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THE

GEOLOGICAL MAGAZINE.

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THE PAST AND PRESENT ASPECTS OF GEOLOGY.

By the Editor.

THE publication of the First Number of a new Journal of Geology seems a fit opportunity for noticing the present aspects of the Science, as compared with those it presented during the few principal epochs into which the short term of its existence may be divided; and also for contrasting the ideas that during each of those epochs guided the course of geological investigation, forming for the time, so to speak, the rudder of geological thought.

A retrospect of this sort, forming a kind of map of the country in which we are about to travel, will naturally lead us to consider that undercurrent of ideas which forms the philosophy of the Geology of the present day; and thus to sketch out, though perhaps somewhat indefinitely, the functions which this Journal may be expected to perform, and the present benefit to the Science which may result from its publication.

First attempts at the formation of a science have generally, perhaps always, consisted of sweeping hypotheses, meant to account for well-known, but not understood phenomena; and in Geology, even excluding the Cosmogonies, we all know that 'Theories of the Earth' were for a long time all that could be shown in proof that the mind of man had endeavoured to penetrate the mystery of the origin and formation of the planet on which he lived. Every one is familiar, also, with the proximate cause of these 'theories;' namely, the necessity of accounting for the occurrence of sea-shells at various levels above the sea; and undoubtedly the first step towards the formation of the Science of Geology was to establish the organic nature of such things. This having been admitted, the next great advance was made by Playfair and Von Buch, proving that the surface of the earth was subject to alterations of level. These two facts having been established, the evolution from them of the *Idea of Geological Change* became easy; although the popular and general belief that all the known phenomena had been produced by a universal deluge, long proved an obstacle to further progress. The last difficulty having at length been removed, chiefly through many fossils having been shown to belong to extinct species, the *Idea of*

Geological Time became at last familiar to the minds of Geologists. By means of these two ideas combined, men were able to discern the local succession of strata. We thus arrive at the first epoch of Systematic Geology—the beginning of the period of Werner and William Smith. At that time the characters considered distinctive of strata were mineralogical and stratigraphical, as the terms grauwacké, floetz-rocks, &c., indicate: organic remains being regarded as subsidiary, or more or less accidental, and usually called 'Extraneous Fossils,' a term that now has a widely different meaning, and to which William Smith was even then giving a new aspect, by showing the essential value to Geology of the objects included under it.

The close of this period was characterized in a far different manner, having been fruitful in controversy respecting the Wernerian and Huttonian hypotheses, as well as in philosophical discoveries and opinions, some of which have immortalized the name of the Father of English Geology (William Smith); while others have invested that of De Luc with a light that will not be extinguished.

Thus we may close the first era in the History of Geology—long in duration, and divided into a few great periods, in each of which the followers of our Science were occupied in discussing and establishing, one by one, some three or four propositions, which together now form the basis of our present knowledge. We have seen that the first great fact which was established—the organic nature of fossils—led immediately to the acceptance of the idea of *Geological Change*; this was succeeded by the rejection of the *diluvial dogma*, a conclusion which gave birth to the notion of *Geological Time*. The latter step was quickly followed by the detection of the local sequence of phenomena in different districts; and this, aided by William Smith's discovery, that *strata could be identified by organic remains*, led to the formation of a Systematic Geology, which, however, was at the time thrown into the background by the fierce controversy between the Wernerians and the Huttonians; but the *Idea of Contemporaneity* involved in