor district, and the other (the Terap field) is in the vicinity of Makoom. The Terap field, as at present known, furnishes much better coal than that of Jaipoor, which, however, has an advantage in geographical position; but the Jaipoor coal appears to be fit only for such purposes as burning bricks and lime, while all the coal taken to the Bramahpootra for steam purposes is from Terap. Mr. Medlicott's expedition does not appear to have been attended with any very encouraging results respecting the discovery of new coal-fields, and his time seems to have been taken up, to a great extent, in discovering that the "information" on which he was to act was entirely untrustworthy. At the present time, however, any information on the subject of colonial coal-fields is received with interest.

III.—"Our Coal Supplies and our Prosperity"

Is the title of the only paper interesting to geologists in the "Quarterly Journal of Science" for October. It is illustrated by a map of the world, on which are marked all the coal-fields as yet known.

Many interesting questions are discussed; we will, however, confine ourselves to quoting some of the general conclusions which are deduced:—

1. That it is at present utterly impossible for any one to define the boundary, either vertical or horizontal, of our coal strata, and therefore no estimates that can at present be offered are fit data for calculation; but that it is highly probable our resources are far in excess of the views of our most sanguine geologists.

2. That, looking at the coal resources of other countries, our exports are not likely to prove a permanent drain upon our resources, and our ocean steamers will probably ere long obtain cheaper supplies for their homeward voyages than they at present draw from English collieries.

3. That any considerable increase in the cost of coal is likely to interfere materially with our iron trade, more especially the raw material; and that it is not unlikely that we may not only have to submit to the loss of our export trade, but may even find it more economical to import various forms of iron, crude and manufactured, from foreign countries.

4. That there is no element of certainty in the continued increase in our consumption of coal for heating and lighting purposes, especially the latter; and that it is probable that the use of gas (which now takes about one-eighth of our whole supply) will, in time, be superseded by better lighting agents, just as *it* has to a large extent superseded candles.

5. That the most valuable staple manufactures of Great Britain absorb a comparatively insignificant portion of our whole coal resources, and it is to be hoped that any enhancement in the price of coal will be more than compensated by increasing material prosperity, enabling the manufacturer without inconvenience to pay such an extra cost of fuel. At any rate it is clear that a very great absolute increase may and probably will take place in our general home production and foreign barter trade in valuable manufactures, with hardly a perceptible effect upon our coal resources.

REPORTS AND PROCEEDINGS.

I.—British Association for the Advancement of Science.

Nottingham, August, 1866.

ADDRESS TO THE GEOLOGICAL SECTION OF THE BRITISH ASSOCIATION.

By Professor A. C. Ramsay, LL.D., F.R.S.[1]

SINCE I last had the honour of acting as president of the Geological Section a custom has crept in of opening the meetings of

[1] This address was very imperfectly taken down in shorthand, and the speaker has since corrected it, and supplied the omissions of the reporter, to the best of his ability, from memory.

the various sections with presidential addresses. I have, however, been called upon unexpectedly, and rather late in the day, to occupy this chair, when I was busy with a multitude of other avocations, and I have not had the time to prepare an address; nevertheless I shall endeavour to the best of my ability to say a few words upon the state of opinion upon various subjects connected with physical geology, so as, possibly, to prepare in some degree the minds of persons, who are not thoroughly conversant with the state of opinion on all branches of the science, for topics that may, perhaps, be touched upon in some of the papers that may be brought before us. The great question which underlies much that concerns geologists is whether the economy of the world as we now see it represents in kind, and partially or altogether in degree, the average economy of the world as it has existed in time past, as far as it can be traced by reference to rocks and their contents as they appear at the surface, or as deep beneath the surface as we may be led to reason upon by the limits of presumed legitimate inference?

When people had thoroughly made up their minds that the world consisted, as far as the outside of it is concerned, of two classes of rocks—igneous and aqueous—it was for a long time the fashion to attribute most of the chief disturbances which the crust of the earth exhibits to the intrusion of igneous masses. The inclined positions of strata, the contortions of the formations in mountain chains, and the existence even of many important faults—in fact, disturbance of strata generally, were apt to be referred to direct igneous action operating from below. But a closer analysis of the rocks founded on careful surveys, not of a little area here, and a little area there, but on surveys of kingdoms and continents, has tended to disprove these old-fashioned ideas, although you may constantly see them brought up again and again in a certain class of popular works, and sometimes even in memoirs by authors who ought to be better informed than merely to repeat the notions that we find in common-place popular works on geology. Now, if we look at those British formations in which igneous rocks are most generally developed, what do we find? Go first to North Wales, to the Lower Silurian formations, which is to a great extent intermixed with igneous rocks. There, instead of finding great masses that broke through the stratified crust of the earth and tumbled the strata into confusion, the igneous rocks consist chiefly of beds of felspathic lava and ashes of great thickness interstratified among the Lower Silurian strata, with here and there a boss of porphyry, which may sometimes represent, as I think, the underground nuclei of old volcanoes of Lower Silurian age; but the mountainous character of the country is due, not to the direct igneous action of that period heaving up the rocks. On the contrary, all the rocky masses of which the region consists, both igneous and aqueous, have been disturbed and thrown into great sweeping undulations formed of curved strata, thousands of feet thick, by those agencies, whatever they may have been, that, at a later date, produced disturbance. The igneous rocks were not that cause, for they have themselves been disturbed, together with the fossiliferous Lower

Silurian rocks amid which they lie; and the mountainous character of the country, as it now presents itself, is due, not to direct volcanic action, but to the unequal hardness of igneous and aqueous masses, acted on by many denudations both ancient and modern, both marine and subaërial. These causes, aided by faults which often brought hard and soft rocks into immediate juxtaposition, have given rise to all the rugged outlines on the surface of Wales, the hard rocks more strongly resisting decay and waste, the soft ones yielding to time, the sea, and the weather, with greater ease; and thus it happens that the harder masses generally form headlands, and the summits of the mountains, though often found elsewhere; while the softer strata, wasted away by the sea and by rain and rivers, are apt to lie in the recesses of bays and valleys. This kind of argument I could equally well apply to the Carboniferous formations of Scotland, where igneous rocks are rife, and, indeed, to all those areas where igneous masses of ancient date are found intermixed with sedimentary strata.[1]

Again, if we go to the Alps, and look at the strata there, which are disturbed on the greatest scale; in all that part of the range that I best know, from east to west for more than 100 miles in length, I have never seen a fragment of what I can call a true igneous rock. Gneiss there is, and granite there is, which, according to old ideas, a great advance in their day, some have been apt to classify either as common igneous productions or as closely allied to them; but no basalts or greenstones, or rocks allied to them, play any important part in the structure of the country, although the strata have been disturbed in a manner of which no conception can be formed by those who have only studied such minor mountains as those of the British Isles. There, in the Alps, we find areas as large as half an English county, in which a whole series of formations has been turned upside down. But by what means were masses of strata many thousands of feet thick bent and contorted and raised into the air so as to produce such results and thus affording matter for the elements to work upon? Not by igneous or other pressure and upheaval from below, for that would *stretch* instead of *crumpling* the strata in the manner we find them in great mountain chains like the Alps, or in less disturbed groups like those of the Highlands, Wales, and Cumberland, which are only fragments of older mountain ranges; but, perhaps, as some have supposed, because of the radiation from the earth of heat into space, producing gradually a marked shrinkage of the earth's hardened crust, which, giving way, became crumpled along lines more or less irregular, those producing partial upheavals, though the bulk of the whole globe was diminishing. A modification of this hypothesis does not attempt to explain the positive cause of the shrinkage, but simply states, that from some unknown cause, irrespective of radiation, great areas of the earth's crust having been depressed, broad lines that lie between them have been contorted and heaved into the air in the manner already indi-

[1] This argument has of course no *immediate* application to existing or late Tertiary volcanic areas, such as those of Auvergne, where entire and ruined craters still exist.

cated. Such shrinkage and crumpling, however produced, when most intense and on the greatest scale, is always (where I know it) accompanied by the appearance of gneissic or other metamorphic rocks, and of granite or its allies; and it has often been the custom to attribute the disturbance of the strata in such mountain ranges and their metamorphism into gneiss, crystalline marble, and the like, to the intrusion of granite. But my opinion is that with regard to gneiss and granite the first has been produced by processes of metamorphism which I cannot now enter upon, and without any necessary connection with the intrusion of granite, while granite itself is often simply the result of extreme metamorphism, having passed through and beyond the stage of imperfect crystallization, characteristic of gneiss, into that state of more perfect crystallization which marks well-developed granite. If this be so, then, so far from the intrusion of granite having produced such mountains as those I speak of, both gneiss and granite would rather seem to be results of the forces that formed the mountain chains, I cannot tell how, but possibly connected with the heat produced by the intense contortion of such vast masses of strata, the parts of which now exposed by denudation were then deep underground. There is, however, a difficulty here, perhaps insuperable, and which my knowledge does not enable me to grapple with; viz., that if the shrinkage that contorted the strata was slow, the heat resulting from it might never have attained sufficient intensity, to have produced, with the aid of alkaline waters, those common metamorphic masses, known as gneiss, granite, syenite, etc., and others less commonly recognised as metamorphic, such as some of the quartz porphyries, for the heat thus generated may have escaped as fast as it was formed. But I cannot now enter on these details.

It has often been customary to speak of the Cumbrian mountains as a great dome, forces from below having heaved up the strata towards a central point, from whence the main valleys radiate as great rents produced by that upheaval. But the strata of Cumberland are not dome-shaped in the true geological sense. If it were so, the strata ought to dip from the centre. But instead of that we find Lower and Upper Silurian strata from the equivalents of the Llandeilo flags to the Ludlow beds though contorted, yet forming an ascending series all across Cumberland from Cockermouth to Ambleside, with an average south-easterly dip. There is, indeed, nothing cone-like in the manner of their arrangement, and the igneous rocks associated with the Cumbrian strata have partaken of disturbances of the same ages as those that heaved up the Silurian rocks of Wales. Afterwards the whole series was planed across by marine denudation before the age of the Old Red Sandstone of the area; and then, but chiefly at later periods, the valleys were scooped out from a great tableland, especially after the removal by denudation of the Carboniferous rocks which at one time probably cased and concealed the whole of the Silurian strata. In this manner the character of the mountains of the country was produced, the harder masses being apt to form the heights, craggy, yet often rounded by glacial denudation.

Now in disturbed districts, and in many not much disturbed, faults are more or less numerous, and they are of all ages and of varying amounts. On the continent of Europe and in Britain, for example, from the Middle Tertiary strata downwards, somewhere or other, all the formations have been dislocated, some of the faults being of the amount of only a few inches or yards, and others of many thousands of feet. Several I know in Wales of 2,000, 5,000, or even 12,000 feet in amount; and as a rule it is found that the greatest faults, intersect strata that have been most disturbed, while also it often happens (but not always) that the oldest strata have undergone most disturbance, because they have been more frequently affected by disturbing agents. On the north side of the Alps the Miocene rocks of the Rhigi are inverted and faulted against the older formations, and the amount of the throw must be very large, and as many Miocene species of molluscs are still living, far as it is removed from our epoch, this fault, by comparison with older ones, may almost be said to approach our own day.

Now the question arises whether the agencies that produced contortion of strata and faults, which in certain cases have resulted in the formation of great mountain chains, have been sudden in their operation, or if the changes have been as progressive and gradual as the operation of those agents of denudation—the sea in the formation of plains of marine denudation, old and new, and the outlines of coasts, and the work of air, rain, rivers, frost, snow, and ice, that, long continued, have produced the familiar sculpturing of hill and valley. This is a very puzzling question to geologists, and various opinions have been stated. One of these is that we now live in a world, as it were, nearly in a finished state, and which will suffer no more catastrophes; another that the world now remains in a temporary state of repose after a succession of spasmodic throws which broke up suddenly great portions of the earth's crust, and repeatedly revolutionised the world, and that such efforts may recur at later periods a long way beyond our time; or again, that the state of tranquillity we now enjoy, in which change is constant, more or less slow, and very sure, has been the order for all time, as far as geologists can trace back the history of the world in the rocks that form its crust. These are the leading opinions on the subject, and my own inclines to the last.

But in the present state of our knowledge it is impossible to reduce to a demonstration the truth of this opinion. Those who fancy the world to be in a finished state, are forgetful of the fact that the old rocks were made by the same operations as the rocks that are now forming, and those who advocate sudden violence and wide-spread revolution have, it seems to me, nothing beyond assertion to help them, founded on that kind of wonder and awe that arises from the contemplation of crags, peaks, and the invertions of the strata of great mountain chains, or of other and kindred phenomena; while the advocates of peaceful change have little to say beyond an appeal to observed facts, gathered from a study of rocky masses and their contents, that to them seem to point throughout to gradual and continuous changes; and these imperfectly understood phenomena have induced a half intuitive and growing belief that the laws, both physical and biological, that govern the world are quiet, progressive, and unviolent.

Proceeding now a point further, the connection of life with the modifications which have taken place in the crust of the earth somewhat helps us in our endeavours to understand the question. As every one knows, there have been great numbers of different genera and species inhabiting the world at different geological epochs, the remains of which lie buried in the various formations; and looked at on a large scale, and over broad areas, it is evident that there has been a succession of life, each of the greater series of formations being more or less marked by their own particular fauna. This fact led to the old geological doctrine that there had been many sudden creations, by which the world was at various times peopled, that these inhabitants, after long intervals, were as suddenly destroyed, that new creations came in, and that each formation was in this way marked by its peculiar forms of life. When, however, it was found that in some formations a few, or sometimes many, of the same species were common to two or more formations, this theory of complete and sudden extinction and creation was seen to be untenable. By and by, when the geological structure of Britain began to be minutely analysed, it was found in cases of unconformable stratification, even when the upper formation was *in time* the next *known* member of the series to that which lay below, that breaks in the succession of *marine life*, partial or total, always accompanied such unconformities in stratification. It has, indeed, been a question with some geologists whether two marine faunas, commonly recognised as belonging to two distinct and far apart geological epochs, such as the Silurian and Carboniferous, could not have been contemporaneous in past eras, or indeed even now. It is very possible that something of this kind may have been the case; but in my opinion only in a mixed and minor way between periods or formations that in a geological sense were not far apart in time. When we consider the greater formations, such as Silurian and Carboniferous, Oolitic and Cretaceous, the probabilities, as I have elsewhere argued, are almost infinitely against this assumption, for if so, for example, an Oolitic fauna in whole or in part might both underlie and overlie Cretaceous formations. But, however we may look upon this question, it is certain that the great principle of a succession of life, showing a method of change and progress, the old disappearing, and the new coming in, and *breaks in succession of life*, as I have shown in detail elsewhere, have a close connection with unconformability of strata, and *gaps in geological time unrepresented by stratified formations* over areas of varying size, such areas being determined by those agents that produced upheaval and denudation of continents and islands.

I could follow out this view with particulars, but without now doing so this reasoning seems to assure us that there never has been universally over the world any complete destruction of life, but that the succession of being has gone on in regular order and sequence, though for a time, or for ever, we have lost many of the records—whole chapters, whole books, in consequence of the disturbances and slow denudations which the earth's crust has undergone. This must show, therefore, that there was then no universal catastrophe which destroyed the life of the world; there cannot possibly have been so because many of the forms are still alive that belong to comparatively old epochs, and to my mind the continuity of genera and even of broader distinctions leads to a like result. But great changes in physical geography have often taken place in times *too limited* to have involved total changes of life; for life, I believe, dies out or changes not by violence or sudden edict, but by the slow effects of time. The north of Europe and America has been more than half submerged during the last glacial epoch, and re-arisen without the disappearance of any one marine mollusc. Of the fossils of the Crag, part of an old German ocean, large percentages still remain, and the Miocene formation of the Alps, which contain many land plants barely distinguishable (if distinguishable), from living species have been formed, upheaved, inverted, and faulted without a total destruction of life. Putting all these things together, I feel myself almost driven to the conclusion that all these changes have been so slow and gradual, that to occupants of old time, had there been human intelligence to observe, everything would have seemed to go on in the same slow, steady, and appearently undisturbed manner in which they appear to us to go on now; and if this be true, then, instead of having recourse to unusual catastrophic action to explain what is seen to have resulted, it all resolves itself into time, and for ever time; to effects in fact produced by small cumulative causes, and so were more than equal to all the destructive forces which were attributed to eruptions of igneous rocks, the production of faults, and immense contortions of strata; and the result of all, but not final, has brought about the astonishing changes which the world has so visibly undergone, resulting in the present physical geology, physical geography, and life of the surface of the earth.

Norwich Geological Society.—On Tuesday, August 14th, the members of this Society made an excursion to Mundesley. The main object of the visit was to examine the old River Bed, to be seen in the cliffs near the village. Descending to the beach, the members were joined by the President of the Society, the Rev. John Gunn, and Sir Henry Robinson. With his characteristic straightforwardness the President led the party directly to work. The Norfolk cliffs are Mr. Gunn's *forte*, and no geologist is so well able to explain the many mutations through which they have passed as he. The cliffs range in height from fifty to one hundred feet, and although composed principally of clay and gravel, they have a geological history which is transcended in interest by none. At low water, in the Happisburgh direction, the visitor may see dark-looking patches lying along the sea-bottom, and on examining these he finds them to be parts of a Forest bed—a dark clay in which are imbedded fallen trunks of trees still extending their rootlets into the ancient soil. In the swampy rivers which sluggishly meandered through this dim forest land, huge beavers built their dams. The hippopotami wallowed in droves, and various species of elephants fed on the young shoots of the trees. Deer by thousands, and of a variety of species, inhabited the same localities. Meantime the rivers deposited mud containing fresh-water shells, and the remains of water beetles. The fir cones and hazel nuts dropped in countless thousands into this same mud, and so have been preserved until now. A dense bog was formed of the aquatic and other plants, aided by the autumnal foliage of the forest. The falling trunks lay imbedded and obtained a geological immortality, and so was formed the Forest Bed of the Norfolk coast. Meantime immense changes came on. The land sank, not by *sudden* submergence, but slowly, and extending over a period immensely vast, if calculated in years. A fresh fauna and flora were introduced. A rigorously cold climate came on; the Forest Bed became a part of the sea-bed, and great icebergs floated over its site, and stranded amid its vegetable ruins. Arctic fish and molluscs migrated thither in order to obtain a fresh location. Dark fringes of sea-weed attached themselves to recumbent trunks of elm and oak, and the deep icy sea covered the submarine forest from the light. Packs of icebergs and sheets of field-ice, as well as great glaciers from neighbouring lands, brought down immense quantities of mud, and thus the old Forest Bed was covered up to a depth of a hundred feet. Such is a portion of the physical history of this coast. Again, the dread rigour of a Greenland climate is slowly retreating before an advancing and increasingly warm Gulf-stream. The ocean bottom is being gradually uplifted, and on its clayey beds are thrown down banks of sand. The sea-floor at length emerges above the waters. England was once more joined to the continent, and the Forest Bed lay a hundred feet below a mass of clays and gravels. Various agencies scooped out the present bottom of the German Ocean, possibly during a *second* or partial submergence. Meantime a great river, emptying itself probably into a fresh water lake, the site of which is now occupied by the sea, flowed near Mundesley. The old clay and gravel were worn away by the river until the Forest Bed was again laid bare, and in this excavated hollow was deposited a series of fresh water strata until it had been filled up. Finally, a last general submergence of the land coated all these older deposits with a bed of gravel, ten or twelve feet in thickness, now to be seen running along the top of the Norfolk cliffs.

Such is the history self-related by these beds, and the reader will willingly grant them of interest. The first bed visited on Tuesday was a bed of *marine* shells, corresponding probably to the Upper Crag bed found near Norwich. Most of the shells were in a shattered and comminuted state, but they were none the less good evidence of the conditions under which the bed had been formed. Further on, the party proceeded to the black-looking strata of old river mud, which at once proclaim their fresh-water origin. A few minutes' digging with a trowel, or cleaving open the laminæ of the strata, exposes their contents. Here are the remains of fishes, perch, and pike, wings of fresh-water beetles, seeds, leaves and stems of plants; together with the same fresh-water shells now found in our rivers.

Mr. Gunn read a paper by Mr. Prestwich, on the Mundesley river bed, in which was shown the purely fresh-water character of the deposits, and how they had been formed. Many of the members walked to Trimmingham, in order to study still further the coast-line, and more particularly to visit the peculiar outliers of Chalk which there rise up amid the clay-beds by which they are surrounded. Repeated stoppages were made to notice the varied geological features of the coast. In one place the overlying sands were seen contorted into the most fantastic shapes, this having been effected when those very sands formed part of banks on which icebergs stranded, and pushed the sand out of its original layers into the contorted position it now presents. At another part, fragments of marine shells, such as *Tellina solidula,* might be seen plentifully scattered through the tenacious clay, indicating its marine origin. Here some boulder of granite or trap would be disinterred, and its well worn and *scratched* surface told of the ice action which had grated it against other hard substances and produced these striæ—there, a land-slip, which had brought down to the foot of the cliffs a portion of the upper beds, enabling the party to study them better. At length the Trimmingham Chalk outliers were reached. These immense masses were formerly supposed to have been portions brought down by still greater icebergs, and dropped on their present site. A careful examination, however, points out their true nature. The trained eye sees in the contorted flint bands and strata a similar upheaval to that seen at Whitlingham, and suggests that these *outliers* have been upheaved higher than the rest of the Chalk, and so preserved whilst other beds were wasted away by abrading agencies. In fact, these bluffs of Chalk are the only remains of beds of which they once formed part—beds to be seen in Holland. There can be little doubt that the area now occupied by the ocean was formerly filled by these upper Chalk beds. It is from the wreck and waste which subsequently ensued that we have the vast beds of flint gravels so common in this county. The very quantity of these disengaged flints indicates how extensive the wear and tear has been. Another fact is very remarkable. The gravel flints often contain fossil sponges, *not* to be found in the flint bands and nodules still lying in the Chalk. Indeed, these fossils prove them to have been mainly characteristic of an upper bed. Now, singularly enough, the flint nodules lying *in situ* in the Trimmingham Chalk contain fossil sponges in immense quantities, *identical* with those found near Norwich in the liberated flints. This fact proves that the Trimmingham Chalk outliers are of the very highest strata of that formation, and that our local flint gravels are the remains of the wear and tear to which it has been subjected in the geological ages which have elapsed since its deposition.

Lying on the top of these Chalk outliers is a thin seam of shells, very much resembling in appearance some portions of the Norwich Crag. No fewer than *six* different species of marine shells were obtained, all of which are characteristic of the Crag. The bed at Trimmingham also holds a corresponding place to the true Crag, for it rests immediately upon the Chalk. If it be the *true* Norwich Crag, it will extend that deposit over a greater area than has been hitherto supposed. The members occupied some time in extracting flints containing sponges, for the purpose of microscopical examination. —J. E. T., *Norwich Mercury*, Aug. 18, 1866.

Richmond Naturalists' Field-club.—We reported an excursion of this club to Saltburn-by-the-Sea, on the 31st July, in the Geological Magazine for September (p. 429). On that occasion the president of the club, Edward Wood, Esq., F.G.S., invited the members to dinner at the Zetland Hotel; but, owing to the unfavourable state of the weather, the intended visit to the iron mines of J. W. Pease, Esq., M.P., had to be deferred. On the 25th August, however, a second visit to Saltburn was arranged, and the programme most successfully carried out. The party, nearly 100 in number, arrived at Saltburn about noon, under the conduct of Mr. Wood, accompanied by Sir George W. Denys, Bart., Sir John Lawson, Bart., Capt. Denys, the Rev. J. Thompson, and other leading members. Having been successfully photographed, the company started for the very extensive and valuable iron-mines of Mr. Pease, M.P. Before entering the mine, the president, Mr. Wood, delivered an address on the geology of the Cleveland Ironstone district. These deposits form part of the Lias formation, and were described by Young and Bird in 1822, and subsequently by Professor Phillips in his "Geology of Yorkshire," in 1835. So early as 1811 an attempt was made to smelt the ore, but it was so intractable as to be considered valueless. It was the introduction of the "hot-blast furnace" (first used here in 1831) which has converted this district into a rich centre of mineral wealth. The Ironstone was formerly collected upon the shore, as boulders, and sent up to Middlesborough in boats; then from open workings in the hill-sides; but the great means of production is by driving a level into the hill-sides, which is the plan adopted at Mr. Pease's works. Messrs. Bell Brothers have lately sunk some shafts to work the iron-ore, as coal is worked; but they are the first here who have adopted this plan. Some idea may be formed of the value of these mines when it is stated that the yield of the Cleveland Ironstone district amounts to a million tons of pig-iron annually. Having explored the mine, under the intelligent guidance of the manager, Mr. Cockburn, and witnessed the method of blasting the rock to gain the Ironstone, the party returned to daylight and crossed the fields to Saltburn Glen, or Gorge, celebrated for the great beauty of its scenery. From thence the members walked to the beach and examined the interesting cliff-sections, which were explained by Mr. Wood. The dinner upon this occasion was given by the club in honour of their esteemed president, the chair being occupied by Sir

George W. Denys, Bart. Professor McChesney, U.S. Consul at Newcastle, Dr. Walton, Mr. Bowes, and Mr. Cockburn joined the party. The chairman, after dinner, in an appropriate speech, alluded to the manner in which their president had before entertained them at Saltburn, and to his uniform kindness and untiring efforts for the good of their society and the spread of a taste for natural history pursuits. Mr. Wood having responded, other speeches followed, and the pleasure of the excursion was completed by a visit to Rushbrook Hall, the seat of John Bell, Esq.—*Darlington and Stockton Telegraph.*

CORRESPONDENCE.

NOTES FROM OUR CORRESPONDENTS.

1. Dr. Gustaf Lindström writes from Wisby, Island of Gotland (August 18th): "The debates on the recent changes of the surface of the land, now going on in the pages of your Magazine, are of great interest to us Swedes, as our Geological Survey has had almost exclusively for some years to handle questions of that kind. We have natural features similar to your Eskers and Kaims, your Boulder-clay, Leda-clay, etc.; I think these formations have been more thoroughly studied here than elsewhere."

2. In a subsequent letter, dated October 4th, Dr. Lindström writes: "The marks figured by Mr. Mackintosh in the last number (September) of your Magazine, Plate XV., Fig. 5, are evidently *ice-marks* (or made by Glaciers) not made by the waves and stones as he supposes. We have plenty of them here, and their exact counterparts may be seen in the Alps."

3. Mr. Spencer G. Perceval[1] writes (August 20th) to correct an error as to the discovery of "Wulfenite,"[2] in Pembrokeshire. "It is not," he writes, "'Wulfenite,' as I was led to suppose, but 'Brookite' (oxide of Titanium); for which information I am indebted to Mr. Warington Smyth" (Mineralogist to the Duchy of Cornwall). "The crystals which I supposed to be of Tin, are likewise Titanium. Those of Brookite much resemble specimens from Snowdon, but are far more minute."

4. Mr. Thomas C. Brown, of Further Barton, Cirencester (Sept. 11th), gives a long and interesting account of an ancient forest near Loch Maree, Ross-shire, of which the following is a summary:

"The stools of the trees are wholly embedded in peat, varying from 18 to 36 inches in thickness. Beneath the peat is a bed of gravel, in the surface of which the trees appear to have grown. They were generally, if not exclusively, Fir, the natural tree of the Highlands."

The diameter of the bole of several measured from 14 to 28 inches, consisting exclusively of heart-wood—the sap-wood had

[1] Severn House, Henbury, Bristol.

[2] See Geological Magazine, August (No. 26), p. 377.

perished. The rings showed a slow but uniform growth of about twelve annual lines to an inch. Trees of this size far exceed those now growing south of Loch Maree in less exposed positions. The roots are extremely singular. In one case Mr. Brown found a plexus of inosculating roots, ten feet in diameter, forming almost a platform, the separate roots measuring ten inches in width.

Mr. Brown proceeds to infer that the change of climate must have been very considerable to have first caused the growth of such fine forest trees, and then their overthrow and the production of peat.

Mr. Brown suggests that this Highland region of Laurentian Gneiss surmounted by Cambrian rocks has remained elevated above the sea, and clothed with vegetation when all the younger rocks were submerged beneath its waters, which would by their genial iufluence favour a more rich vegetation than the present climate.

5. Mr. E. B. Kemp-Welch, of Lindfield, Malvern (Sept. 17th) announces the discovery of a Trilobite new to the Malvern district, viz: *Ampyx nudus*, March; the specimen was obtained "from the Woolhope limestone, at the tunnel shaft, on the Worcester and Hereford Railway, Colwall, near Malvern." Mr. Welch encloses a sketch, which is certainly very like an *Ampyx*, a remarkable find, indeed, in the Upper Silurian of Malvern.—We had, however, the pleasure to see this new find the other day; it was kindly brought for our inspection by Dr. Grindrod, of Malvern. We are sorry to state that *it is manufactured.*—Edit.

MACKINTOSH ON WELSH VALLEYS. GEIKIE ON SCOTTISH KAMES.

To the Editor of the Geological Magazine.

Sir,—As sure as there are alternations of hard and soft strata in the course of a valley or river so sure will there be alternations of gorge and alluvial flat. Mr. Mackintosh credits this principle to Professor Jukes. I, however, first published it in 1857, in the first edition of "Rain and Rivers," p. 53, in accounting for the river-gorges through the north and south Downs. Also at page 174. And I have since sung the cuckoo-note in various letters to periodicals. In the "Athenæum" of 26th December, 1863, I advanced the principle as "the open sesame of the secret of the parallel terraces of Glen Roy." In February, 1864, Mr. Jukes kindly sent me a copy of an article of his in the "Reader." I remarked to him that he had used my argument. His letter in reply begins, "I had your description of Glen Roy in my head when I wrote the passage you allude to." In page 16, second edition of "Rain and Rivers," I have said, "Any one may make parallel terraces for himself in the road-side gutter. Dam up the run of rain. A pool will form above the dam. Every rain will deposit on the bed of the pool, till the flat alluvium rises to the height of the dam. Take away the dam. The rain cuts through the alluvium which it has deposited and runs between two parallel terraces till they vanish by denudation. This is the whole secret of the terraces of Glen Roy, or of any other valley or river."

I might have added, and this is the whole secret of Kames. For rain, in destroying extensive alluviums, cuts them into the ridges and knolls, called "Kames." Mr. Mackintosh's *facts* precisely accord with my theory. Whenever the strata are hard the valley is narrow, and the river runs in a gorge. In the softer strata above the gorge atmospheric decomposition, the erosion of rain, and the river, cut a wide *flat* valley at the level of the gorge. Though, according to Mr. Mackintosh's *theory* "rivers (apart from deposition during floods) can only produce *inequalities*." And his expression, "a river, when it *enters* a plain," should be "when it *has made* a plain." The flood-water of the wide flat plain, checked at the gorge, overflows and deposits an alluvium. The bed of the gorge is lowered; away goes the old alluvium, and a new one is begun at the lower level of the gorge, leaving remains of old alluviums as parallel terraces on the hill sides. This is the solution of Mr. Mackintosh's "Great Denudation puzzle." His "river tricks" are very curious indeed. They make Welsh water quite exceptional in its properties. He assures us that Welsh water-falls do not cut their gorges backward. Will he apply his Welsh rule to the gorge of Niagara? Welsh rivers, "after long-continued heavy rain, run as clear as crystal." He tells us of "a stream flowing very nearly along the summit of a rocky ridge." To say nothing of a river which, as I understand him, has no channel, while "the ground on each side slopes away from it." He photographs a small valley as "all that the stream has been able to effect." Is nature to have no small valleys because she has large ones? Mr. Searles Wood's "river tricks" are as fantastic as Mr. Mackintosh's. Indeed he asserts—

> Arduis
> Pronos relabi possé rivos
> Montibus, et Tiberim reverti.

He talks of the "*reversal*" (!) of the Medway! The alluvial flats of the Weald rivers inside the gorges of the Chalk downs result from the easy erosion of the Weald clay. Did the nine rivers which now flow *from* the Weald *hill* through the Chalk formerly flow (*arduis montibus*) *to* the Weald hill?

Mr. Geikie ("Scenery of Scotland," p. 308) says of Kames, "notwithstanding all that has been said and written about them, they are as complete a *mystery* as ever to the geologists of this country." He describes the Kames at Carstairs as the most remarkable that he knows. They are simply the remains of patches of alluvial plains formed by rain and rivers, and in the act of being carried away by the same agents. They have been formed by the Clyde and its affluent, the Mouse-water. The hard rocks which still form the falls of the Clyde at Lanark, and the gorge of the Mouse-water through Cartland Crags between those falls, have formerly sustained the beds of the Clyde and the Mouse-water as high as the Kames are now at Carstairs, and have allowed the formation of enormous patches of alluvial plains. As the gorges at Bonnington, Corra Linn, Stonebyres, and Cartland Crags have been lowered, the alluviums have been cut through, and are vanishing in the form of parallel terraces and "Kames." There are ancient terraces and alluviums recent and in actual formation, in the long and beautiful gorges of the Lower Mouse-water wherever an interval of soft strata occurs in the banks of these gorges. One may be seen from the road and bridge immediately above the magnificent gorge through Cartland Crags. Another immediately above the almost equally magnificent gorge, beginning at Cleghorn bridge. Man has run his roads and bridged the river at these two crossing places of nature. Below Cartland Crags vast alluviums have always (that is, for millions of years) existed above Stonebyres Fall, caused by the hardness of the rocks there. The remains of these alluviums are still to be seen on the hill side, and modern ones are still growing from the same cause. Indeed, the singularly hard Devonian conglomerate rocks at Stonebyres Fall still give the level to the bed of the Mouse-water through Cartland Crags. Every one (except Mr. Mackintosh) will allow that the Mouse-water has cut the gorge through Cartland Crags backward, and that it must once have run at a level as high as the top of these Crags. Who shall say how much higher these rocks have been? though we scarcely need them higher than they are to account for all the alluviums behind them. The Clyde becomes smooth and sluggish about Tullyford, above Bonnington, with new alluviums, and the banks are terraced with old alluviums of sand, with pebbles. While, where the railroad from Lanark to Douglas crosses the river, the country is one wide sea of ancient terraced alluviums. These extend over the hills between Lanark (by Ravenstruther) and Carstairs. So that the water-parting between the Clyde and the Mouse-water is formed by hills capped with these alluviums. The Clyde, from Carstairs up to its source, is at the same work now, which it has been at for millions of years. That is, it is still cutting through old and recent alluviums, or "haughs," of all ages and at all levels, and forming *new ones*, which it gives, as Aladdin did his lamps, in exchange for *old ones*. This may be *seen* from the railway at express pace. Mr. Geikie seems wantonly to introduce "mystery" and marvel where in nature simplicity itself reigns. He turns a certain pool into the crater of a volcano, like one of those in the Eifel. Now the bed of this *volcanic* pool is formed of the most perfectly *water-worn* pebbles, and its sides of drifted sand, boulders, and pebbles—most remarkable materials for the construction of a volcanic crater! Yours, &c., &c.

George Greenwood, Colonel.

Brookwood Park, Alresford,
5th September, 1866.

P.S. 17th October.—In the Geological Magazine of this month, page 435, Mr. Topley applies the rain and river theory most admirably to the northern half of the *alluvial* streams which unite at the Humber *gorge*, as he formerly did to those which unite at the Medway gorge through the North Downs. But the principle at the beginning of this paper applies equally to the Trent and to all the southern and western streams which flow from the Pennine chain across the Plain of York to the Humber gorge. That is, the hard Oolites and Chalk of the York wolds on the north and of the Lincoln heights and Lincolnshire wolds on the south, have formed the gorge of the Humber, which once flowed as high and higher than these heights. In the meantime rain and the rivers have always excavated deep flat valleys in the soft Triassic strata west of these heights and have deposited *patches* of alluviums in them ever varying in height with the ever varying level of the bed of the Humber gorge. Now that the Humber gorge is cut down to the level of the sea, these alluviums (like all alluviums next the sea or deltas) will constantly rise from overflow and deposit, except where they are embanked.

G. G.

MARKS OF SEA-ACTION ON THE CLIFFS, GORGES, AND VALLEYS OF WALES.

To the Editor of the Geological Magazine.

Sir,—Having not long since explored a considerable portion of the country described by Mr. Mackintosh, in his interesting paper on the "Cliffs and Valleys of Wales," chiefly with a view to studying the physical geology of the district, I venture to ask space for a few thoughts on "the great denudation puzzle." Admitting the facts brought forward by my friend Mr. Maw, in his admirable remarks on "Watersheds," and the general soundness of his arguments, might we not still expect to find marks of marine-action in the formation of beaches, the erosion of cliffs, etc., in precisely those situations in which Mr. Mackintosh claims to have found them? And can such marks be considered, then, as any real evidence against the subaërial theory of denudation? These are the questions I propose very briefly to consider.

Granting that the Eglwyseg cliffs, for, example, *do* bear marks of having, at one time, been washed by the waves as those of Llandudno are now—if we mark the elevation of the supposed beach line at their base, and trace out the line of such elevation on a contour map of North and South Wales, shall we not get just such an intricate outline of land and water, such a series of small islands, and land-locked inlets, as Mr. Maw has shown to be found in the case where a tract of land, with its recent configuration of hill and dale, is *known* to have been suddenly submerged within historic times, but which can *not* be found anywhere in the world where the sea washes the coast of land long raised to any considerable height above its level? There was, beyond doubt, a period when the waters of the Glacial sea covered the low lands of Cheshire, Flint, Denbigh, and North Shropshire; while such elevations as Wenlock Edge, the Longmynd, Caradoc, and Wrekin-Cyru-y-Brain, and Eglwyseg rocks were above water, as well as the higher peaks. (Mr. Maw has himself shown this in the case of Wenlock Edge, in his paper on the "Severn Valley Drift," in the Quarterly Journal of the Geological Society for May, 1864.) And we may reasonably look to find traces here and there at the bases of those high lands of the action of the sea. Supposing, then, the general contour of the land to have been *in the main*, what it now is, previous to that submergence, are not almost all the phenomena described by Mr. Mackintosh precisely such as we might expect to have been produced by such a subsidence as would permit the sea to flow into the existing valleys of Wales? Are not the traces[1] of sea-action, which he finds, more consistent, in short, with the theory of a temporary submergence of land already modelled into nearly its present contour, than with that of the eating out of such an intricate network of "fiords" by the gradual operation of the sea upon an elevated and rocky land? How, again, I would ask, can Mr. Mackintosh possibly explain the formation of such a long tortuous gorge as that, for example, through which the river Alyn flows for some miles above Gresford? Taking that gorge in connexion with the ridge of Drift-gravel, at the east of Gresford and Wrexham (the old sea beach, perhaps,) through which the river cuts its way, we have as clear a case as may be of *river-action*. And if there, why not in other similar gorges throughout the country? Even Mr. Mackintosh will scarcely argue that the long alternations of tunnel and deep cutting, through which so many of the limestone rivers of Yorkshire find their way, were made for them by the sea.

I am, Sir, yours faithfully,

William Purton.

Stottesden Vicarage, Bewdley.

To the Editor of the Geological Magazine.

Sir,—Mr. Hull's letter on the "River-denudation of Valleys," in your number for October, is valuable as again calling attention to a very puzzling fact, which I agree with him in thinking has not yet received a perfectly satisfactory explanation. I pointed out some time ago two cases in North Staffordshire of a valley crossed by a watershed, exactly like the instances described by Mr. Hull, but on a larger scale.[2]

It is not, however, my intention to attempt a solution of this knotty problem, but to point out one sentence in Mr. Hull's letter, so plausible, and, at the same time, so illogical, savouring of the *post hoc ergo propter hoc*, that I hope the author will excuse me if I show the flaw in his reasoning.

The sentence is, "It is less incredible (to say the least of it) to assume the agency of the sea in the formation of these valleys (or parts of them), which we know *was* there, than that of a stream of which there is no trace."

The argument stated formally runs thus:

We know that the sea has been over the ground now occupied by the vale of Todmorden.

[1] Except, indeed, his supposed instances of "sea-worn summits of hills," about which I confess I am rather sceptical.

[2] See the Memoir of the Geological Survey on the country round Stockport, Macclesfield, Congleton, and Leek (p. 13).

We do not know *for certain* that any stream has run through the valley.

Therefore it is less incredible to assume that the sea cut out the valley than that it was made by a stream. In a like strain, a stranger, unacquainted with the antiquity of the valley, might urge.

We know that Mr. Hull, heavily shod and armed with a ponderous hammer, after the manner of field-geologists, has been often seen in the neighbourhood of what is now the vale of Todmorden.

We do not know for certain that any stream has run through the valley.

It is, therefore, less incredible that the valley should have been excavated by Mr. Hull than that it should have been hollowed out by a stream.

I do not say that Mr. Hull's argument is as absurd as this; but both break down for the same reason, because both involve a tacit assumption—the one, that the sea, and the other, that my worthy colleague, is capable of performing the task assigned to him.

Indeed, it seems quite to have escaped Mr. Hull that before the claims of sea against river can be entertained at all, we must show that sea and river *can* both cut out valleys like those described; we must be able to point to valleys excavated by the sea alone, as well as to valleys hollowed out by rivers; and, having thus shown that *à priori*, it is an open question whether the sea or a river has been the cause of any given valley, other considerations, like those brought forward by Mr. Hull, come in to decide which of the two has the better claim.

In short, the first clause of the argument wants to run thus:

We know that the sea has been over the ground now occupied by the vale of Todmorden, *and we can also point to cases of like valleys which have undoubtedly been hollowed out by the sea.*

Mr. Hull has tacitly assumed the important part in italics; and, if he were justified in doing so, his conclusions would legitimately follow: but I utterly deny that the above would be a true statement of the case in the present state of our knowledge; we are told, on good authority, of valleys which can be due only to stream-action—witness those of Auvergue; but where shall we find a long, narrow, winding inlet which has been undoubtedly cut out by the sea alone?

The ungrounded assumption, which I have noticed, is so constantly made, that I have thought it worth while to dwell on the subject at length, and have left no room for the more agreeable task of confirming, from other sources, the accuracy of Mr. Hull's facts, and endeavouring to give some explanation of the difficulties they offer: but this I hope to attempt before long.

I am, Sir, yours obediently,

A. H. Green.

116, Dodworth Road, Barnsley,
October 10*th*, 1866.

ON THE OCCURRENCE OF MOLYBDENITE IN LEICESTERSHIRE AND OF LINARITE IN CORNWALL.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—During the late meeting of the British Association I happened to form one of the party which visited the Mount Sorrel Syenite (or granite) quarries. Some of the workmen brought us specimens of what they called *lead* on the stone. I bought a piece from one of the men, recognising in their *lead* the mineral Molybdenite, and since my return from Nottingham I have confirmed my opinion by the ordinary tests for Molybdenum.

I am not aware that the occurrence of Molybdenite at Mount Sorrel has been noticed hitherto; at all events, it is not mentioned either in Phillips' "Mineralogy" or in Bristow's "Glossary" as occurring there.

It will, perhaps, not be uninteresting to some of your readers to learn that the mineral Linarite has been found in Cornwall. I lately found a specimen at Huel Penrose, near this town,—a mine long noted for its beautiful specimens of Pyromorphite, Mimetesite, and Cerusite, and where Anglesite also occurs in small quantities.

I remain, Sir, your obedient servant,

CLEMENT D. NEVE FOSTER.

HELSTON, CORNWALL,
17th October, 1866.

SIR J. F. W. HERSCHEL ON TIDAL CURRENTS.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—As it might be too much to expect you (considering the great increase in the number of your contributors) for several months to come, to find room for a *full* reply to Mr. Maw's elaborate article,[1] I shall at present only direct the attention of your readers to what Sir J. F. W. Herschel says relative to the concentrated force of tidal currents in inlets, channels, and shallow seas; and to the great variety of effects which must result from the localization of currents by which they are made to assume the form of curving, eddying, revolving, re-acting, returning, connecting, bifurcating, joining, deflected, and reflected streams. In speaking of "the peculiar nature of the tidal undulation," the above great *dynamical* authority remarks: "The full effect of this power is only to be appreciated when we contemplate the rounded forms of hills, and the branching and sinuous valleys of a very large proportion of the surface of the land, where the action of the existing rivers, or any conceivable amount of atmospheric precipitation, is quite inadequate to have performed the work of excavation."[2] Sir Charles Lyell and Sir Roderick I. Murchison have likewise borne testimony to the denuding influence of marine currents.

D. MACKINTOSH.

WESTON-SUPER-MARE.

[1] GEOL. MAG., Oct. 1866. [2] "Physical Geography," p. 91.

MISCELLANEOUS.

New Carboniferous Reptile.—A new reptile has recently been found in the upper part of the Carboniferous series at Muse, near Autun, by M. Frossard, which it is proposed to designate by the name of *Actinadon*, from the peculiarly radiated appearance of the teeth under the microscope. The skull was ·156 of a metre in breadth, and, from the occipital margin of the otocrane to the anterior edge of the vomer, measured ·182 of a metre. The lower jaw measured ·190 of a metre; all the teeth were perfect, and the remains showed, beyond doubt, that the branchial arches were well developed. The bodies of the vertebræ were incompletely ossified, with the sides greatly developed. This reptile evidently bears a great resemblance to the *Archegosaurus latirostris*, of Jordan, from the Coal-formation Saarbruck, described by H. Von Meyer, in the Palæontographica. Besides the regular teeth seated in the arch of the jaw, the *Actinadon* appears to have been furnished with a number of small palatine teeth, which though common in many fishes, and indicated in the *Zygosaurus* found in the Permian beds of Russia, does not appear to have been hitherto observed in any other reptile. A slab, with traces of the footsteps of a reptile with four long flat toes, the terminating phalange apparently considerably incurved, has since been found at Muse, and is conjectured to indicate the footprints of the *Actinadon*.—*London Review*, Oct. 13.

The following interesting Notice has just been published in the Natural History Transactions of Northumberland and Durham. Vol. I., Part 2, p. 201. 1866.

On Siliceous Casts of Palæozoic Corals found amongst the Refuse of Alkali-works. By Henry B. Brady, F.L.S., &c.—Some time ago my friend, Mr. Archibald Stevenson, brought to me a lump of refuse picked up from the waste-heap at the Jarrow Chemical Works, which was so far different from the rest in its general appearance as to have excited his curiosity. The mass had certain characters which seemed to indicate an organic origin; but they were too obscure to admit of any very positive judgment without more opportunity of comparison than this specimen afforded. Further search set the matter at rest, bringing to light specimens of two species of carboniferous corals.

On making inquiry into the history of the refuse in which these specimens were found, I ascertained that a quantity of "Black Limestone" had been brought into the Tyne from Ireland (Co. Dublin?) as ballast, and had been taken into the chemical works as material for the production of carbonic acid, but it was found to contain so large a proportion of matter insoluble in hydrochloric acid that it could not be used for the purpose. The insoluble residue remaining in the generators was thrown out as refuse, and the remainder of the stone was burnt as quick-lime.

Subsequently, I had the opportunity of searching the heap, very carefully, in company with Mr. Stevenson, and Mr. D. O. Brown, and we had the good fortune to find examples of about half a dozen species of Carboniferous Limestone Corals. Dr. P. Martin Duncan, M.B. Lond., For. Sec. Geol. Soc., has been good enough to examine these, and states that several of the specimens belong to a species of *Zaphrentis* hitherto undescribed; that the rest are well known and are as follows:

Syringopora geniculata, Phillips.
Michelenia megastoma, Phillips, sp.
Zaphrentis caryophylloides, Scouler, sp.
Lithostrotion Phillipsii, Edwards.

The specimens consist of siliceous casts of the calcareous skeleton of the corals, and they are so completely decalcified that they remained unaltered on a second maceration in strong acid. Chemical analysis of a fair sample of the limestone showed that it contained nearly 30 per cent. of silica, and that there were also present sensible quantities of organic matter (bituminous) free sulphur, phosphoric and sulphuric acids, and protoxide of iron.

Much fresh interest has been recently excited in the processes by which the infiltration or impregnation of organic bodies with silex takes place, in connexion with the history of *Eozoön Canadense.* In the case of *Eozoön*, the sarcode or animal-jelly appears to have been gradually replaced by siliceous material, which has accurately filled even the minutest tubuli of the canal-system, whilst the calcareous skeleton has remained unaffected. But in the corals an opposite condition is found—the skeleton has become silicified, and we have no traces of the soft parts. Whether a certain portion of silex was secreted with the carbonate of lime during the life of the animal, or whether its presence is entirely due to infiltration, subsequently, is a question very difficult of solution.

It is well worth while for those that have the opportunity, to keep an eye on the insoluble matters turned out of the carbonic acid generators in our chemical works. Carbonate of lime, in many of its forms, abounds in siliceous fossils, and these are left among the refuse thrown out; indeed, the process of chemical manufacture, as practised on the Tyne, supplies us on a grand scale with a means of separating organic remains, which palæontologists are prevented from employing, except in a very limited way, on the ground of expense and the want of suitable apparatus for its proper application.

Earthquake in Devon.—A correspondent of the *Exeter Gazette* writes from East Budleigh: "Two distinct shocks were felt here at a quarter to ten on Thursday night, Sept. 13th. The windows of my house rattled violently. About five minutes elapsed between the two shocks, and the last was the more violent of the two. I believe that the cause was an earthquake. The night was quite calm at the time." The same paper states that inhabitants of neighbouring villages also felt the shock. Can there have been any connexion between this wave and the one felt in Paris?—See GEOL, MAG., 1st Oct., p. 479.

OBITUARY.

G. W. FEATHERSTONHAUGH, ESQ., F.R.S., F.G.S., British Consul at Havre, died early in October, aged 80 years. In 1827 he was elected a Fellow of the Geological Society of London, and in the same year he communicated a short account of an ancient excavation in the Chalk at Heigham Hill, near Norwich, which had been discovered in digging a well; afterwards, in 1829, when in America, he sent a paper on the series of rocks in the United States, published in the same (1st) vol. of the Proceedings of the Geological Society. His reputation as a geologist consists mainly in his publications on American Geology. He was elected a member of the American Philosophical Society in 1809. In 1831 and 1832 he conducted the "Monthly American Journal of Geology and Natural Science," a periodical in which were published a great number of interesting geological papers, very many of which, including an "Epitome of the progress of Natural Science," were written by Mr. Featherstonhaugh. In 1835 he published a geological report on the Elevated Country between the Missouri and Red Rivers; and in 1836 a report of a geological reconnaissance made in 1835 from Washington, by Green Bay, &c. In 1844 he read a paper before the British Association at York, "on the Excavation of the Rocky Channels of Rivers by the Recession of their Cataracts;" the author, in travelling through North America, had noticed that at some points of the course of all the great rivers there was either a cataract, or evidence of the former existence of one, in rapids now obstructing navigation; and on comparing the quantity of water in the rivers now, with certain marks which appeared to indicate the quantity which formerly flowed in their channels, he came to the conclusion that the volume of water was formerly much greater than at present, and that such a state of things was necessary for the excavation of their rocky channels, which he considers to have been effected by the recession of their cataracts. Mr. Featherstonhaugh thought it possible that even in our own island we are not precluded from supposing that the same causes may have excavated river-channels, when England was a portion of a great continent.—H.B.W.

THE

GEOLOGICAL MAGAZINE.

No. XXX.—DECEMBER, 1866.

ORIGINAL ARTICLES.

I.—On the Metamorphic Origin of Certain Granitoid Rocks and Granites in the Southern Uplands of Scotland.

By James Geikie, Geological Survey of Great Britain.

THE special proofs of metamorphism which it is the object of this paper to point out, are rather of a geological than chemical nature. They consist, in short, of such evidence as may be readily gathered in the field, and although, to render them complete, they ought perhaps, to be followed up by analyses of the rocks, yet it is believed that the phenomena to be described tell a plain enough story.

The rocks referred to below are *Diorite, Minette,* and *Granite,* all of which, with one exception, are admitted by most geologists to have *generally* had an igneous origin,—that is to say, they have not only been in a state of fusion, but have also at various periods forced themselves among pre-existing strata. For example, diorite and minette are met with abundantly throughout Scotland as eruptive rocks—the former seeming to prefer strata of Carboniferous age (to which, however, it is not confined)—the latter seldom travelling beyond the range of Old Red and Silurian regions. But the diorite to which reference will presently be made is of a more granitoid and less basic character than the usually finer-grained and often dull earthy rock of the dykes which here and there intersect the Coal-measures.[1] So far as its mineralogical nature is concerned, however, the granitoid diorite alluded to, might be *eruptive,* for it is simply an admixture of hornblende with white and pink felspar. Minette, or quartzless granite, is a rock that sometimes forms intrusive dykes through Lower Silurian greywackés, very beautiful examples of which may be seen in Priesthill Burn, near the village of Innerleithan, on the river Tweed. The exclusively eruptive origin of granite is advocated by several geologists; but the proofs which are thought to establish this theory have been called in question, and the metamorphic character of the rock strenuously upheld. In the

[1] Most of the trap dykes of the Scottish Carboniferous strata, however, are not hornblendic but augitic greenstones, or *dolerites.*

present state of our knowledge, we are induced, like old Sir Roger, to conclude that much may be said on both sides. It is obvious, however, that many of the so-called eruptive granites must be re-examined, their igneous character having been assumed at a time when as yet the study of metamorphism had made little progress. No disrespect for the work of the laboratory is implied in the belief that the question of the origin of granite and other allied rocks will ultimately be solved by the field observer. The labours of the chemist have been invaluable, but experience is ever showing us that the chemical or mineralogical composition of a crystalline rock cannot always be taken as a test by which to discover its *geological* nature. For this purpose it becomes necessary to study the behaviour of the rock with surrounding strata, and to mark how these may be affected by its presence. The composition of the sedimentary deposits must be carefully noted, in order to prove whether they make the raw material out of which a crystalline rock, such as that with which they may be associated, could have been formed. But even after the composition has been ascertained to be such as, under metamorphic conditions, would readily give rise to the crystalline mass in question, it will still be necessary to examine carefully the junction of the stratified and amorphous rock; for if the latter be eruptive, its association with any particular strata might, of course, be quite accidental. It must also be remembered that contact with an igneous rock has often induced a certain degree of change upon beds of aqueous formation. But this appearance, even when the immediate junction of the two rocks remains concealed, is not likely ever to be taken as a proof that the crystalline rock has resulted from the alteration of the stratified deposits. If we are thus to guard against hastily inferring the metamorphic nature of a rock, we must also 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.

As the phenomena connected with the quartzless syenites and granites perhaps evince a less intensity of metamorphic action than the corresponding phenomena of true granite, it will be proper to treat of them first.

Diorite and Minette.—I have elsewhere[1] given the results of a detailed examination of the metamorphic rocks of Carrick in Ayrshire, and shown how passages can be traced from granular and comparatively unaltered greywackés into distinctly crystalline and igneous-like rocks, such as felstone, felspar-porphyry, felspathic, amygdaloid, diorite, etc. None of the rocks of that region, however, are micaceous. But in another smaller area of metamorphism, near the little village of Sorn, Ayrshire, a series of felspathic sandstones of Lower Old Red age have become changed in places into a rock of

[1] In a paper read before the Geological Society, June 6, 1866:—*vide* GEOL. MAG. p. 321.

variable composition, which is sometimes a quartzless syenite, sometimes minette or mica-trap.[1] Where this rock is typically developed it shows a granitoid texture, and is, moreover, marked by special phenomena, the meaning of which can be traced, and as these last are frequently met with in granite, they seem to throw light on the obscure history of that highly crystalline rock.

The unaltered portions of the strata consist of reddish-, pinkish-, and greenish-grey felspathic sandstones, coarse and fine-grained. They contain little or no free silica, but often show a considerable admixture of mica. The finer-grained beds are fissile or flaggy, the surface of the flags being often coated with a pellicle of pale greenish clay, while here and there, both in the fine and coarser-grained beds, the rocks show streaks of a similar green colour, but generally of a darker hue. In many places the sandstones are marked with thin, short, lenticular bands or ribands, and with abundant little galls or irregular blotches and flakes of brown, greenish, and dark red clay or mudstone.

The first indication of change presented by the strata consists simply of hardening—the fracture becoming gradually more splintery and conchoidal, as the induration increases. At the same time, the texture begins to lose its dull sandy character, and to assume instead a somewhat sparkling, compact, and baked appearance. Every gradation from semi-crystalline to crystalline succeeds—in some portions the rock being fine-grained, and the component minerals indistinguishable—in other places the beds becoming changed into distinctly crystalline and well-marked varieties of diorite and minette. The little layers and flakes of clay mentioned above, have also undergone change, but are still recognisable, even in the most highly metamorphic portions of the strata,—here as hard splintery Lydian stone and porcelanite, there as dark compact or fine-grained crystalline rock, which is sometimes hornblendic, sometimes micaceous,—differences that are no doubt due to the original chemical nature of the separate "nests" and lenticular layers. For the ultimate character of a metamorphic rock must always depend upon the composition of the stratum acted upon. In the coarser-grained minette,[2] or quartzless granite, the included "nests" or galls reach the maximum of their metamorphism. There they are changed into a hard, dark, finely crystalline rock, in which minute points of mica could be detected. It is somewhat noteworthy that, in this highly altered condition, the "nests" seldom occur as lenticular layers, but most usually as amorphous nodules and flakes.[3]

[1] The best exposures of these metamorphic rocks occur on Tincorn Hill and Blackside; the unaltered strata are well seen in a few quarries in the same neighbourhood, and fine sections are also obtained in the tributaries of the Gower Water, a stream that joins the Irvine above the village of Darvel.

[2] It ought to be mentioned that here and there this minette contains a few crystals of hornblende.

[3] It is impossible not to be impressed with the exact resemblance of these altered fragments to the similar "nests" of metamorphic rock in granite, which are described in the sequel. One is also interested by observing how the minette sometimes takes on a faintly "schistoze" arrangement of its minerals. In a few places dark mica lies in

Such are some of the more interesting appearances exhibited by these altered sandstones of Old Red age—appearances which we find reproduced in certain true granites.

Lower Silurian strata, and associated Grey Granites of Southern Scotland.—The grey granites of the Lower Silurian uplands of Southern Scotland are associated with the usual grey and greyish blue felspathic greywackés, interbanded with occasional beds and broad belts of shales and mudstones. In these greywackés flakes or galls of hardened clay or shale and mud are of common occurrence. Those of Peeblesshire, for instance, and the corresponding rocks in Carrick and Galloway, furnish excellent examples. And so abundant do the galls sometimes become, that they impart to the beds a finely brecciaform aspect. There can be no doubt that were the strata of those regions attacked by metamorphism they would give rise to rocks of dissimilar appearance. The felspathic greywackés would necessarily assume a crystalline structure more readily than the less easily reducible shales. Hence we should expect to find that any alteration affecting the strata *en masse* would be more marked in the former than in the latter—in other words, that crystalline beds would alternate with fine-grained compact and jaspideous rocks.

A very characteristic granite of the district under review is that of Loch Doon, Ayrshire. It is a ternary compound of the usual kind —grey or white felspar, white quartz, and black mica. In some places it also contains hornblende. It is bounded by a set of hard fissile slaty shales, which, along the line of junction, are crumpled and puckered, much indurated, and finely crystalline. Across the strike of these beds, the granite does not extend, but it is otherwise where the strata are highly felspathic, these last having apparently offered no hindrance to its out-growth. The same phenomena have been observed by my colleague, Mr. B. N. Peach, who has detected several undescribed masses of granite to the north-east of Loch Doon. These granites are developed in certain broad bands of vertical felspathic greywackés, flanked on either side by hard flinty shales, which are finely crystalline along the line of junction with the granite; but this metamorphism quickly ceases as we recede from the junction, at right angles to the strike. On the other hand, when we leave the granite, and proceed along the direction of strike, we

certain horizontal lines which seem to coincide with the bedding, leaving intermediate spaces of a finely crystalline greyish felstone. Flakes of dark shale, *somewhat less highly altered than those alluded to above*, occur in these incipient schistoze portions of the minette. But from this, it is not inferred that an amorphous crystalline state is necessarily preceded by a streaky or schistoze condition of the minerals. With regard to the peculiar arrangement of the minerals in gneissoze and schistoze rocks we have still much to learn. It is certain, however, that rocks such as diallagite, hypersthenite, diorite, syenite, and even granite itself can be developed directly from aqueous rocks, without passing through an intermediate gneissic or schistoze state. This will probably always be the case when the aqueous rocks acted upon are thick-bedded and of an equally diffused composition. The exact conditions which gave rise to our schistoze-, hornblende-, diallage-, and hypersthene-rocks, and to gneiss itself have yet to be discovered, but it is not unlikely that thin bedding and variable composition of the alternating layers may have been among the causes that determined a schistoze arrangement of minerals.

find the felspathic greywackés altered to a much greater distance. And it is further remarkable, that the more muddy beds which are interstratified with these greywackés, are the first to resume their original character. The appearances at the immediate junction are still more instructive. Where the hard slaty shales impinge upon the granite we have no difficulty in laying our finger upon the line that separates the one rock from the other; but at the point were the granite and the felspathic greywackés come together, the union of the two rocks is so intimate that we have usually no line of demarcation, but, on the contrary, a gradual passage.

"Nests" of altered rock in the Grey Granites of the Southern Uplands.—Those who have wandered over granitic tracts, must often have seen little nests[1] of dark fine grained or semi-crystalline and baked-like rock, sealed up in the solid granitic matrix. Very often they show distinct traces of lamination, and perhaps their most usual character is that of exceedingly fine-grained mica schist, the dark almost black shade being due to the abundance of the mica, They are usually of very irregular shapes, and are by no means confined to those portions of the rock that abut upon the outlying bedded or aqueous strata, but are scattered indiscriminately throughout the granite. The granite and the rock of a nest are firmly knit together, so that when a suitable edge has been obtained, a smart tap with the hammer will fetch away a good specimen to show the junction. This is commonly so marked that one may place a knife-edge upon it, but I have sometimes (though rarely) met with "nests," the fine-grained or compact rock of which seemed to pass by insensible gradations, both of colour and texture, into the outside granite. As far as my observation goes, the "nests" are as a rule, harder, tougher, and less easily weathered than the granitic matrix, so that on exposed surfaces the "nests" usually stand out in relief. In some granites and granitoid rocks, however, the reverse is the case, the "nests" decomposing out and leaving behind them little pits, and irregular hollows. When the granite and the contained nests are of the same or nearly similar hardness, it sometimes happens that decomposition has set in along the line that separates the one from the other, affecting both equally. The short description already given of the nests of altered shale in metamorphic minette and diorite has prepared the reader for an explanation of the similar phenomena in granite. For if we must admit that the galls or nests of the former rocks represent the small interrupted ribands and flakes of shale and mud, which occur so abundantly in the unaltered felspathic sandstones—then, doubtless, we ought to allow a similar origin for the "nests" so characteristic of the Ayrshire granites. These last either represent such little detached portions of shale as are of common occurrence in the Lower Silurian greywackés, or they may be the remnants of thin bands or beds of shale that interleaved the original strata. Those who deny the metamorphic origin of granite will probably suggest that the nests of altered rock may have been caught up by the

[1] They are well shown in many granites of the north of Scotland as well as in those of the districts more immediately referred to.

granite during its progress through the strata that envelop it. But if this had been the case we should certainly expect to find the nests not only more abundant near the junction of the granite with the stratified rocks, but indeed almost if not exclusively confined to that area. They are not more characteristic, however, of one portion of the granite than of another, but, as already remarked, are scattered indiscriminately throughout. I am therefore forced to conclude that the crystalline rocks described above have resulted from the alteration *in situ* of certain bedded deposits. The occurrence of the "nests" cannot be accounted for on any other theory. But the explanation advanced is quite in keeping with the phenomena presented by the rock-masses themselves; as, for instance, their peculiar development in and tendency to eat along the strike of felspathic greywackés in preference to muddy shales—the sharp junction-line that separates the granite from the latter, and on the contrary, the gradual passage that is traceable from granular greywacké into granite.

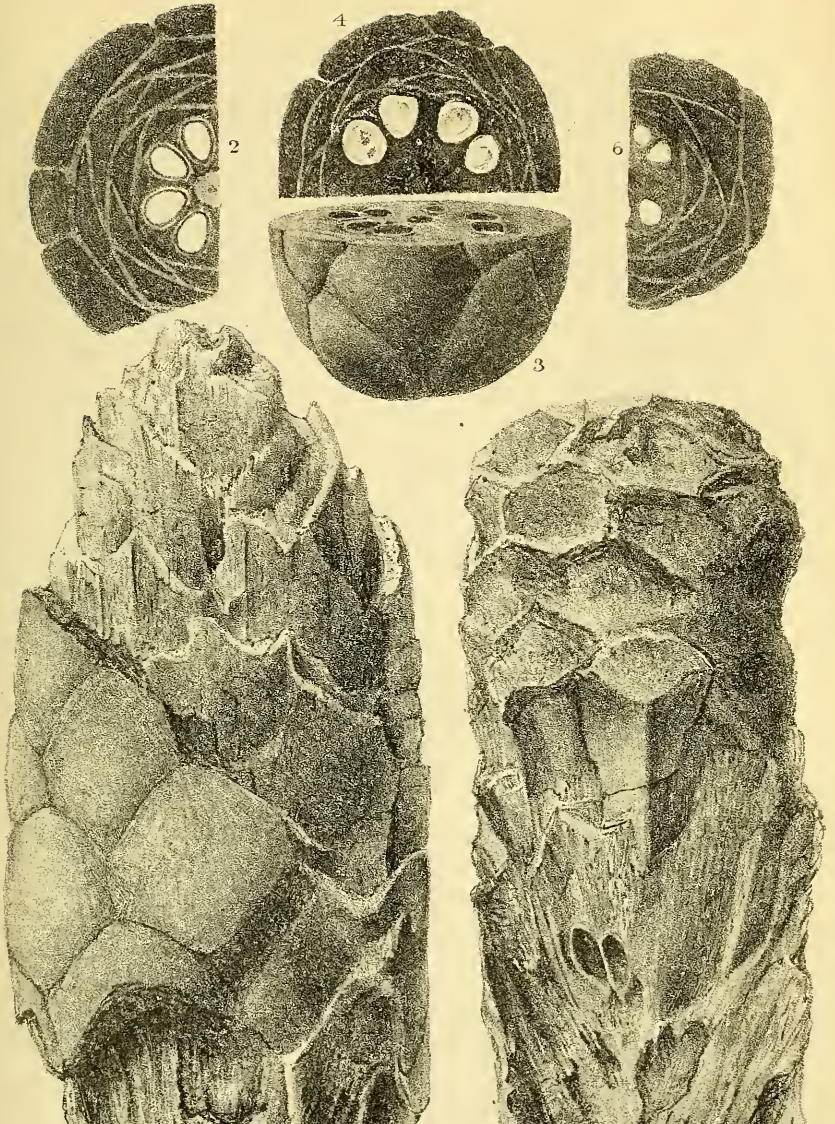
II.—On some Fossil Coniferous Fruits.

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

(PLATES XX. AND XXI.)

It was my intention to have devoted this paper to the Coniferous Fruits found in Strata of Secondary age in Britain, reserving for future examination, those belonging to the later periods, but in the progress of my investigations I have found that, two remarkable cones, which have hitherto been considered as belonging to the Greensand, are certainly Tertiary fossils; and having placed them on the plates which illustrate this paper, I shall include them in my descriptions.

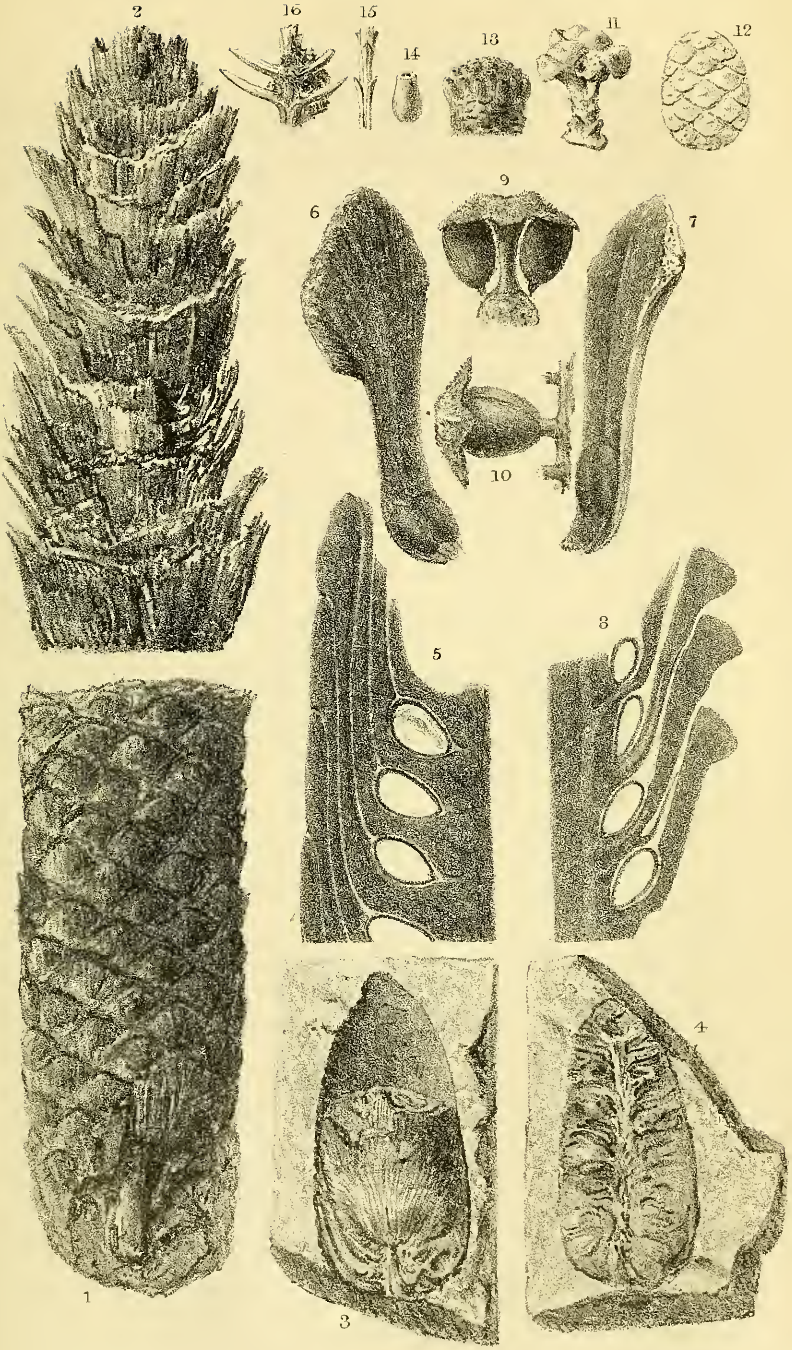
The existence of *Coniferæ* during the geological history of the globe is determined by the occurrence of wood, fruits, and leaves in the rocks of different periods. Leaves are very rare, and almost always when alone are unsatisfactory evidence, as the forms of the leaves, and their arrangement on the stem, are similar in many *Coniferæ* to what are found in other and very different orders of plants. The fruits and wood are more frequent, and are also more satisfactory indications of the organisms to which they belong. Coniferous wood exhibits a peculiar structure which cannot be mistaken, and which is found in no other set of plants. This structure is the absence of any dotted ducts in the concentric layers of wood, and the presence of discs in the lateral walls of the woody fibre. The disc-bearing tissue alone, is not sufficient to determine a fragment of wood to be coniferous, as this structure is found also in the wood of several *Magnoliaceæ*, but the two characters together are found in no known wood except that of *Coniferæ* proper, and their gymnospermatous allies. The fruits, again, are peculiar to this order, for while cones are found in some *Proteaceæ*, the internal structure is very different, the seeds being contained in true seed-vessels, and rising from the axis in the axils of the scales or bracts; the pseudo-cones produced in diseased branches in some other plants can easily be distinguished, as they never contain seeds. True Coniferous cones have been



Ford del. et lith.   M & N Hanhart imp.

BRITISH FOSSIL CONIFEROUS FRUITS

of Secondary & Tertiary age.



E. Fielding del. et. lith.

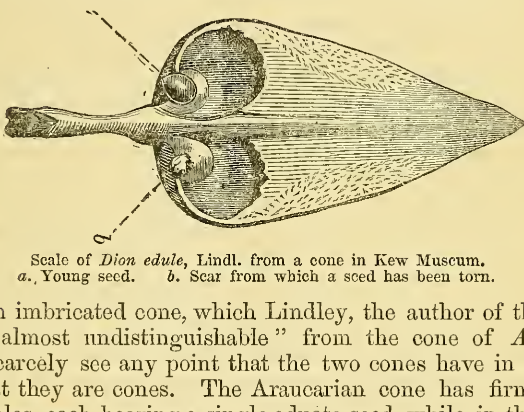
M & N. Hanhart, imp.

BRITISH FOSSIL CONIFEROUS FRUITS.

of Secondary age

referred to *Cycadeæ,* and this is not to be wondered at, as in orders so nearly allied, and in both of which the female flower is evidently constructed on the same plan, difficulty in discrimination might be expected. There are, however, characters by which they can easily be separated, and an exposition of these will enable the reader to appreciate the reasons why, in the sequel, I remove some cones to *Coniferæ,* hitherto referred to *Cycadeæ.*

The Cycadean fruit is of more simple structure than that of *Coniferæ.* In *Cycas* the female spadix is a contracted leaf bearing seeds on its margins. If the fruit-bearing leaf or spadix be considered the representative of the corresponding organs which bear the seed in the other *Cycadeæ,* we find that in all the other genera of the order, the spadices are converted into peltate or flat pedicellate scales, spirally arranged around a common axis, and forming a cone. The pedicels of the scales are placed at a right angle to the axis, or very nearly so, and in all the genera, except *Dion,*[1] the scales are peltate, and not imbricate. Each spadix or scale supports two seeds which hang free from the peltate apex (Plate XX, Figs. 9 and 10), on either side of the pedicel. In *Dion* the spadices are flat scales



Scale of *Dion edule,* Lindl. from a cone in Kew Museum.
a. Young seed. *b.* Scar from which a seed has been torn.

forming an imbricated cone, which Lindley, the author of the genus, says, is "almost undistinguishable" from the cone of *Araucaria.* We can scarcely see any point that the two cones have in common, except that they are cones. The Araucarian cone has firm, sessile, smooth scales, each bearing a single adnate seed, while in the cone of *Dion,* the scales are composed of lax tissue, pedicellate, and covered with a dense and copious wool, and each supports two free seeds.

Three kinds of fruit are found in the *Coniferæ.* First, The cone of the *Abietineæ,* composed of imbricated sessile scales, generally regarded as flat and open carpels, each of which bears one or two seeds, lying on its surface, at or towards the base, and is subtended by another scale, considered to be a bract. Second, The cone of the *Cupressineæ,* composed of indurated peltate scales, or, sometimes fleshy, with the scales concreted so as to form a kind of drupe. One or more winged seeds are supported on each scale. Thirdly, The drupaceous or nut-like fruit of *Taxineæ,* with its single

[1] Lindley spelled this word *Dion,* omitting the second *o,* after the example of the ancients—as, for example, 'επωασμὸς, (Aristotle, Hist. Anim.) *Dioon* is therefore incorrect.

terminal seed. The fruit of *Taxineæ*, and the drupe-like fruit of some *Cupressineæ* cannot be confounded with the cones of *Cycadeæ*. The form of scale, the arrangement of the scales on the cone, and the number and position of the seeds, are obvious diversities whereby to distinguish the indurated cone of the remaining *Cupressineæ* from that of *Cycadeæ*; while the sessile, flat, imbricated scale, bearing the seeds adnate to its upper surface, clearly separates the cone of the *Abietineæ*. Any difficulty in determining the affinity of a cone by its external characters can easily be solved, as to whether it is Coniferous, Cycadean, or Proteacious, by a transverse section, which would show, if the structure is even a little preserved, the form of the scale, and the position of the seed.

In some of the sections of *Coniferæ*, especially in the *Cupressineæ*, the cones have so many striking peculiarities, that it is possible to descend in the determination of a fossil specimen even to the modern generic representative. But in the *Abietineæ* proper I cannot agree with Göppert, who in his valuable Monograph of Fossil *Coniferæ* refers different cones, without any hesitation, to the various sections or so-called genera into which *Pinus* is divided. With all the materials at the command of the student of living plants, and his power of dissecting and examining fresh specimens, he is not able to find in the cones permanent characters which can satisfactorily separate the various sections of *Pinus*. When the materials are so imperfect, and so intractable as fossils generally are, it is vain to propose sub-divisions which cannot be maintained even for recent specimens. The presence or absence of an enlarged apex which distinguishes *Abies* and its allies from the *Pinus* division, is obvious when we are dealing with the well-marked species; but while the sections *Cembra* and *Strobus* of Endlicher are undoubtedly sub-divisions of *Pinus*, they so resemble some of the sections of *Abies* that at least, in fossil specimens, it would be impossible to determine their affinities. I shall accordingly employ the name *Pinites*, in the same comprehensive sense in which Endlicher uses *Pinus*, as including all the Abietineous cones, even when there seems reason for considering them as more allied to one of the sections or so-called genera of the modern genus.[1]

1. Pinites macrocephalus.

Cone cylindrical, obtuse at both ends; scales with thick and flat irregularly six-sided apophyses; basal scales largest.

Zamia macrocephala, Lindl. and Hutt., Fossil Flora, Vol. ii. p. 117, Pl. cxxv.—*Zamiostrobus macrocephalus*, Endl., Genera Plantarum, p. 72.—*Zamites macrocephalus*, Morris, Ann. of Nat. Hist., Ser. I, Vol. vii. p. 116.—*Zamiostrobus Henslowii*, Miquel, Monographia Cycadearum, p. 75.

I have examined three cones of this species, one belonging to Mr. George Dowker, and the others in the collection of the British Museum. The drawings and descriptions in the Fossil Flora refer to a fourth specimen. I have taken advantage of all these in drawing up the following descriptions.

[1] A striking illustration of the futility of the opposite course to that advocated above is afforded by the fossil known as *Strobilites Woodwardii*, Lindl. Göppert, in

Mr. Dowker's specimen, which he has kindly lent me for examination, is converted into silicious chert. The one half—probably that which was originally buried in the mud in which it was preserved—has the apophyses of the scales so preserved as to show their great thickness, yet, as in the other specimens, the original outer surface has been removed. The other half of the cone is without the apophyses, but is very instructive, exhibiting the imbrication of the scales, and at its base, where the axis is laid bare, showing the cavities in a scale which the two seeds originally occupied. This surface is figured on Plate XX, Fig. 1, the apophyses of three scales being restored from the lower half to show the external appearance of the cone. One of the Museum specimens is a fragment from the Bowerbank collection, $2\frac{1}{4}$ inches long from the upper portion of a cone. The transverse section, Fig. 2, is drawn from this. The other Museum specimen is a complete cone from the Cowderoy collection. It is considerably water-worn. Two longitudinal slices for microscopic examination have been taken out of the centre, and a portion of one of these has been drawn on Plate XXI, Fig. 5.

The cone is cylindrical in shape, very slightly tapering upwards, and obtuse at both extremities. It is from $4\frac{1}{2}$ inches (Henslow) to nearly 6 inches (Dowker) in length, and almost $2\frac{1}{4}$ inches across. The axis is about a quarter of an inch in diameter. The scales are broad and sessile. They leave the axis almost at a right angle, and just outside the seed they bend sharply upwards, continuing with a slightly outward direction until they approach the surface, where they swell into the large thickened apophyses or hexagonal apices. These having the appearance externally of being valvate, give the cone a Cycadean aspect; but they scarcely differ from those of *Pinus Pinea*, L. the Stone Pine of the Mediterranean region. Indeed, in the form, size, and arrangement of the apophyses, this recent pine remarkably resembles the fossil cone. The form of the cone and its internal structure is, however, very different, and the fossil is unlike all recent Abietineous cones, with which I am acquainted, in having the basal scales larger than those of the body. The basal scales are barren, and the apophyses rise from their whole surface; in the series immediately above them there is a short flat body to the scale, but the greater portion of the scale is covered with the apophysis; the third series are fertile, and have a longer and more ascending body. The outer surface of the apex or apophysis of the scale is destroyed in the specimens I have examined. The Bowerbank fragment is the most perfect in this respect. In it the apex is three-eighths of an inch thick, and the surface of each scale is slightly convex on the centre of its upper portion. Henslow made a diagram of the phyllotaxis of the cone, and he considers that the

his "Fossilen Coniferen," p. 210, establishes the genus *Laricites* for this fossil, it being the only known species of the genus. Professor Heer, however, when, some time ago, examining the Tertiary fossils in the British Museum, showed my colleague, Mr. H. Woodward, that it was only the axis of a cone, with the scales bitten off, (by a squirrel ?) leaving thin stumps. I have examined the specimens and am satisfied that this is really the case.

arrangement of the scales is represented by the fraction $\frac{11}{29}$. This is an anomalous arrangement, and does not belong to the recognised series. My examination of Mr. Dowker's cone leads me to a different result. I find that there are three spirals to the left and eight to the right, so that this cone belongs to the eight-ranked arrangement, represented by $\frac{3}{8}$. Each scale supports two seeds in the hollowed superior surface near its base. Plate XXI, Fig. 6. The seeds are oval, nearly half an inch long, and are apparently wingless.

Having explained, at length, the difference between the Cycadean and Coniferous cones, the description I have just given sufficiently establishes that this fossil is a Coniferous fruit. The thickened apophyses would indicate its affinities to the *Pinus vera* section of the genus, but it is remarkably different, as I have pointed out in the large size of the basal scales. The longitudinal section of a portion of *Pinus Pinaster*, Sol., Plate XXI, Fig. 8, shows how nearly the in ternal arrangement of the parts of the recent cone agree with the fossil when compared with Fig. 5.

This fossil was originally figured and described by Henslow in the "Fossil Flora." He referred it to the genus *Zamia*, and in estimating its relations to modern plants he said it differed from the figure of *Zamia* in Richard's "Memoires sur les Coniferes et les Cycadées," Tab. xxvi, in its more slender axis, longer scales, and the inclination of the seeds consequent on the form and upward direction of the scales. He inserts in the text, a diagrammatic longitudinal section of the cone, making each scale support the seeds pendant from a little below the middle of the upper surface, somewhat after the manner of a Cycadean fruit. In the flat ideal section which he gives, he could exhibit only a single seed attached to each scale: his object was to show the method of attachment, and not the number of seeds on each. Lindley adds a particular description of the specimen, and agrees with Henslow as to the affinities of the fossil, asserting that its relation to *Zamia* is shown "in every point of its structure."

Endlicher in his revision of the *Cycadeæ* for the "Genera Plantarum," (1836) established the genus *Zamiostrobus* for this cone, giving as the most remarkable character of the genus, that the carpellary scale bore on its upper surface, a little below the middle, a *single seed*. Neither Henslow nor Lindley specified the number of seeds borne on each scale, and Endlicher misled by Henslow's diagram, erroneously assumes that there is only one seed, and on this establishes a new genus, which, with good reason, he characterises as a very remarkable one. He considers it intermediate between *Encephalartos* and *Zamia*.

Presl, in Sternberg's "Flora," parts vii. and viii. p. 195 (1838), established the genus *Zamites*, giving in his diagnosis of the genus the characters of the fruit as—strobiliform, oval, pedunculate, with large imbricated scales spirally arranged. He describes twenty-five species, five based on stems and the remaining twenty on leaves. Where he got his fruit characters is not apparent, as he does not seem to have had any specimens of fruit. Morris, in a revision of the Fossil Cycadeæ, published in the Annals of Natural History, 1st series, vol. vii. p. 115 (1841), adopts Presl's genus, and places in it the fruits figured by Lindley and Hutton under the names of *Zamia crassa, Z. macrocephala,* and *Z. ovata.*

Miquel, in his "Monographia Cycadearum" (1842), accepts Endlicher's genus *Zamiostrobus,* but places it at the end of the order on account of its anomalous one-seeded carpellary scale. Göppert also adopts this genus (Uebersicht der Schlesischen Gesellschaft, 1844, p. 128), considering, with Endlicher and Miquel, that it is the type of an extinct tribe of *Cycadeæ.* He adds three additional species which had been referred by Morris in the first edition of his "Catalogue of British Fossils," to *Zamites.* I think, with him, that it is well to have a provisional genus for detached fossil Zamia-like fruits until their relation to stem and foliage has been established, but I regret that he adopted Endlicher's genus with the original description, and placed in it three additional cones, the internal structure of two of which was altogether unknown; and that of the third, as far as known, was totally different from the supposed structure of *Z. macrocephalus.* The confusion thus introduced was increased by Unger, who added three other species in his "Genera et Species Plantarum Fossilium," 1850, not one of which has anything in common but its strobiliform shape. Miquel, in his "Prodromus Systematis Cycadearum," 1861, gives all the seven species, adding in a note that perhaps some are species of *Cupressineæ,* and specially querying *Z. crassus,* the only one in the seven which is probably Cycadean.

Corda, in Reuss's "Die Versteinerungen der Böhmischen Kreideformation," vol. ii. p. 84 (1846), carefully examines the affinities of *Zamia macrocephala.* From its structure he concludes that it is certainly not a species of *Zamia,* as the scales are arranged in a different order, and the seeds are on the upper surface of the scales, unless, as he suggests, the woodcut by Henslow is a mere fiction. He shows that it is totally different from *Dion,* the only recent genus of *Cycadeæ* with imbricated scales. And he concludes that if *Zamia macrocephala* has seeds in pairs on one plane, or even if it has only a single seed, it may be a Conifer, belonging to a new genus allied to *Dammara,* if it is not a species of *Dammara* itself. He thinks Endlicher did well in creating the Cycadean genus *Zamiostrobus* for it. Except that Corda did not observe that Henslow's figure was a diagrammatic restoration to show his notion of the relation of the seed to the scale, and consequently, like Endlicher, misinterprets it, he has from the materials at his command made a very masterly investigation into the affinities of this fossil.

This brings the literature of this interesting fossil up to the present time, and before leaving this subject it may be as well to state what the seven species placed in this false genus are. Three species are in this paper shown to be true *Coniferæ.* I have already referred another species, *Z. Pippingfordiensis,* Ung. (Geol. Mag. vol. iii. p. 249), to *Araucaria.* 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. tab. 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." *Z. familiaris*, Ung., judging from Sternberg's fig. (tab. 46, *f.* 2) is a true conifer. And *Z. crassus*, Göpp., is, as I have said, perhaps a Cycadean fruit; but this I may probably more carefully investigate on a future occasion.

There has been an error in regard to the age as well as to the structure of this singular cone. It is always referred to the Greensand; but Mr. Dowker having found his specimen *in situ* in a pit near Canterbury, I am able to correct this error. Henslow's specimen was found in clearing out a pond near Deal, and from the general appearance of the material (a light yellowish-grey sandstone) of which it is composed, he referred it to the Greensand. It appears to be in the same mineral condition as Mr. Dowker's specimen, which he obtained from a bed near the junction of the Woolwich and Thanet beds; and he obligingly informs me that similar cones have been found near the Reculvers, where great quantities of silicified wood are met with. The wood occurs, he says, at Richborough, at the bottom of the Woolwich beds, associated with *Corbula Regulbiensis;* and to this position he refers the bed in which his cone was found. The cone is then a Tertiary fossil, and this is confirmed by the Bowerbank specimen, which is from Sheppy. The Cowderoy specimen is without locality.

2. Pinites ovatus.

Cone ovate, with a truncate base and obtuse apex; scales with thickened, flat, subquadrangular apophyses; basal scales largest.

Zamia ovata, Lindl. and Hutt., Fossil Flora, Vol. iii. p. 189, Pl. 226 A.—*Zamites ovata*, Morris, Ann. Nat. Hist. 1st series, Vol. vii. p. 116.—*Zamiostrobus ovatus*, Göpp., Uebers. d. Schles. Ges. 1844, p. 129.

There is an imperfect specimen of this cone, without the apex, in the British Museum, from the Cowderoy collection, which, as far as it goes, answers in every respect to that figured by Lindley and Hutton.

The cone is smaller than *P. macrocephalus*, and can readily be distinguished from it by the form of the apophyses of the scales which are longer than they are broad, and quadrangular or subquadrangular, the upper and lower angles being acute or but slightly truncate. They both agree in the great size of the scales at the base of the cone, a structure peculiar to these two species, but not sufficient as it appears to me to separate them from the genus *Pinites*. A transverse section of the specimen in the Museum, exhibiting the structure beautifully preserved, shows that it had a slender axis, the centre of which is occupied with cellular tissue, and surrounded by a cylinder of wood. Being transverse the section cannot exhibit the discs on the vascular tissue, but it exactly agrees with transverse sections of recent cones. A regular series of large ducts are arranged symmetrically around the axis. Each scale supports two seeds. The tissue of these has entirely disappeared, the cavity being filled with carbonate of lime. Three other scales are seen beyond that bearing the seeds in the section, Plate XX, Fig. 4.

The Cowderoy specimen is without locality, and that described and figured by Lindley and Hutton is a rolled fossil, which was found upon the coast of Kent, near Feversham. These authors refer it to the Greensand because of its affinity to their *Z. macrocephala,* for the same reason I consider it more likely to be of Tertiary age, and the locality where it was found would favour this opinion rather than the other.

3. Pinites oblongus, Endl., Synops. Conif. p. 284.

Cone cylindrical; scales broad and thin at the apex, with the seeds very near the base; axis slender.

Abies oblonga, Lindl. and Hutt., Fossil Flora, Vol. ii., p. 155, Pl. 137.—*Abietites oblongus,* Göpp., Fossil. Conif. p. 207.

This species is founded on a single cone rather more than 2½ inches long, found on the Dresent shore. It had been rolled to a pebble, and reduced at both extremities so as to lay bare the seeds.

I know this species only from Lindley and Hutton's drawing and description.

Being found on the shore it was believed by Buckland to have been washed out of the Greensand Cliff near Lyme Regis.

4. Pinites Benstedi, Endl., Synops. Conif. p. 283.

Cone oval; scales broad and thin at the apex, leaving the thick axis at a right angle then ascending beyond the seed.

Abies Benstedi, Mant., Quart. Jour. Geol. Soc., Vol. ii. p. 52, Pl. ii. fig. 2.—*Abietites Benstedi,* Göpp., Fossil. Conif. p. 217.

The single cone described by Mantell, and on which the species is founded, is now in the British Museum. It is an inch and five-eighths long and one and a quarter broad. It is nearly perfect. The section is accurately figured by Mantell; but the artist, in restoring the external aspect, has made the exposed apices of the scales nearly equal-sided; whereas, in the specimen, they are at least four times broader than they are deep. The axis occupies somewhat more than a third of the diameter of the cone. The position and shape of the seeds, the form of the scales, the shape of the exposed apices, and the general aspect of the cone, are very like those of a cedar. It may be compared with *Pinus* (*Cedrus*) *Atlantica,* Endl.

5. Pinites Sussexiensis.

Cone oblong, truncate at both ends; axis slender; scales leaving the axis at a very acute angle, bearing two ovate seeds in a hollow, very near the base; scale in transverse section triangular.

Zamia Sussexiensis, Mantell, Quart. Journ. Geol. Soc., Vol ii, p. 51, Pl. II. fig. 1.—*Zamites Sussexiensis,* Morris, British Fossils, 1st Ed., p. 25.—*Zamiostrobus Sussexiensis,* Göpp. Uebers. d. Schles. Gesellsch. 1844, p. 129.

The specimen in the British Museum formed part of the extensive collection of the late Robert Brown. He had a transverse section taken from near the apex, (Plate XX, Fig. 6.) which clearly establishes it to be a cone. When examining it, I found that it had been cracked, and inserting my knife into the crack, I separated the pieces, when it exhibited, as has been accurately drawn by Mr. Fielding (Plate XX. Fig. 5,) the internal structure of an Abietineous cone.

The specimen, which is the one described and figured by Mantell, is $5\frac{1}{2}$ inches long, and nearly 2 in diameter. The apex is almost perfect, but the base wants one or more whorls of scales; the small stalk referred to by Mantell is a portion of the axis from which the absent scales have fallen. The cone is so much decayed on the outer surface that the apices of the scales are mostly absent; but a portion which still retains some of the matrix in which it was preserved seems to show the form of the apex. It was a flat scale like that of *Pinus Strobus,* L. but the superior margin had a tumid border, without any terminal umbo. The scales in transverse section, as exposed on the weathered surface, are sub-triangular as figured by Mantell, and on the upper portion of our Fig. 5, Plate XX. The axis is slender, and the scales on leaving it take at once their ascending direction. The two narrow ovate seeds are borne very near the base of the scale, in a cavity sunk into it. The two cavities shown in Fig. 5, are formed by the testa of the seeds, the contents having disappeared.

Mantell submitted a plaster cast of this fossil to Brongniart, but as might have been expected, that distinguished palæontologist was unable, with such materials, to determine anything positive in regard to it. Mantell had no hesitation in referring it to *Zamia*, as a fruit of that genus, and every subsequent writer has followed him. The fossil certainly belongs to the *Pinus* division of the genus, and is near to *Pinus Strobus,* L.

The specimen which is, as far as I know, still unique, was found in the Lower Greensand at Selmeston, Sussex, in a bed along with water-worn fragments of stems and branches, which are generally more or less perforated by boring mollusca.

6. Pinites Dunkeri.

Cone elongated cylindrical; scales broad, with a rounded and thin apex; axis slender; seeds oval compressed.

Abietites Dunkeri, Mant., Geol. Isle of Wight, 2nd Ed. p. 452, 3rd Ed. p. 337, Lignographs 43 and 42, fig. 5. (exclude figs. 1-4 and 6, which belong to a Cycadean fruit). Med. of Creation, p. 179, Lign, 61.

There are six specimens of this species in the British Museum.

This is a very remarkable cone, little more than an inch in diameter, yet attaining, according to Mantell, a length of thirteen inches. The cones have generally opened before they were buried in the sand in which they are preserved, and as the sand has penetrated between the expanded scales, they are always broken when the fossils are exposed, their apices still remaining in the piece of rock which has been separated, just as the scales on the side of the cone are seen to penetrate the rock in which the fossil is imbedded, (Plate XXI, Fig. 2). This condition and aspect of the cone has led Mantell into the error of supposing that it was furnished with large foliaceous bracts, which he has represented in his somewhat restored figure in the 'Medals of Creation,' p. 179. I was fortunate enough to remove the stony matrix from one of his specimens, which had been buried unopened, and which exhibits the form of the scales (Plate XXI, Fig. 1). The apices are rhomb-shaped, but with the upper angle somewhat rounded. There is no indication of bracts. The fossil has the aspect of a very elongated and cylindrical cone of *Pinus Abies*, L. to which it is evidently nearly allied.

There are four specimens of this species in the British Museum from the Wealden of Tilgate Forest, and two from Brook Point, Isle of Wight.

A third specimen from Brook Point appears to belong to an allied species, in which the cone is more slender; but it is too imperfect to determine satisfactorily.

7. Pinites Mantellii, Tab. XXI, Fig. 3.

Cone ovate-acuminate; scales broad, flat, and thin at the apex; axis slender; seeds roundish.

This cone is about an inch and three-quarters long, by fully three-quarters broad. The specimen is fragmentary, but the form of the cone is preserved in the matrix. The apex of the scale is very broad and thin.

This cone was found in the Iguanodon quarry at Maidstone, Kent, and formed part of the Mantell collection, now in the British Museum.

8. Pinites patens, Tab. XXI, Fig. 4.

Cone ovate-acuminate; scales leaving the slender axis at a right angle, and supporting large seeds.

The single specimen of this cone which shows only a longitudinal section through the axis, is sufficiently different from the last species to warrant its being separated as distinct. The seeds are large, and in section of an oblong form.

This species is also from the Iguanodon quarry, and, like the last specimen described, is in the British Museum.

9. Pinites Fittoni.

Cone ovoid, truncate at the base, tapering upwards; apophysis of the scale pyramidal with a ridge across it; umbo terminating the apex of the pyramid.

"A cone," Fitton, Geol. Trans., 2nd Ser. Vol. iv. p. 230, Pl. xxii, fig. 9.—*Dammarites Fittoni*, Ung., Gen. et Sp. Plant. Foss., p. 384.

This cone is said by Fitton to have "some slight resemblance to the cone of a *Dammara* of the Moluccas." He must have made a slip of the pen in this statement, or transferred a note in regard to one fossil by a mistake to this, for his very characteristic drawing, on the face of it, contradicts his supposed resemblance. The cone has much more affinity to the cone of the common Scotch fir, the only indigenous British pine, as I shall presently show; but on the faith of this supposed "slight resemblance," Unger, in giving the fossil a name, places it in the genus *Dammarites!* Mantell (Geol. Isle of Wight, 3rd ed. p. 330, foot-note), seems to have made some mistake as to his *Pinites Fittoni*. He quotes pl. xxii. fig. 10 (l. c.) for it, and says it does not agree with *Dammara* because of the double ridge on the scale. But Fitton, as we have said, compares the cone of fig. 9 (l. c.) with *Dammara*. It is, however, evident from Mantell's remarks that he means the cone which he quotes, and which

I have described as *Araucaria Pippingfordiensis*, Geol. Mag. Vol. III. p. 250, and I must request the reader to add Mantell's name, as a synonym, to that species; Unger's specific name, which I adopted, is older.

The original specimen, which, through the kindness of the Council of the Geological Society, I have had the use of for description, is a beautiful cast in carbonate of lime of the cavity which contained the cone. It is a somewhat ovate cone, an inch and a half long by a little over an inch broad. The apophyses of the scales in the middle of the cone are about twice as long as deep. They are pyramidal, having a sharp keel which runs across the whole of the scale. The umbo has terminated the apex of the paraphysis, but only the cicatrix is seen, and from the direction it takes the umbo seems to have had a somewhat downward direction, as in *Pinus rigida*. The fossil in other respects very much resembles this species, except in its smaller size.

The cone is labelled from Purbeck, without locality or name of collector.

10. Pinites elongatus, Endl. Synops. Conif. p. 286.

Cone elongated, cylindrical; scales very broad and thin.

Strobilites elongatus, Lindl. and Hutt, Fossil Flora, Vol. ii. p. 23 Pl. 29.

I know this fossil only from Lindley and Hutton's drawing and description. It appears to be a true cone, but so fragmentary that until additional specimens are obtained nothing satisfactory can be made of it. The specimen figured, which is the only one that has been found, has been an open cone, like the majority of those of *P. Dunkeri*, and in breaking the rounded nodule in which it occurred all the external characters have been lost.

11. Sequoiïtes Woodwardii, Plate XXI. Figs. 11–16.

Cone sub-globose; leaves of two kinds, the one sub-opposite, very short, acute, with a long decurrent base; the other squamose, linear, acuminate, sub-falcate, with a broad nerve below.

This is a very interesting plant, and undoubtedly a fossil species of the genus *Sequoia*. I have, however, employed the name *Sequoiïtes* in accordance with the almost uniform practice of botanists,—a practice of great value in enabling one at once to distinguish the recent from the fossil species of a genus. The genus *Sequoia* is at present represented by two Californian species, the monster trees of that country, known in our lawns and parks as Wellingtonias. Five other species have been reported from Tertiary strata, the oldest being, as I believe, *S. Coutsiæ* from Bovey Tracey. Debey cannot separate *Geinitzia* from *Sequoia*, and Heer, accepting this determination, supposes that *Sequoia* probably begins in the Cretaceous formation. We have here a genuine Cretaceous species from the Upper Greensand.

The materials in the British Museum consist of three specimens of leaves (Plate XXI. Figs. 15 and 16), an imperfect cone (Fig. 11), and the termination of a branch containing the female bud with the ovules, without the scales (Fig. 13 magnified two times).

The leaves are of two kinds, the one very short and acute, scarcely leaving the branch from which they rise, but with very long decurrent bases (Fig. 15). The larger leaves scarcely differ from those of a variety of *Sequoia sempervirens*, Endl., in the Herbarium of the British Museum, that was collected by Bridges in California in 1846; they are also similarly arranged on the branch, being scattered around the axis, and having an upward direction and a sub-falcate form. The nerve below is broad, and bounded by two furrows similar to those in the recent species which bear the rows of stomata (Fig. 16). The apex of the fertile branch (Fig. 13) is crowded with erect sessile ovules, each showing the opening through the testa at the apex (Fig. 14). The scales have been broken off, but the scars can be detected. The cone is about two-thirds the size of those on the recent specimen to which I have referred. The vertical rank consists of six scales. In form and arrangement they exactly agree with *S. sempervirens*, Endl. There are no remains of the seeds.

The specimens are from the Upper Greensand of Blackdown, Dorsetshire; they were collected by Mr. Sclater.

I have associated with this interesting fossil the name of my late valued and talented colleague, Dr. S. P. Woodward, who first drew my attention to the fossil as a Coniferous fruit.

The following is a list of the remains of *Coniferæ*, as far as I know them, which have been found in the secondary strata of Britain, excluding the Trias, with the fossils of which I am little acquainted.

Upper Chalk.—Wood in flint nodules.

Upper Greensand.—Foliage and cone of *Sequoiïtes Woodwardii*, cone of *Pinites oblongus*.

Lower Greensand.—Water-worn and bored pieces of wood; cones of *Pinites Benstedi*, and *P. Sussexiensis*.

Wealden.—Drift wood; foliage of *Abietites Linkii*; cones of *Pinites Dunkeri*, *P. Mantellii*, *P. patens*, and *P. Fittoni* and of *Araucaria Pippingfordiensis*; foliage (and drupes?) of *Thuites Kurrianus*.

Purbeck.—Fossil forest *in situ* at Isle of Portland; cone "nearly related to *Araucaria excelsa*" in the Dirt-bed.

Portland Stone.—Drift-wood of *Araucarites*.

Oxford Clay.—Drift-wood and foliage of *Araucarites*.

Great Oolite.—Drift-wood of *Araucarites*; foliage of *Thuites acutifolius*, *T. articulatus*, *T. cupressiformis*, *T. divaricatus*, and *T. expansus*, and of *Taxites podocarpoides*; detached cones at Helmsdale, Sutherland.

Inferior Oolite.—Wood of *Peuce Eggensis*; foliage of *Brachyphyllum mammillare*, *Crytomerites? divaricatus*, and *Palissya? Williamsonis*; cone of *Araucaria sphærocarpa*. *Pinites primæva*, Lindl. and Hutt. is a Cycadean fruit.

Lias.—Wood of *Pinites Huttonianus* and *P. Lindleyanus*; foliage of *Araucaria peregrina* and *Cupressus latifolius*; cone of *Pinites elongatus*, and "cone with long bracts like those of *Pinus bracteata*" from Cromarty.

EXPLANATION OF PLATES XX. XXI.

PLATE XX.

Fig. 1. Cone of *Pinites macrocephalus*, with the apophyses of some scales restored. Slightly reduced. From Mr. Dowker's collection.
2. Diagram of transverse section of ditto from the Bowerbank specimen.
3. Base of a cone of *P. ovatus*.
4. Transverse section of ditto.
5. Cone of *P. Sussexiensis*.
6. Transverse section of ditto.

PLATE XXI.

Fig. 1. Part of an unopened cone of *Pinites Dunkeri*.
2. Part of an opened cone of ditto.
3. Cone of *P. Mantellii*.
4. Cone of *P. patens*.
5. Longitudinal section of *P. macrocephalus*, from Robert Brown's collection.
6. Restored scale of ditto.
7. Scale of *P. Sussexiensis*.
8. Longitudinal section of *Pinus Pinaster*.
9. Scale of *Zamia Yatesii* seen from above.
10. Ditto seen from the side.
11. Cone of *Sequoïites Woodwardii*.
12. Restored cone of ditto.
13. Ovules of ditto, with the leaves broken of. Twice the natural size.
14. A single ovule magnified.
15 and 16. The two kinds of foliage.

III.—THE PRE-HISTORIC SETTLEMENTS OF THE REINDEER AGE IN SOUTHERN GERMANY.

[BEING THE SUBSTANCE OF THREE REPORTS ON THIS SUBJECT IN THE "STAATS ANZEIGER FÜR WÜRTTEMBERG," September and October, 1866. By Dr. OSCAR FRAAS, of Stuttgart]

Translated by JOHN EDWARD LEE, F.S.A., F.G.S.

TWO years ago the French savans, Messrs. Lartet and Christy, laid before the Academy of Paris an account of their discoveries in the Dordogne, which proved the existence in that district of very ancient settlements of wild races of men, who kept herds of reindeer. Since then, up to the present time, no further proofs have come to light, either in France or Germany, of the extraordinary fact that this animal—the existence of which is now limited within the 70th degree of north latitude—ever lived so far south as our own districts. The account we have now to give will probably therefore be read with great interest.

At the head of the brook Schussen, which runs into the lake of Constance, was formerly a pond forming the springhead : the level of this pond was, at that time, 8ft. 8in. above that of the small neighbouring lake called the Feder See. But when the marshes of Steinhäusen were drained some years ago, and ditches were cut for this purpose, the water from the spring began to take a different course, and instead of flowing as formerly into the Rhine, now began to run in another direction into the Danube. Mr. Kaes, the proprietor of mills in Schussenried, therefore determined to deepen the spring-head and the water-course of the Schussen brook, and this has been done to such an extent that the spring-head, which before (as mentioned above) was 8 feet above the Feder See, now is 13 feet below it, and the supply of water—now far greater than before—is made available first for the mills of Mr. Kaes, and afterwards for the royal foundry of Schussenried. While these works were going on, a great number of stags' horns and bones were found, and excited the curiosity of the resident naturalists: the matter was then taken up jointly by the Royal Cabinet of Natural History, and that of Antiquities, and very singular facts were brought to light during the excavation. Gigantic horns of the reindeer, from four to five feet long, and smaller ones, down to those of quite young fawns, lay there in the mud by hundreds: they were mixed with bones of the extremities, the skull, and the vertebræ of the same animal. The whole of these bones had been cracked and broken evidently to get out the marrow; so as to recall the accounts given us by travellers of the Ostiaks and Koriaks, who esteem the warm brain and marrow of recently-killed animals as very great delicacies. A large proportion of the horns have been formed in a very simple and inartificial manner into clubs or hammers, awls (some of which have projecting ears), or into agricultural tools, and other implements of incipient industry.

Here, then, we have the fact of the existence on this spot of one of the earliest known settlements of the human race. Let us glance for a moment at the changes which have taken place in this locality. But a short time since there was here the pleasant little tarn, the spring-head of the brook Schussen—700 years ago the Premonstratensian Monks built their monastery—1000 years still earlier a Roman road, with all its traffic, is said to have passed this way; but long before all these periods there existed here a settlement where human beings carried on all the avocations of life. Judging from the remains of their feasts, which appear to have been thrown into the clear little pond, these early settlers had abundance of animal food. Besides the remains of deer, there were found the broken skulls and bones of oxen, bears, and wolves; bones of birds and fish were also met with. Even the flesh of the northern glutton (*Gulo borealis*) was not despised, as is proved by a broken skull and some well-preserved teeth. Great hopes had been entertained of finding the skulls and bones of this primæval race of men, so that they might be examined by the critical eyes of the 19th century. These hopes, however, have not been gratified; but many particulars respecting the settlers may be gathered from the specimens found in the pond of Schussenried. The flint implements and the tools of reindeer horn are the evidence of great labour and perseverance; the abundance and variety of animal remains indicate their joyous feasts, and they also tell us what was their favourite food; while their ornaments and paints give us some faint notion of the manners of these settlers beyond the mere supply of the necessities of life.

After these general remarks, we will give a few detailed particulars as to the excavation and its results.

The "relic bed" (as it is now called), or the bed in which lie the products of human industry, is from 15 to 19 feet below the surface, and about 12 square rods of it were laid open and carefully examined —no trace of metal was found, nor the mark of anything at all approaching that of a metal tool. Stone appears to have been almost the sole material amongst the settlers for obtaining the necessaries of life. For this purpose, these early races naturally chose the hardest kinds, such as jasper and flint, which, having a conchoidal fracture, could more easily be made into what was wanted. Long narrow strips were then hammered off, some of them three inches in length, in some cases very sharp on one side, and in others, on both; sometimes very flat, like broad flakes, which apparently were set and wedged in wood, and sometimes very slight, and with fine points. Of all these varieties of flint flakes, from the size of a lancet, to that of a lance-head, about 600 specimens were found at Schussenried; most of them were lying together in one spot, probably indicating the place where the ancient tool-maker carried on his work, and struck off a number of flakes, out of which he chose the most convenient for use. Besides these, the flint-cores were scattered around from which these flakes had been struck. It is remarkable that amongst these flints, some are decidedly of foreign origin, only a part appear to have come from the neighbouring mountains; the majority were derived from the flint beds of the chalk hills either of Switzerland or France. Together with the flints there were found hundreds of common stones from the gravel of Upper Swabia, evidently brought together intentionally for some special object; some of them had been worked in a very rough manner. The large quantity of split skulls and bones show clearly that they had been broken by these stones for the sake of the marrow and brains; and probably the larger stones, neatly rounded off, which were found here and there, served for anvils or blocks. Occasionally, paints were met with, made of oxide of iron, ground down very finely, and probably kneaded with fat into small grains. The colour varies from a brick red to red brown, and is so effective, that both hands and face can be coloured a deep red with a little bit the size of a pin's head. It cannot be imagined that this red paste can have been scattered by accident amongst the stone implements and remains of bones; or that it has arisen from them by some chemical combination. Any unprejudiced person would consider it as a product of human art, probably similar to the paint so lavishly used by savage nations when preparing either for the war or the dance.

These mineral products, however, are of less interest than the remains of animals, which have evidently been used for food. The most important of all these is the reindeer (in German, Renthier not Rennthier, but with the first syllable Ren or Rein, so called by the northern nations, on account of its cleanliness, "Reinlichkeit"). This animal was evidently of the greatest importance to the pre-historic Swabians, on account of its flesh and marrow, and probably, also its milk was used; horns and portions of horns, parts of the skull, jawbones, vertebræ, ribs, and bones of the extremities lie mixed together; the only bones found united were some tarsal bones, and a few dorsal and lumbar vertebræ, but with these exceptions, they were all lying together in a confused heap, like those in the refuse hole of a butcher's shop. Every bone which had contained marrow was broken in pieces, and not a single skull was found perfect—the vertebræ also had been partially split open, that everything eatable might be taken out. There were no traces of any cutting instruments on any of the bones; they had evidently been broken by blunt tools; in fact, by the stones above-mentioned. The horns of the adult reindeer, male and female, measure more than four feet; the right and left branches differ from each other, for the right branch bears a broad shovel-shaped plate, which may almost be said to shade the whole face. The branches are very much curved inwards, and a great number of projecting offshoots are placed on the shovel-shaped portion at the end. These horns lie by hundreds together, so that the greatest care was required, in excavating, not to injure them, but not a single perfect specimen was found; in every case either the offshoots were broken off, so as to leave the main branch isolated, or the branches were sawn in pieces lengthwise, apparently with the view of these pieces being turned or rather scraped into long round awls or daggers. The fact that of these implements only broken or waste specimens have been found, confirmed the view that the Schussen pond was merely a kind of refuse-pit, into which everything was thrown which had become useless. We can only mention two of these implements which were found perfect, and these probably were thrown away by chance; one of them is a pin or piercer about five inches long, with a round ear or handle, and as thick as the finger at the base; the other is a double pointed side-shoot of the horn, with one larger and one smaller round hole at the base. Another main branch has been worked into the form of a sabre with a solid hilt, just fitting the usual human hand. Besides the things cut out of horn, there were also pieces of broken wooden pins, thin and neatly scraped round like the wooden pins for making nets, The remains of reindeer very much exceed in number those of other animals, being nearly 98 per cent. of the whole; but still the other rarer relics are no less interesting as they help to complete the fauna of that age. The horse is the only one of our domestic animals which was found, and probably the remains were only from two or three individuals. 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 had 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.

It is also perfectly natural that the bear was used for food; the front portion of an under-jaw and some broken bones of this animal have been met with. As far as we can judge from these few remains (which afford, in fact, but slight means of comparison), this bear seems to have had but little resemblance to the brown bear (*Ursus arctos*), and agrees no better with the cave bear (*Ursus Spelœus*). The size of the teeth, and the presence of two premolars, and the form of the first lower molar would rather indicate the *Ursus priscus* (Goldfuss), which some time since was found fossil in the Bavarian caves. But besides the bear and the horse, genuine carnivora were used for food; for the remains of the wolf, the fox, and the *Gulo*, or glutton, are found together in the same excavation. Of the wolf there is a broken under-jaw; of the fox there are not only several under-jaws, but several pieces of the skull and bones—these remains, however, do not belong to the fox of the present day, for the teeth of the Schussenried fox are smaller and thinner; the projections of the molar teeth are more pointed; the form of the skull is blunter, and a comparison of it with that of the recent fox leads to the conclusion that we have before us the remains of an Arctic or blue fox (the *Canis lagopus*), so notorious amongst travellers in the polar regions for its consummate audacity and thievish propensaties. In hunting these animals nothing more is wanted than a cudgel in one hand and a piece of flesh in the other; or, according to Brehm, they are dug out of their holes in the snow by the Samojedes with a spade made of reindeer's horn. Besides the remains of the Arctic fox, there were found those of two individuals of the Glutton or *Gulo* (in German, Fiälfrass, or more commonly Vielfrass; but in Swedish Felsenbewohner). This carnivorous animal of the far north, which is as much feared as the bear or the wolf, lies more especially in wait for the reindeer, on the backs of which it springs from the boughs of trees. The flesh of this animal also was eaten, as is proved by the bones of the skull having been opened. With the exception of the foot of an unknown small variety of ox, no further remains of mammalia were met with, and more particularly no trace of the game or domestic animals of the present day—no trace of the common cow, the sheep, the goat, the pig, or of the stag, the roe or the hare; nay, what is still more remarkable, no remains of the dog. Had these animals been living at that time in our districts we should most certainly have met with their remains in the Schussenried refuse. On the other hand, there are remains of birds and fishes which the ancient Swabians must have known how to secure by the bow and arrow and the fish-hook. Thus we have a very distinctive head and bones of the wild swan, which now breeds in the north; also many remains of a Penelope or tufted Pochard duck, somewhat larger than our present Fuligula cristata. Several bones of the extremities of the heron, a foot long, as well as other bones belonging to smaller birds, are now waiting careful examination. Some of the vertebræ of fish have belonged to a large pike.

Such are the main features of the late discoveries; they require only two remarks. First—That the facts now stated indicate the existence of an ancient intelligent race of men, quite unacquainted with the use of metals, and, like primæval man, having only stones to make use of in their struggle for existence; and secondly, that the discovery at Schussenried indicates a totally different climate, such as now begins at 70 degrees of north latitude in the arctic lands lying between the forest region and the frozen sea, which are free from snow only a few months in the year.

It is hardly necessary to say, that the age of these primæval men, and of the above mentioned climate, stretches far beyond that of the lake dwellings. In none of these lake settlements have any remains been found of arctic wild and apparently domesticated animals, as at Schussenried. Even in the oldest lake dwellings the animals which are companions of men, do not differ in species from those of the present day. No one, however, can believe that the Schussenspring was merely an isolated station of these primæval-men. Flint knives are found in various places scattered over our country, just as in the district of the Dordogne, and seem to have escaped the inquisitive eyes of our archæologists who have hitherto considered Roman roads and Celtic tumuli the earliest remains of our country. These implements of flint occur very commonly around the Schussenspring, and may be collected in considerable quantities when the ground is newly turned up, and this to such an extent as to be well known to the manufacturers of instruments for tobacco smokers.

There can be no doubt that numerous other places in Upper Swabia, besides Schussenried might serve to illustrate the grade of civilization of our ancestors. But the same cause which has preserved these relics—viz., the water, which protected them from the atmosphere renders the investigation of them in general very difficult. For how seldom is a trench nineteen feet deep excavated under the bed of a pond, and this in soft mud, as at Schussenried? and even when such works are undertaken, it is very rarely the case that a keen observer of nature is at hand like Mr. Valet, of Schussenried, who by utilizing the discoveries of chance has rendered incalculable service to science.

DR. OSCAR FRAAS.

STUTTGART, *7th October*, 1866.

NOTICES OF MEMOIRS

I.—NOTES ON THE GEOLOGY OF WESTERN AUSTRALIA.

By the REV. W. B. CLARKE, M.A., F.G.S., etc.

(*Continued from the November No. p.* 506.)

The occurrence of felspathic dykes in the granite is quite in accordance with the experience derived from other regions, both in and beyond Australia, as on Bathurst Plains and in other instances in New South Wales, where there is no doubt as to relative age. Moreover, as in other granitic regions, so in that under review, the edges of the boss-like mass can be shown to have been subjected to the influence of the forces by which it has been denuded. Referring still to Mr. Lefroy's testimony, we find an eroded surface in 31° 53′ S., and 117° 31′ E., and a pot-holed surface in 31° 29′ S. and 120° 11′ E.; whilst, at what must have been the limits of the boss, we have the regular association of gneiss, chlorite, mica, and clay slates on the surface, and at the edges of Mr. Lefroy's and Mr.

Hunt's country; and, according to Gregory, at the Mounts Barren on the south coast, and on the flanks of the Darling Range, as well as at the heads of the Lyons and Gascoyne Rivers on the north-west.

Mr. Lefroy gives the localities in which he found the relics of old sedimentary formations, as gneiss or mica-schist in 29° 50′ S., 122° 3′ E., and in 29° 53′ S., 121° 21′ E. In 31° 8′ S. and 119° 49′ E., a talcose slate occurred; and quartziferous schists are mentioned in 31° 8′ S., 119° 49′ E. as well as metamorphic slates in 30° 5′ S. and 121° E.; the slates being *polished* in 29° 53′ S., and 121° 21′ E. So that, incorporating Mr. Lefroy's experience with that recorded in Mr. Hunt's map, we may assert, that over an area of very nearly 9000 square miles those gentlemen have established the fact, that fragmentary ancient or metamorphic schists occur at repeated intervals, whilst Mr. Lefroy states that a kind of dip or slope of the surface of the granite exists to the southward, and Mr. Hunt gives reason to believe, that the granite rises into loftier elevation towards the north, and, so far as I can decipher from the collection forwarded to me, has an extreme termination somewhere about 122° E.. near the limits of his exploration.

The agreement between Mr. Lefroy and Mr. Hunt is considerable as to the occurrence of the overlying rocks in fragmentary beds. Thus, No. 4 in Mr. Hunt's collection is a gneissose rock, and Nos. 1, 2, 3, and 13 are clay slates, all of which have an air of great antiquity, and correspond in texture and composition with rocks of the same name in the Lower Silurian series.

Neither Mr. Hunt nor Mr. Lefroy indicate any formation intermediate between these schists and what are probably Tertiary deposits. But it must be remembered that near Mount Barren on the South, and near Champion Bay on the north-west side of the imagined granitic boss, a Carboniferous formation exists, succeeded in the latter neighbourhood by Secondary formations ranging as high as Cretaceous. Regarded in this light, we have the relics in consecutive order of the members of the geological scale without any anomaly; and quite in agreement, when looked at in a broad view, with the features of other, though more limited regions.

In regular order we ought to have the coming in of the Tertiary formations. Such appear to be indicated by Nos. 29, 35, and 37 in Mr. Hunt's collection, as well as in some others, and by the mention on his map of drift gypsum in 119° 30′ E., a mineral of some importance further to the east in the low regions of the northern, north-western, and western part of South Australia.

Besides the above indications, we have in Mr. Hunt's collection a very numerous series of aluminous deposits of various colours, which, at my request to him, have been submitted to analysis by Mr. Theodor Staiger, of Hobart Town. His chemical determination agrees remarkably with the conclusions I have come to, on different grounds.

Similar deposits, sometimes resembling chalk, are well known in the settled parts of Western Australia and in New South Wales, and have often been noticed by explorers. In some cases there appears a close relationship between them and igneous rocks, with which silicates of alumina are connected; but in the cases now under notice the origin seems to be of a distinct kind.

Whether these deposits are Recent or Tertiary, they appear to owe their origin to the decomposition of felspathic granite, or such slates as No. 13; nor is the occurrence of felspathic clays, such as *kaolin*, unknown elsewhere in Australia, for the latter exists in abundance in connection with the granite of the You Yangs, near Geelong, in Victoria, from the decomposition of which it has resulted. Nevertheless, some of the Lake Lefroy beds in Mr. Hunt's list have been altered by the action of some more recent igneous agent, but of this no external evidence exists except in a minute fragment of some dioritic rocks entangled in No. 5, though of the fact of metamorphism there is distinct evidence in Nos. 16, 28, 29, 32, 33, 34, 35, 36.

Mr. Lefroy has positively declared, that no basalt or greenstone exists in all the extensive region described by him; we can, therefore, only regard the indications referred to as belonging to some other locality from which they have been drifted, and as pointing to a further succession of geological formations to the eastward or north-eastward of the 122nd meridian, and a gradual approach to the features and phenomena of the lower portions of the South Australian territory.

The frequency of the salt-lakes and samphire-lagoons, mentioned as occupying much of the country, as well as in similar tracts of Australia where flats occur in a hilly region, and the presence of lime in No. 5, favour the notion that the marine Tertiary beds of the Great Bight and South Australia are not far distant to the eastward of "Hunt's furthest," and of these I shall find something more to say.

I may now remark, that the quartz specimens, Nos. 14 and 31, and the mention of quartz hills on the map, about eighty miles to the westward, and again fifty miles south-west of that locality, as well as traces of a vein in No. 1 imply, that the granites and slates are in the same condition as those of auriferous tracts in Australia, whilst the presence of iron pyrites in No. 4 and of the iron in Nos. 5 and 15 serve to establish a similar inference as to the age of granite.

But the only economic value of the production here discussed seems to belong to the iron and to the clays, of which latter deposits some certainly belong to the fire-brick and porcelain species.

The thinness of the coating of slates, clays, etc., would imply, probably, a very limited supply of these products, which in many cases only serve to fill in the gullies and hollows formed by erosion on the granite, as in 31° 29′ S., 120° 11′ E., where that rock is pot-holed and supports a mass not more than 100 feet thick. The superficial red clay, the ferruginous red gravel, the sandy patches, the rotten soft schists, the deposits of fine white sandstone, the fragments of soft slates, all mentioned by Mr. Lefroy, are so many additional reasons for concluding that the region traversed by the 122nd meridian is covered by a capping of the upper beds that along the

Bight, and towards the coast southwardly, are succeeded by those marine beds, at the base of which, according to Flinders and Eyre, white aluminous beds lie below the shelly deposits, and repose on granite. Those I have little hesitation in comparing with the aluminous beds near Lake Lefroy, an extension of which is also indicated at several points to the westward in the journal of Mr. Lefroy.

That gentleman was led to a somewhat similar view from a section of a gully in 31° 29′ S., 120° 11′ E., about sixty-five miles W.S.W. of Hunt's "White Hills." The evidence already obtained leads, therefore, to the conclusion, that not far from Mr. Hunt's furthest, a change takes place where Tertiary beds become prevalent. The following considerations will strengthen the probability of this view :—

Mr. Hunt's eastern limit seems to have been about half-way between York and the *high* cliffs of the Bight (*Bundah*), and about 120 miles from the extension of the outlying Tertiary Bight limestone, near the Salt Lakes west of Esperance Bay, (*Eyre*), in the neighbourhood of which on Middle Island (*Flinders*) the granite is covered by a crust of calcareous matter ; and about 170 or 180 miles from the spot, near Point Culver, where the limestone becomes covered by the superficial sandy and ironstone detritus which, according to the aborigines, is the general character of the country between Lefroy's and Hunt's furthest and the sea, of which twenty-five miles seems to have been seen by the latter observer from the last elevated land on the 122nd meridian.

It may be remarked here, that the projections of granite along the coast which forms an arc between 118° and 136° E., and of which the chord is strictly the parallel of 35° S., are all more or less covered with a calcareous crust before mentioned, of which evidence exists in King George's Sound and Cape Arid to the west, and from Cape Radstock to Cape Catastrophe to the east. This is by itself an interesting fact, as showing how vast an area has been destroyed. By a rough but tolerably careful calculation I find that the water-area, allowing for the winding of the coast, is not under 144,000 square miles, and if the *average* thickness of the removed Tertiary beds was that of the Bight Cliffs, viz., 300 feet, the enormous mass of removed matter is upwards of 1200 billions of cubic feet. (See note, p. 000.)

Coupling with this the bearing of Mr. Hunt's specimen No. 5 it is only a fair inference that, at the limit indicated, the explorers were on the edge of the Bight formation, the head of which is on the parallel of Mount Eaton, between Lake Cowan and Lake Lefroy. We may therefore presume that a change of country, assimilated to that of the western part of South Australia, there begins, the distance from the frontier being only 630 miles.

There is one further deduction which, until refuted by discoveries of another kind, has a considerable interest for the geographer.

Looking to the facts exposed at the Bight and on the north west coast, between Mount Blaze and Cape Joubert, and to the facts discovered by Mr. A. C. Gregory on Sturt Creek, and by Mr. F. T. Gregory about 500 miles to the westward and southward of the former, where he had indications of an evident great water-channel, we may conclude that there is a presumption in favour of a probable Strait between the Bight and the north-west Coast, now filled in by Tertiary, Post-pliocene, and Recent accumulations; and the features disclosed on Stuart's line of route agree with what may be considered the north-east side of a region traversed by such a Strait, whilst the features of Lefroy's and Hunt's territory equally agree with the south-west or opposite side of the Strait. Between the most eastern granite near the Russell Range on the south coast and that at Fowler's Bay, the distance is nearly the same as that between the respective extreme limits of the desert discovered by the Messrs. Gregory, so that there is much to justify the conclusion, so far as the present evidence goes. And if such an hypothesis be adopted, then it follows, that to the north-east and north of "Hunt's furthest," the country would be low-lying and desert also, so far as the watershed of streams crossed by Stuart, which are but 200 miles from the supposed eastern bank of the assumed Strait.

This view will explain in some degree the occurrence of the lakes and watercourses, the drainage of which Mr. Lefroy says is scarcely perceptible in any direction.

As the height of the cliffs at the Bight is not more than 600 feet, unless there is a much greater elevation than that of the lakes, there could be no drainage to the sea, and accordingly no streams are found passing to the coast from the north. The drainage, if any, should be to north-east or north from Hunt's furthest, if the idea of a Strait be correct, and in that case, probably, Mr. F. Gregory's "supposed" river from the interior would carry off all supplies falling into the hypothetical Strait.

A final remark remains. In Mr. Lefroy's Journal it is stated that no trace was found of any bituminous fluid such as was alleged to have been met with in the former expedition of Messrs. Dempster, and that no Carboniferous rocks exist in the country traversed. This, however, ought not to prevent further research, because it is now established that hydrocarbon fluids are not confined to the Carboniferous rocks, but rise from great depths below their horizon. Without venturing to form any opinion as to the fact stated, or as to its value, a further inquiry may be properly recommended.

In No. 25 of Mr. Hunt's collection we have a clay containing a small per-centage of some carbonaceous matter; but this fact is not in collision with the origin of such clay from Silurian slates, since it is well known that, in the rocks of that age, there is often an abundance of carbonaceous matter, though no such deposits of coal as occur in the Carboniferous formation. Yet, had there been any traces whatever of vegetable impressions, it might, in the absence of evidence to the contrary, have been inferred that such a clay belonged to a Carboniferous formation, and Mr. Staiger hinted at such a possibility. That, however, is very far from probable.

The quantity of saline matter contained in this and some other of the associated silicates of alumina might lead to the inference that they had once formed the bottom of a marine lake or estuary, in which they were deposited from the decomposition of the rocks forming the shores; an inference supported by the present condition of the surface, viz., a series of saline lagoons and water-channels among hills and knolls, which would be insulated at no great depression of the horizon so as to admit the influx of the ocean, or other increase of the lakes in depth. But the existence of salt in some of these clays shows how, in certain instances, the saline nature of the lagoons and water-channels of the interior may be accounted for without reference to the ocean.

W. B. Clarke.

St. Leonard's, near Sydney,
21*st March*, 1866.

By favour of the Colonial Secretary we publish the Rev. W. B. Clarke's remarks upon the Geological specimens brought in by Mr. Hunt from his last visit to the Eastern interior. We have on several occasions had to acknowledge the value of the remarks of Mr. Clarke upon the various specimens forwarded to him, but probably upon no occasion has his kindness been so valuable to the colony as on the present. So far as the specimens went they have enabled Mr. Clarke to give us a general idea of the constitution of that portion of the interior traversed by Mr. Lefroy and Mr. Hunt, and lead to the inevitable conclusion that in this great portion of our territory it is almost hopeless to look for any valuable addition to its mineral resources, unless possibly the specimens derived from the salt-lakes and their neighbourhood were too few to enable him to arrive at a definite conclusion. Mr. Clarke refers to the bitumen found by the Messrs. Dempster (of which we have the specimen still in our possession), and stated to have been found oozing from a granite rock; that may hereafter be worthy of more careful inspection, but at present, however valuable it might prove, it is too remote from the occupied districts to be available, with any chance of the deposits proving worth trying for in a commercial point of view. We have been particularly struck with the hypothesis ventured by Mr. Clarke, after considering Mr. Hunt's specimens and the geological data afforded by other observers, as to the possibility that the former had arrived at the western edge of a Strait running from the Great Bight to the North Coast. *From the various articles noticed by Mr. Hunt in the possession of the natives at his farthest Eastern point, such as pearl shell ornaments*, etc., we have before observed they argued that an easy communication with the north on that parallel probably exists, and this undoubtedly would be the case if Mr. Clarke's hypothesis should prove to be a true one, and the country intervening would, there is no doubt, be one easily traversed, providing supplies of water are obtainable. From the knowledge we have lately gained as to the country lying between Nicol Bay and King's Sound, we now know, however, that no large river exists along the whole line, and if the desert with waves of sand which stopped Mr.

F. Gregory does border upon any large river, as he supposed, it must be the Fitzroy, which again we also know to be, at least in the present age, too small to have produced such appearances. This fact goes greatly in favour of Mr. Clarke's hypothesis of an ancient Strait.—*Editor of the "Perth Gazette."*

II.—Quarterly Journal of the Geological Society of London. Vol. XXII. Part. III. November, 1866.

In noticing this part of the Geological Society's Journal, we must content ourselves with calling attention to the number and variety of the papers contained in it. There are thirty-three papers, besides several miscellaneous abstracts. It would occupy too much space to give an analysis of each of the former, the list alone of which would occupy nearly two pages, nor is it necessary, as abstracts of the whole of them have appeared in previous numbers of the Geological Magazine, in the reports of the meetings of the Geological Society from March 21, to June 20, 1866.

We feel sure that no geologist could fail to find some one or more subjects of special interest to himself among these communications now published.

In the Miscellaneous part of the Journal are papers which we have not noticed before:—

1st. Abstracts of M. Dupont's researches among the caverns of the valley of the Lesse (see p. 564) ; a notice, by Chevalier von Hauer, of a new genus of Cephalopods, *Choristoceras.* It is somewhat similar in form to *Crioceras,* with the lobular ornamentation characteristic of *Ceratites.* Specimens of this new genus—to which the name *Marshii,* has been given in honour of Mr. O. C. Marsh, F.G.S., who first noticed its occurrence—have been discovered in Austria in a bed resting on Kössen strata and overlain by Liassic limestones.

2nd. The occurrence of the Marmot (*Arctomys marmota*) in a recent formation in Styria is noted.

3rd. A notice on the Gasteropods of St. Cassian, by Dr. Laube. This fauna possesses many species analogous to forms found in the Carboniferous Limestone, and is particularly interesting as being a "limit-fauna," comprehending representatives of a number of undoubtedly Palæozoic genera associated with others whose full development took place afterwards in the course of the Mesozoic Period.

III.—Tabellen zur Bestimmung der Mineralien nach äusseren Kennzeichen (Tables for the Determination of Minerals by External Characters). Herausgegeben von Albin Weisbach, Professor an der Bergacademie zu Freiberg. Leipzig, 1866. pp. 109. Arthur Felix.

The object of these Tables is to enable a person to find out what a mineral is by means of its physical characters. The author has lately succeeded the veteran Professor Breithaupt in the chair of Mineralogy at Freiberg, and is a son of the well-known Professor of Mechanics at the same place. An extract from his preface will give a general idea of the book:—"If a mineral is to be determined by means of these Tables, the kind of lustre, degree of hardness, the streak, and also the colour, when the mineral has a metallic appearance, must be made out. If these characters are properly determined—and this is a very easy matter—the Tables show that the choice is confined to a small number of minerals, among which the right one can be fixed upon either at once, or after consulting some Handbook on Mineralogy, and can nearly always easily be found out if the crystalline form is plainly recognizable. If this characteristic is wanting, the determination is undoubtedly more difficult, or, rather, takes more time, especially if the mineral has a non-metallic lustre and a colourless streak. In such a case, the number of minerals suggested is sometimes very large, and it appears advisible to make use of the supplementary Tables, in which are given the behaviour of these minerals in the matrass, with water and hydrochloric acid." These Tables will be useful to the student, in making him pay more attention to the physical characters, for, with von Kobell's tables by his side, he is apt to trust too much to the chemical properties to be determined, and consequently, when called upon to determine a mineral without his blowpipe and re-agents, he may feel somewhat at sea. No doubt von Kobell's tables are most valuable (and it is to be regretted that the English translation is out of print), but, at the same time, it is well if the student accustom himself to determine minerals by even simpler means.

C. L. N. F.

REVIEWS.

I.—Memoirs of the Geological Survey of Great Britain, and of the Museum of Practical Geology, Vol. III. The Geology of North Wales, by A. C. Ramsay, F.R.S., with an Appendix on the Fossils, by J. W. Salter, A.L.S., F.G.S. 8vo. pp. 381; Plates 28. (Longmans & Co.)

THIS long promised Work will be heartily welcomed, more especially by those geologists whose affections centre chiefly in Palæozoic rocks, and who are perhaps of opinion that the exploration of newer geological territories has of late years occupied somewhat exclusive attention. At the same time, however, the work before us will be scanned with interest by those who are so eager in their enquiries into the causes which have given rise to the contour of the land. Its appearance cannot fail to remind us of one, now alas! no more, whose ability, joined to his enthusiasm, few could rival—the late Sir Henry De le Beche. Under his direction the survey of North Wales was begun, and so many years have elapsed since then, that those of his associates who at that time were comparatively young as geologists, have now come to rank among our most eminent experts. Those to whom the greater share of the work in North Wales fell, are Professors Ramsay and Jukes, and Messrs. Aveline and Selwyn.

The beautiful maps, of which this memoir is descriptive, have long testified to the great labour and the admirable skill employed in their construction. The careful delineation of the chief rock-divisions in a profoundly faulted and contorted region must always be tedious and difficult, but when, in addition to this, there are innumerable beds and masses, of volcanic and metamorphic origin,—many of them of singularly erratic character,—to be defined upon the map, perhaps only those who have had a like task to perform can appreciate the degree of mental and bodily fatigue involved. As an example of the skill with which the disjointed strata have as it were been pieced together, we might instance the recognition of the felstones and ashes of the wild Snowdonian district as the equivalents of the Bala limestone beds. The numerous sections and copious details supplied in the memoir in regard to this point, amply bear out the conclusions expressed on the large "six-inch" sections of the Survey, which have now been before the public for some years.

Those who were interested in Prof. Ramsay's Presidential Address to the Geological Society in 1863, will be glad to have the details here given of the stratigraphical breaks that characterize the Silurian formation. The reasons for inferring (apart from fossil evidence) that the Llandeilo and Bala beds over-lap unconformably the Lingula flags are very clearly stated, and the other breaks in succession are further elucidated.

The igneous geology of North Wales occupies, as might be expected, a considerable portion of the memoir, and those who work at this department of the science will find here a large accumulation of facts, and among them, some rather hard problems to solve, Two great groups of contemporaneous felstones and ashes are described, the first of which forms the basement of the Llandeilo beds, and the second occupies the horizon of the Bala limestone. From the great bulk attained by these rocks in Cader Idris and Aran Mowddwy, and from the fact that, when traced westward, they are found to decrease rapidly in thickness, it is inferred that the volcanic centre or centres were probably to the eastward of a line drawn between Tremadoc on the north, and Llanegryn on the south; and it is further conjectured that some of the felspathic masses that break through the Silurians, in the region indicated, may possibly mark the site of the volcanic foci. The innumerable intrusive greenstones that lie either among or beneath the bedded traps and ashes, but which never make their way through the overlying strata, so as to assume the character of lava-flows, are a great puzzle. Their position proves them to be "intimately connected with the volcanic phenomena of the district," but the nature of that connexion cannot be clearly made out. The almost total absence of hornblende from the felstones renders it more than improbable, as Professor Ramsay remarks, that they could ever have formed the upper or lava-portion of a melted mass, which at certain depths from the surface crystallized into greenstone. The greenstones are therefore not likely to have been the feeders of any of the overlying felspathic rocks: unless, indeed, we hazard the speculation that a melted mass (containing the elements of hornblende) which under the influence of pressure would develop into greenstone, might, if it were poured out at the earth's surface, form sometimes only a variety of felstone, the hornblendic ingredients having entered into other less easily detected combinations, consequent upon the more rapid cooling of the rock. Another anomalous circumstance connected with these intrusive greenstones is that they will sometimes run in the line of strike, and occupy the place of some of the ashes without appearing to thicken the general mass of the beds. "However strange it may appear, this circumstance almost induces the belief that these greenstones have been formed by the melting up of a part of the ashes amid which they lie," and which in such cases must be supposed to have contained the elements of hornblende. Our space will not permit us to notice more fully the truly erupted rocks of North Wales. They are to be referred, as already stated, chiefly to two great horizons—namely, the Llandeilo and Bala periods. But there are certain narrow greenstone dykes that intersect the strata in an east and west direction which are believed with some probability to be of post-Carboniferous age.

Those who carefully consider what is advanced with regard to the metamorphic nature of certain crystalline masses will find in the highly suggestive details many facts that strike at the root of that theory which seeks to account for the origin of granite and other kindred rocks by supposing them to have been intruded from below. All the phenomena associated with the great Cambrian quartz-porphyry, that stretches between St. Ann's Chapel and Llanllyfin, undoubtedly go to prove that this rock has originated from the metamorphism of the aqueous strata; and the same may be said of the granite of Anglesey. Both rocks melt insensibly into the surrounding beds. The latter are not pushed aside to make room for them, but have actually supplied the material which, under the influence of metamorphism, has crystallized into granite and porphyry. This being the case, it is not surprising to find that contortions and faultings affect both stratified and amorphous rocks alike.

In the description given of the geology of Anglesey there is much suggestive matter on the subjects of cleavage and foliation. After having stated his opinion—which is also that of other geologists—that foliation may follow lines of dip or false bedding, or planes of cleavage according to circumstances, Prof. Ramsay suggests an ingenious theory to account for the origin of contorted foliation. He says, "Suppose true slaty cleavage to cut in straight lines through beds inclined at any angle, and that afterwards foliation was superinduced in the line of the cleavage planes; then, while foliation was being produced by a chemical re-arrangement of matter accompanied by moisture and heat, the expansion produced by heat at great depths would induce intense pressure, one result of which might be that such pressure, if exerted vertically from below, would in some instances compress the beds and reduce their individual thickness without obliterating the stratification, while *the foliated cleavage planes, also vertically compressed, might be forced into contorted lines more or less across the planes of bedding.*" The theory is further explained by means of a diagram.

The data from which have been inferred the relative ages of the two great movements of disturbance that gave rise to the contortions and many of the minor faults of the rocks of North Wales are lucidly explained. But we can do no more than merely direct attention to these and the many other important questions that come up for discussion in the memoir. No one can only glance over its pages and their numerous illustrations without being impressed with the abundant proofs of tremendous denudation which every mountain and valley of the region exhibits. The former extension of certain beds is indicated upon plate xxviii, from which it may be seen that in some places a thickness of solid rock has been removed to the amount of 20,000 feet, and this does not take account of the still higher beds which are believed to have originally swept over the now denuded strata. The mind is lost in trying to apprehend the time requisite for the gradual transport of such immense masses of strata. And if we believe, with Prof. Ramsay, that the valleys have been cut out in old table-lands (plains of marine denudation), "by the weather, by running water, and by glaciers;" that, in short, the old mountains of Wales have grown into existence no faster than hills of denudation are forming now, to what an inconceivable distance in the past does the beginning of all these slow changes appear to recede.

The bulky Appendix is devoted to lists and descriptions of the fossils illustrative of the memoirs, for which we are indebted to Mr. Salter, whose ability as a palæontologist, and whose intimate acquaintance with palæozoic forms, are sufficient guarantee for the value of this portion of the work. Of the 26 plates of fossils that accompany the Appendix it is enough to say that they have been prepared by Messrs. C. R. Bone and W. H. Baily.

II.—Rev. W. B. Clarke on the Auriferous and Non-Auriferous Quartz-Reefs of Australia.

SINCE the publication of Mr. Selwyn's report on the Auriferous Drifts and Quartz-Reefs of Victoria, (p. 457,) our attention has been directed to a recent number of the 'Sydney Morning Herald,' (June 8, 1866) in which Mr. E. S. Hill points out that in a paper read in 1864 before the Geological Society of London, Mr. W. Keene had clearly indicated the position of the division of auriferous and non-auriferous rocks; and that it is to Mr. Keene, and not to Mr. Selwyn, that we are indebted for the earliest information on this subject. In reference to this assertion, he quotes the following passage from Mr. Keene's paper.—"I also divide the quartz as belonging to different epochs. That is to say, there is a quartz at the base of the Coal Measures, in many cases of great purity, in which I have in vain sought for any sign of gold; whilst the auriferous quartz is in upheaved beds, with which the Coal Measures are unconformable, and contains the old fossiliferous limestone, and drift-gold is to be found where this limestone and the accompanying quartzites and shales have presented their edges to destructive influences."

In a subsequent number of the "Herald," the Rev. W. B. Clarke states, that having read Mr. Hill's letter, and judging from the extract given by Mr. Hill, as compared with Mr. Selwyn's report, he is persuaded that Mr. Keene and Mr. Selwyn treat of different matters. The former seems to refer to "quartz" geologically below the Carboniferous formation. The latter reports a "drift" of quartz merely, below the Miocene beds, but in immediate association with them, and conformable thereto. All this is quite different to what Mr. Hill supposes. He adds, that geologists in Victoria are not satisfied with Mr. Selwyn's generalisation, that because in some places the drifts have been found non-auriferous, it is therefore to be concluded they are always so. It is believed, that, if non-auriferous, they have been derived from non-auriferous rocks, such as the Bacchus Marsh, and other Carboniferous rocks, Mr. Selwyn considers them as derived from rocks of "Miocene age." This has nothing to do with Mr. Hill's idea of "Quartz" at the base of the Carboniferous rocks.

In the *Silurian rocks themselves* there are instances of *reefs* without gold for considerable distances. This was reported to the Government in 1852. From a long experience since, in examining various rocks, and in connection with careful analytical experiments, conducted by skilful analysts, Mr. Clarke states that all the evidence about non-auriferous rock is merely *negative*, that gold does often occur in rocks of all ages, and that he is quite satisfied that any statement claiming discovery for indications such as Mr. Hill refers to, is of no value.

Mr. Clarke remarks further, that gold occurs in parts of the Carboniferous formation, above and below the coal, and even in one instance, in coal itself; and that it occurs not only in the Silurians, but in the Calcareous conglomerates of the Secondary formations. He mentions many of his own published observations, giving the following extract from his report of the 28th December, 1852:—"We may thus be led to understand, why, as in Australia, ridges and bands of quartz that follow the strike of the slates that contain them, may be traced for miles and miles without a sign of auriferous mineral, or gold, though in other instances, every quartz vein may be, more or less, auriferous. *The difference depends upon the ages of the silicious intrusions*, the impregnation of auriferous quartz having occurred at various epochs."

In conclusion, Mr. Clarke states that Mr. Selwyn's valuable observations on the Tertiary deposits of Victoria do not bear on any practical question yet mooted in New South Wales. And although at present he concedes to Mr. Selwyn's hypothesis about the Lower Miocene drifts, the facts on which that gentleman bases his opinion, have been, as he has shown, long known to himself, and "proclaimed to the world."

III.—New Work on the Antiquity on Man.

["L'Homme Fossile en Europe, Son Industrie, ses mœurs, ses œuvres d'art aux temps antédiluviens et préhistoriques." By M. H. le Hon, Chevalier of the Order of Leopold, etc. Brussels, 1866.]

HAVING been favoured with a few of the sheets of this work, now in course of publication, we are enabled to form some idea of its purport. And in this respect, as might be expected, it resembles Sir Charles Lyell's "Antiquity of Man," some of the wood-cuts of which have been borrowed for its illustration.

As stated in the prospectus, the author gives an exposition of all the great discoveries bearing upon the Antiquity of the Human race, commencing with a brief sketch of the earth's history, from its creation to the appearance of man, and concluding with a résumé on "Darwinism," translated from the Italian of Prof. Omboni. In the table of contents are indicated chapters on the Glacial Period, the age of the Great Bear and Mammoth, the age of the Reindeer, Diluvial Inundations, the ages of Polished Stone, Bronze, and Iron Implements, and on Lacustrine Habitations. We shall take an early opportunity to notice this book again; it will doubtless prove an acceptable addition to our library of Pre-historic literature.

REPORTS AND PROCEEDINGS.

Geological Society of London.—November 7, 1866.—Prof. A. C. Ramsay, LL.D., F.R.S., Vice-President, in the Chair. The following communications were read:—1. "On some remains of large Dinosaurian Reptiles from the Stormberg Mountains, South Africa. By Prof. T. H. Huxley. LL.D., F.R.S., V.P.G.S.

The specimen more particularly described in this paper is a portion of a right femur, 25½ inches long, so that the entire femur may be safely assumed to have exceeded 30 inches in length. The peculiar form of the bone, and the characters and position of the trochanters, leave no doubt of the Dinosaurian affinities of the reptile to which it belonged, which must have been comparable in point of size to its near allies, the *Megalosaurus* and the *Iguanodon*. To the former of these it possesses the closest affinity, but differs in the proportional size and form of its trochanters, and in its much heavier proportions; and the author proposes for it the name *Euskelosaurus Browni*.

A portion of the distal end of a femur indicating another genus of large-sized Dinosaurian reptiles was also described, the characters yielded being sufficient to prove that it belougs to another genus than *Euskelosaurus*.

The discovery of these remains in the Stormberg rocks was stated to be by no means decisive of their geological relations, as Dinosaurian reptiles lived throughout the Mesozoic period, and may have existed during the Permian; but it is interesting to observe that the Stormberg rocks conformably overlie the Karoo beds, which have yielded the Dicynodonts and so many other remarkable Reptiles and Labyrinthodonts.

2. "Additional Notes on the grouping of the rocks of North Devon and West Somerset." By J. Beete Jukes, Esq., M.A., F.R.S., F.G.S.

Commencing with the country around Wiveliscombe, near which place Sir H. De la Beche had indicated an east and west fault of small extension on the maps of the Geological Survey, Mr. Jukes described the rocks of the district reaching from that place north-west to the Brendon Hills, and westwards to Dulverton, including the valley of the Tone, more to the south. From Dulverton he examined the country towards Simonsbath, and then, proceeding to Barnstaple, made traverses from that place to Challacombe and to Bittadon. Similarly, after examining the neighbourhood of Combe Martin, he proceeded along the north coast in an easterly direction, through Countesbury, Porlock, and Dunster, and across the Williton valley to the Quantock Hills. The observations made during these several journeys were given in detail by the author; and the principal conclusions at which he had arrived in consequence were stated to be the following:—(1) There are three areas of Old Red Sandstone in this region, namely, *a*, The Quantock Hills; *b*, The Porlock, Mindhead, and Dunster area; and *c*, The Morte Bay, and Wiveliscombe ridge. (2) Each of these masses of Old Red Sandstone dips under a great mass of Carboniferous Slate. (3) The Coal Measures, the Carboniferous Slate, and the Old Red Sandstone of Devon, are contemporaneous with the Coal-measures, the Carboniferous Limestone, and the Old Red Sandstone to the north of the Bristol Channel. (4) That if the great fault which the author believes to exist be proved to be absent, his other conclusions will not be altogether vitiated, for the red rocks of Porlock and Dunster may then be taken as the top of the true Old Red Sandstone lying underneath a great thickness of Carboniferous Slate. Mr. Jukes had also been able to construct a geological sketch-map of North Devon in conformity with his views; and the paper concluded with a few notes explanatory of it.

Woolhope Naturalists' Field-club.—At a recent meeting of this club, the Rev. W. S. Symonds read a paper, entitled, "Notes on a visit to the Bone Caverns of the Lesse, in Belgium," by Sir William V. Guise, Bart., President of the Cotteswold Field-club, and the Rev. W. S. Symonds, President of the Malvern Club, of which the following is the most important portion:—

Ever since the announcement in 1859 and 1860 by our distinguished countrymen, the late Dr. Falconer, Mr. Prestwich, and Mr. John Evans, of the detection of human implements associated with the bones of the great extinct mammalia in ancient river drifts, and their appreciation and acceptation of the discoveries of M. Boucher de Perthes, the President of the Cotteswold Club (Sir W. Guise) and myself have studied, in various localities, the drifts and gravels of those ancient rivers which long ages ago flowed in broad streams along the existing vales of our Severn, Avon, Wye, Usk, and other rivers. We also visited many of the caves, which, in Somersetshire and Wales, contain immense quantities of the bones of the extinct animals, and here and there the implements of ancient men.

We have for some time been of opinion that many of the cavern deposits would turn out to belong to the same epoch, geologically speaking, as do the old valley gravels, and are, therefore, separated from the history of our existing rivers and their alluvia, by the lapse of untold ages. We visited the caves of Gower, which I had already seen, in company with Sir Charles Lyell, and were convinced that Lieut.-Col. Wood, the ardent explorer of the cave history of that beautiful peninsula, had himself detected flint implements under circumstances which proved the existence of man during the life-time of the rhinoceros and other extinct mammalia. Again, the caves of Tenby furnished us with corroborative proofs in the collection of the Rev. Mr. Smith, of Gumfroston, and the researches of the Rev. H. H. Winwood. We also visited the celebrated Salisbury sections, under the guidance of Dr. Blackmore and Mr. Brown, and made ourselves acquainted with the physical geology of the surrounding neighbourhood. On this expedition we were accompanied by our friend Mr. Reginald Yorke, who had previously studied the drift deposits of Amiens and Abbeville. We thoroughly examined the high-level drifts, and the low-level drifts, and the remains of the extinct animals collected by Dr. Blackmore; we saw the places from which many perfect implements were extracted by Mr. Brown and Dr. Blackmore with their own hands; and we all agreed with Mr. John Evans, who first described these drifts, with regard to the inevitable conclusions which must be drawn by any student of physical geology, as to the antiquity of these remains of human industry and art.

From Salisbury we also visited Hill Head, on the shores of Southampton water, where other flint implements had been detected. Here Mr. Yorke obtained a specimen which was no doubt imbedded when the physical and climatal conditions were very different from the present, and when what is now the summit of a sea cliff was the bed of a great river, or an estuary, over which flowed waters charged with ice rafts, which melted and deposited large, drifted, angular blocks of Tertiary sandstone[1] and quartzite in the gravel-drift which contains the implements, and which, doubtless, belongs to the same geological epoch as the old river shingles of Salisbury, which were deposited under very different circumstances to those under which the Salisbury streams now deposit their alluvia. When every vale was filled, and every hill and eminence was covered with snow and ice during the winter months, and when the waters rolled rapidly under every summer's sun, carrying with them the eroded quartzite masses, and the sharp, sub-angular flints.

It was not then without much previous preparation and study among the peculiar class of geological phenomena we wished to investigate, that we determined to proceed to Belgium, to examine the geological conditions under which the fossil remains of human beings had been found by Dr. Edouard Dupont, of Dinant, in caves in the Carboni-

[1] See Lieut.-Col. Nicoll's paper, GEOL. MAG., Vol. III., p. 296, Pl. XIII.

ferous limestone which rises above the river Lesse, which flows into the Meuse, near Dinant, in the south of Belgium.

As my own notes are strictly confined to the geological phenomena we observed, I will here quote from the daily journal kept by Sir Wm. Guise, which he has kindly lent me, and in which descriptions and details of the scenery, as well as the geology, are noted :—

"In July we left Brussels for Namur, in company with our friend, Mr. John Jones, formerly Hon. Sec. of the Cotteswold Club. From Namur we proceeded to Dinant, accompanied by Mons. Dumont, Engineer-in-chief of the province, to make the acquaintance of Dr. Dupont, who has superintended the great cave excavations made under the auspices and with funds supplied by the Belgian Government.

"The River Lesse flows into the Meuse at a distance of about one and a quarter miles from Dinant. Our course lay up the valley of the Lesse; a narrow valley, bounded by rocks of Carboniferous Limestone, frequently much contorted, while their jagged and angular outlines tell of some other force than the mere erosion by water having had to do with their present abrupt configuration. The slopes are richly clothed with wood, while the river winds through a green pastoral valley, never, probably, much more than half a mile in width, and for the most part far less. We crossed the Lesse three times at fords which were sufficiently deep to admit the water into the carriage. About two and a half miles from Dinant the road passes under the castle of Walzin, which stands on the summit of a bold rock immediately above the stream, and presents a most picturesque appearance. Thence to the village of Challeux is about two and a half miles of execrable roads. Here we descended from our carriage and made our way to the river, at this point deep and still. A shout of recognition was exchanged, and presently a narrow, flat-bottomed shallop was poled across to convey us to the opposite side of the stream, where a long talus of broken earth and stones showed where operations were being carried on. A course of steps cut in the hill-side led up the slope, at the top of which we found ourselves in front of a yawning cavern, and in the presence of a young man in the dress of an excavator. The latter was Dr. Dupont, and the cave that of '*Naulette*,' in which was found the now famous human jaw, associated with *Rhinoceros tichorhinus* and other extinct mammalia. Dr. Dupont welcomed us with cordiality. Armed with lights, we entered the cave, from which large quantities of material had been removed. Dr. Dupont explained the characteristics and relations of the so-called 'Lehm' and 'Loëss;' the latter he considers to be *marine*, and shows that the jaw was found under, at least, seven feet of 'Loëss' sands. The position of this jaw has been disputed, but there were too many persons present at the time of its discovery to admit of any doubts on the subject; its exact position is determined without room for cavil. We were a queer-looking set, as, with wolf-skins over our shoulders to shield our coats from the wet and clay, we emerged again into the light of day.

"From 'Naulette' we proceeded to the 'Trou du Frontal' and the 'Trou des Nutons.' By the way we halted at the little hamlet of

Challeux—quite a little republic of its own in this remote, out-of-the-way spot. It is most pleasingly situated on the banks of the stream, embosomed among trees, and having opposite, bold limestone cliffs, in which is a Bone-cave called the cave of 'La Challeux,' which, in the number and variety of the remains it has yielded, is surpassed by none in the valley. Unfortunately, we did not examine this cavern, being hurried on by our guides, and it was not until afterwards that we were made aware of its importance. In less than a mile the carriage came to a halt at the nearest approachable point to the 'Trou du Frontal' and the 'Trou des Nutons.' The way lay through a dense, woody jungle, in which all trace of a track was nearly obliterated. These were the first opened, and the 'Trou du Frontal' received its name from the frontal or forehead bone of a human being, the first which was discovered in the course of these important excavations. Having read and translated the original report of Dr. Dupont on these caves, I was especially careful in their examination. The structure of the 'Trou des Nutons' is particularly well shown. At the base, a river-gravel with rounded drift; next the 'Lehm,' a fine granular deposit; then the 'Loëss,' consisting of stratified sands and clays, the latter of red colour, of so close and compact a structure that they break with a conchoidal fracture, and, when cut or scraped with a knife, exhibit a shining surface. Over all these, and unconformably to them, lie heaped against the side of the mountain a mass of angular *débris*, doubtless a sub-aërial drift accumulated by the slow action of atmospheric causes, and telling eloquently of the vast lapse of time during which they have, bit by bit, been gathering.

"In returning, Symonds and some of the party scaled the limestone rocks by a precipitous track leading on the summit to the ancient Roman fortress of Hauteraiscenne, considered by M. Van Beneden to be one of the last strongholds of that people before they were driven across the Rhine. Coins of Gallienus have been found there, which seem to point to the date of its final abandonment.

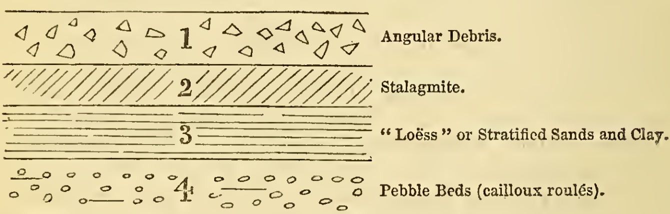
"After dinner, Symonds and myself went by appointment to inspect the museum of Dr. Dupont. This collection fills three rooms and is itself such an illustration of primeval man as cannot be paralleled elsewhere, while it bears no less striking testimony to the energy and enthusiasm of the collector, who has himself personally assisted at the disentombing of every specimen. The cave of Challeux, which we unfortunately failed to visit, appears to have yielded the richest results, no less than 34,000 worked flints, the teeth of as many as 40 horses, the bears *Ursus spelæus* and *arctos*, horns of reindeer, *C. tarandus* and *C. Guettardi*, in many cases showing the marks of human handiwork, bones of badger, fox, goat, water-vole and land-vole, etc., the latter in vast quantities, all of which had been used for food. No human bones were, however, so far as I could learn, found in this cave. But without question the most remarkable object in the collection is the human jaw from the "*Trou de la Naulette*:" this jaw appears to be more ape-like than any yet attributed to man. Yet to MAN it is decided to belong. The bone of the chin is entirely wanting, the canines, which are absent, were evidently exceedingly powerful, as shown by the size of the orifices for their insertion, the jaw is remarkably small and must have pertained to a race of diminished stature.

"Dr. Dupont entertains no doubt of the vast antiqnity of man upon the earth. He said, 'the man of the mammoth is the man of the reindeer; and the reindeer man is the man of the polished flint period.' One fact mentioned by Dr. Dupont is exceedingly curious, namely, that the horse appears to have abounded at the time of the *early* cave men with rudely-worked implements of silex, and were consumed by them for food, but that this quadruped's remains are wholly absent in the polished flint period, from which he argues that the horse was re-introduced at a later period. Amongst the objects found in the cave of Challeux were pieces of fluor-spar and fossil shells, amongst them *Cerithium giganteum,* imported from the country of Champagne, distant 40 or 50 miles, The flints, too, which were used for working, were brought from the same distance, showing evident knowledge of a rude state of trade or barter.

"It is to be noted that the fossil shells were pierced with small round holes, evidently in order to suspend them as ornaments,"

Such are Sir William Guise's remarks upon these most interesting caverns and their contents. I would only add a few brief notes for the information of those physical geologists who have studied the phenomena of ancient river and cave deposits, and would be interested in our endeavours to correlate those of Belgium with our own here in England.

The following is the succession of deposits as sketched for me in my note-book by Dr. Dupont:—



The points that struck me most particularly are as follows:—

First. On ascending the ancient Roman encampment above the "Trou des Nutons," with M. Dumont and Dr. Dupont, they pointed out to me the position of the *Drifts* that overlie the great platform of Carboniferous Limestone. These drifts contain erratic pebbles and boulders, and occupy a similar position above the bone caves on the Lesse, as do those of the boulder drifts of Gower above the caves on the sea coast, or those of St. Asaph above the river that runs below the limestone caverns. The rolled pebbles at the base of the cave deposits are like those on the upper limestone platform.

Secondly. After the Belgian caverns had been hollowed out in the Carboniferous Limestone, and the carbonate of lime removed, probably by springs acting upon longitudinal fissures, it is very evident that either engulfed streams, or the action of waves, affected the interior of the caves precisely as was observed by Sir C. Lyell and myself in the caves of Gower and St. Asaph. Although encrusted with stalactitic matter there are numerous *pot-holes* and marks of water action.

Thirdly. Along the valley of the Lesse there have been undoubtedly physical changes in the configuration of the district since the deposition of all the stratified deposits within the caves. This is also what we know has occurred, in many instances, among the subterranean caverns which contain the bones of the extinct mammalia and the flint implements in England.

Fourthly. It is the opinion of Dr. Dupont, if we rightly comprehended him, that the "Loëss," which underlies the stalagmite of the caverns, and consists of stiff clay and well stratified sands—the same which contained the human jaw and the bones of the *Rhinoceros tichorhinus*—is of *marine origin.* I do not know what reasons Dr. Dupont has for holding this opinion, but we shall soon be made acquainted with them, as that gentleman is about to publish a work upon the physical geology as well as the animal contents of these Belgian caves. This is an important point, for if the basement gravel and silts in the caverns turn out to be *marine,* I see no way of escaping from the conclusion that the valley of the Lesse was submerged beneath the waters that deposited the pebble and drift beds on the summit of the limestone platform that rises above the caverns; and consequently that these cavern drifts are *pre-glacial.* We arrived at other conclusions, upon which however I am unwilling to lay much stress, as our survey was necessarily short. It appears from the statements I gathered from Dr. Dupont, that on the flanks of the Lesse valley, above the bone caverns, but below the platform drifts, there are *high-level valley gravels* which tell of an ancient river which flowed at *a far higher level* than the waters of the existing river, and which old river is not unlikely to have washed down pebbles and drifts derived through streams by lateral sources, from the platform drifts on the high country around. Again the pebble-beds which lie at the base of the deposits of the "Trou des Nutons" and the "Trou de Naulette" do not appear to me to have a marine aspect, they have the arrangement of an old river shingle. My own impression is that this shingle was derived from the platform drifts on the upper surface of the country, and was washed into the caverns by the agency of the underground streams which opened out into the valley of the ancient Lesse. This is supported by the evidence of the animal remains found in the basement deposits. Remains of the *beaver* were found by Dr. Dupont, and this testifies more to freshwater conditions than marine. Again we believe that the "Loëss," or stratified clay and silt which contained the human jaw and mammalian bones, is a *fluviatile silt,* the deposit of waters which once swept into or through the caves before those relative changes of land and water level were brought about, which caused the floodings by turbid waters to cease, and the floor of the caves to become dry land, and the stalagmite to gather above the human and animal relics with its encrusting seal.

Altogether we believe the history of the cavern deposits on the Lesse to belong to that *ancient river history* which geologists now comprehend as the period of the *low-level drifts* of Mr. Prestwich; a period when, as we know, in this country, climatal adaptations, and many of the animals of the period, were very different from the present. Since that period the great mammalia which once inhabited Europe have become extinct, and all our rivers, like the river Lesse, flow in deeper hollows excavated in the hard strata which forms the bottom of their valley.

We consider the drift phenomena of the caverns on the Lesse to bear the same relation to the existing physical condition of the country as our old Severn and Avon *low-level valley drifts* bear to the existing rivers, their silted up lakes and alluvial plains. We see no reason for attributing a more ancient history to the human remains of the "Trou de Naulette," than to the numerous other examples given by Sir Charles Lyell in his "Antiquity of Man," where human bones, or human implements, have been found in cavern deposits associated with the remains of the extinct animals.

The principal interest attached to the caves on the Lesse is owing to the great number of human relics that have been found there; and I may here observe, that the particular cave, in which the very remarkable jaw was found, lying close by the bones of the rhinoceros, is considered by Dr. Dupont to have been a den of the hyæna, for here were found the coprolites of that animal, and also a considerable number of gnawed bones of elephant and other animals. The rhinoceros bone in question presents strong marks of the hyæna's canines.

CORRESPONDENCE.

RIVER-DENUDATION OF VALLEYS.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—The attempt of Mr. Green, in the November number of the MAGAZINE, to render ridiculous my explanation of the physical facts connected with the valleys of Lancashire and Yorkshire, which facts he allows I have accurately given, will scarcely be acknowledged as a fair way of meeting my arguments.

My views—which I advanced with diffidence—may be erroneous, and whenever they are shown to be so on physical grounds, I am ready to abandon them; but, as it seems to me, the attempt of my colleague to prove them *illogical* has only resulted in exposing himself to the charge of being still more illogical, and of mis-stating my argument.

Taking the case of Todmorden valley, he puts my argument thus:

"We know that Jones, heavily shod, etc., has often been seen in the neighbourhood of what is now the vale of Todmorden.

"We do not know for certain that any stream has run through this valley.

"It is, therefore, less incredible that the valley should have been excavated by Jones than that it should have been hollowed out by a stream."

Now, Sir, if Mr. Green had put "cart wheels," in place of the name for which I have substituted "Jones," I think it would have been still less incredible, etc. But the above is an intentional misrepresentation of my argument altogether. "Jones" does not happen to be an agent of denudation in the geological sense, at least; but on this my reasoning hangs.

What I stated was this,—that of two acknowledged agents of denudation, the sea on the one hand, and streams, etc., on the other, we have positive proof that the former overspread the region of Todmorden valley, and we have no evidence of the latter, *therefore* "it is less incredible," etc.

To conclude, Sir, I think it would conduce more to the advance of science if discussions of this kind were confined to the region of physics; attempts at proving, or disproving, the soundness of speculations on natural phenomena by a logical syllogism are, as it appears to me, scarcely creditable to men of science.

I remain, yours faithfully,

EDWARD HULL.

MANCHESTER,
16*th November*, 1866.

PRE-HISTORIC DWELLINGS IN GALWAY BAY.

To the Editor of the GEOLOGICAL MAGAZINE.

DEAR SIR,—I have just learned from the Rev. W. Kilbride, vicar of the Aran Isles, at the mouth of Galway Bay, that he and my old college chum, Capt. Rowan, of Tralee, have discovered on the large island, under the Sand-dunes south of Tramore (*anglicè*, the large strand), and extending from them seaward below high-water mark, ancient habitations, consisting of Cloghauns, Fosleac, Kitchen-middens, etc., etc. This ought to prove that the land about Galway Bay has sunk last, not risen. If this is the case, "The Old Lake" mentioned in the paper "On the Rock Basin of Lough Corrib," in the GEOLOGICAL MAGAZINE for November, may have been partly formed since the Glacial period. The bogs now below high-water mark may also have been formed on high land; but still the fact remains, that the morass between Black-rock and Black's-hill, in which peat is forming and trees growing, is below high-water mark.

G. HENRY KINAHAN.

RECESS, CONNEMARA,
Nov. 10, 1866.

THE DENUDATION OF THE WEALD.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—In the last number of the GEOLOGICAL MAGAZINE, (p. 484), the Rev. O. Fisher mentions our paper on the Medway Gravels and the Denudation of the Weald;[1] and after saying that we "rely much upon a river gravel at an elevation of 300 feet," he adds, "I do not

[1] Quart. Journ. Geol. Soc., 1865, Vol. xxi., p. 443.

know the locality; but does it follow that because the river has once flowed at a higher level, therefore the subsequent degradation of the surface is the work of the river?"

Without discussing Mr. Fisher's views at length, we would beg to call his attention in the present instance to the fact that between the gravel at the 300-feet level and the present river, there exist enormous deposits of gravel and brick-earth at all intermediate heights. From this we infer, as we stated in our paper, "that the river deepened its bed gradually, and that since the Medway flowed at the 300-feet level, no agents except rain and rivers (and possibly river ice) can have been working at the denudation of the rocks contained within the basin of the Medway" (p. 464). During the time that this was going on, at all events, the valley could not have been excavated by an ice-sheet, although several facts mentioned by us point to the existence of ice, but on a much smaller scale than what is suggested by Mr. Fisher, and with different results. (See pp. 458, 465, 469.)

Your obedient servants,

WILLIAM TOPLEY, CLEMENT LE NEVE FOSTER,
GEOLOGICAL SURVEY OFFICE, BREAGE, NEAR HELSTON, CORNWALL.
Nov. 10, 1866.

ON FAULTS IN THE DRIFT-GRAVEL AT HITCHIN.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—In the last number of the Quarterly Journal of the Geological Society there is a paper by Mr. Salter, on some faults in the Drift Gravel at Hitchin, in which the author has expressed himself I think rather more decidedly than the facts of the case warrant.

Mr. Salter mentions two sections: The first is seen in a large chalk-pit immediately to the south of the Hitchin Station, and shows Chalk capped by a mixed mass of gravel, sand, clay and brick earth. As far as I could make anything out of this confused mass, the different members seemed to lie in lenticular-shaped beds, and not to have any definite order of super-position; indeed, I could neither here nor elsewhere in Herts. and Buckinghamshire establish any subdivisions among the drifts that were of the least value, and came at last to put the whole together under the comprehensive name of Boulder-beds. To return to the section: these Boulder-beds rest on a very uneven surface of Chalk, and my impression was, that the inequalities at the junction had been produced by denudation, or by water percolating through the gravel; and, though I paid several visits to the spot, I never saw anything that looked to me like a fault. Far be it from me to deny there are faults, but I do think that, if they had been as palpable as Mr. Salter represents them to be, they would not have escaped my notice. With regard to the other section, close to a bridge, crossing the railway a little further to the south, I dare speak more positively, for I feel almost certain that the gravel here lies in a large pipe in the Chalk. Do the other faults affecting the Drift, of which we hear from time to time, rest on such evidence as this?

I am, Sir, your obedient servant,

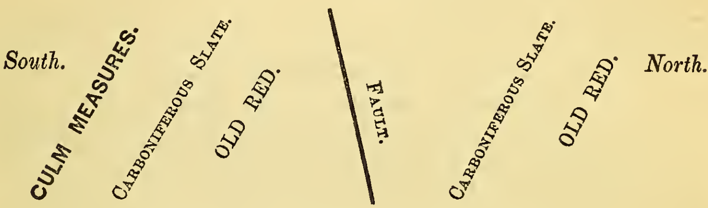
A. H. GREEN.

116, DODSWORTH ROAD, BARNSLEY. *Nov.* 16*th*, 1866.

PROFESSOR JUKES ON THE DEVONIAN ROCKS.

To the Editor of the Geological Magazine.

Sir,—In his recent communication to the Geological Society, on November 7th, Professor Jukes argues that the rocks of North Devon are identical with the Carboniferous and Old Red Sandstone rocks of the South of Ireland. His conclusions seem to be mainly based upon great lithological similarity, and are strongly contested by English Geologists, chiefly upon palæontological grounds. It is admitted by both sides that the Devonshire rocks from the Culm Measures northwards, dip steadily to the south, but the large thickness thus represented is, according to Professor Jukes' view, reduced by a great east and west fault along the strike allowing the northern portion of the rocks to sink upon that side, and causing a belt of Old Red Sandstone to make its appearance crossing the country along with it, and producing the following order of succession :—



His opponents deny the existence of the fault, and look upon the whole as a regular sequence of Devonian (or Old Red) rocks, with successive fossiliferous zones passing upwards into the Culm Measures.

Mr. Jukes' idea, if we mistake not, has been to a certain extent, in one way or another, long since advocated by some Irish Geologists, who have held that plant-bearing beds in North Devon had representatives in the Irish Old Red Sandstone, or at least that the Devonian rocks of that district, and a large portion of the Irish Old Red, both belonged to the obsolete Greywacke formation. At all events, whether the difference between the fossils of these English and Irish areas be sufficient to establish a difference in their Geological nomenclature, or not, it must be remembered that the rocks of both districts having a somewhat similar general strike, and a strong lithological resemblance, are geographically so situated as to have been apparently once connected, although the organic remains on each side of the Channel differ more than might have been expected from the aspect of the rocks.—Yours truly,

London, *Nov*, 9, 1866. ए ब वीन.

GLACIATION IN DEVON AND ITS BORDERS.

To the Editor of the Geological Magazine.

Sir,—The Rev. O. Fisher, in his article on "The Probable Glacial Origin of Certain Phenomena of Denudation," which appears in your current number, says, "Mr. Jukes has described Glacial Striæ in Devonshire;" referring, of course, to the letter by that Geologist, which appeared in the GEOLOGICAL MAGAZINE in October, 1865.

Being quite inclined to believe in "the existence of land-ice at comparatively recent geological periods, even in the south of England," and delighted at the prospect of a fact so confirmatory, I took an early opportunity, in company with Mr. W. Vicary, F.G.S., of Exeter, of visiting the valley of the Exe, for the purpose of carefully studying the mouldings and striæ alluded to.

We found that, so far as it goes, Mr. Jukes' description is very correct and, indeed, graphic; but we found also that he could not have seen anything like all the facts. In short, we were fully satisfied that the mouldings were not produced by any kind of ice action.

Yours, &c.,

WM. PENGELLY.

TORQUAY, *November 8th*, 1866.

ICE-MARKS ON THE MENDIP HILLS.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—While lately comparing the forms of cliffs and rocks among the Mendip Hills with phenomena now produced by oceanic waves and currents, I saw, in the midst of an assemblage of perforated rocks, two stones, one of which (Fig. 1) did not seem altogether like any rock-surface I have yet noticed on the sea-coast. This stone is between two and three feet in diameter, and appears to be a looser and somewhat displaced portion of the underlying Mountain-limestone strata.

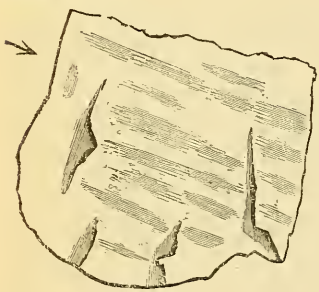


FIG. 1.

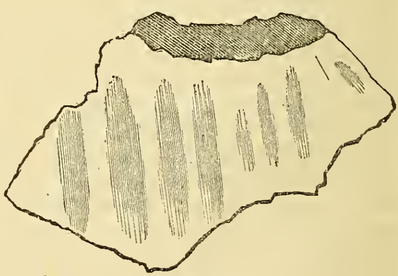


FIG. 2.

The marks seem as if they had been forcibly grooved out in the direction of the arrow by a cause preserving a nearly uniform level and direction. The face of the stone now dips in the direction of the darker marks, which look like shallow cracks enlarged by water. The spot is near the summit of the hill to the north of Axbridge; and from the Shute-shelf road several footpaths lead to it through a wood. Considering the great interest ice-marks are now exciting in Britain, Ireland, and Scandinavia, I lose no time in sending you the above rough sketches.[1]

D. MACKINTOSH.

TAUNTON.

P.S.—I see the Rev. O. Fisher, in your last number, has arrived at a conclusion in support of which I have been collecting facts during the last eighteen months, namely, that the superficial angular debris, earth, and loam, from which our slopes and hills partly derive their smooth and rounded forms, is not principally a disintegration *in situ*, but has been *carried or driven along* by a simultaneously *wide-spread* agency,

---

MARINE DENUDATION AND TIDAL CURRENTS.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—Without wishing to unduly prolong the discussion on this subject, which has recently occupied so much of your space, may I briefly notice a point in the letter of my friend, Mr. Mackintosh, in which, I think, he seems to reverse the order of cause and effect? Admitting the influence which the form of the coast-line has on the direction and localization of tidal currents, the difficulty on the marine theory, still remains unexplained, as to the original excavation of these inlets and channels, before they could determine the direction of the eroding sea-line.

The phenomena exhibited in shallow seas in the constant shifting of sand- and mud-banks, and the ploughing up and re-deposition of matter, such as is now going on in the German Ocean, and is so well exemplified in both the internal structure and surface-contour of much of the marine drift, seem to afford the strongest evidence of the changeable character and want of local persistency of small marine currents,

As regards deep seas, the difficulty in accounting for the marine excavation of continuous valleys, may be briefly stated thus: If the whole was done simultaneously, it would involve—in the case of many of the Swiss valleys—(having a range of altitude of 7000 or 8000 feet)—a depth of action far beyond what is known to be the lower limit of marine currents; and if progressively by coast action, a persistency of position which seems incompatible with the entire change of contour during emergence or submergence, to an extent equal to the range of altitude of the valley.

A friend, who has recently been in Norway, informs me that the Fjords invariably terminate in a valley; admitting that the cliff-girt sides of the Fjords are the result of marine erosion, does it not seem more probable that this was superadded to a previously existing subaërial valley, than that the junction of the Fjord with the valley prolongation was a matter of accidental coincidence? And if the

[1] Fig. 2 is very regularly grooved, and the whole surface smoothed.

whole had been done by marine action, why does not the vertical cliff structure continue up the valley prolongation of the Fjord to the Norwegian watershed? Faithfully yours,

GEORGE MAW.

BENTHALL HALL, NEAR BROSELEY,
November 10th, 1866

DISCOVERY OF *AMPYX NUDUS* AT MALVERN.

In the November number of the GEOLOGICAL MAGAZINE, at p. 519, we stated that Mr. E. B. Kemp-Welch had informed us of the discovery of *Ampyx nudus* in the Woolhope Limestone, at Colwall, near Malvern. We stated that the specimen of *Ampyx* shown to us by Dr. Grindrod,—and supposed to be that discovered by Mr. Kemp-Welch—was manufactured, and in that opinion we are confirmed by our correspondent, Dr. Harvey B. Holl, F.G.S., of Elderslie House, Worcester, who says in a letter just received, "the specimen is composed of the tail of *Phacops Downingiæ;* the rest is artificial."

Having since been favoured with a letter from Miss Eyton, of Eyton, near Wellington, dated November 3rd, stating that she was present at the discovery of Mr. Kemp-Welch's *Ampyx*, and can testify to its genuineness; and having also been favoured with another letter from Mr. Kemp-Welch, dated from Poole, Dorset, 5th November, protesting against the condemnation of his interesting specimen, we cannot but imagine that the Trilobite discovered by Mr. Kemp-Welch has been mislaid by Dr. Grindrod, and that the supposed *Ampyx* examined by Dr. Holl and myself, is one of those manufactured specimens only too frequently sold to the unwary visitor to the Malvern and Dudley districts, and accidentally placed in the Doctor's Museum. "*Ampyx nudus*," says Dr. Holl, "has not hitherto been found in the Malvern district."—H. W.

OBITUARY.

WILLIAM HOPKINS, M.A., LL.D., F.R.S., F.G.S., so distinguished for his researches illustrative of the application of Mathematics and Physics to Geology, died in October last. We understand that for some time past his health had been gradually declining. He resigned in 1865, his fellowship of the Royal Society, to which he had been elected in 1837. In the Geological Society of London he filled the office of President, during the Sessions 1851-52, and 1852-53, previous to which, in 1850, he had received the Wollaston Medal from Sir Charles Lyell, who on that occasion, gave an outline of his principal geological researches. In 1854 he filled the office of President to the British Association at the Meeting at Hull, and held the same office in the Cambridge Philosophical Society, in which Transactions many of his most important papers were published. It is said, that he used to complain, that he could not get Geologists to understand his mathematics, nor Mathematicians to take an interest in his geology.

INDEX.

STEPHEN AUSTIN, PRINTER, HERTFORD.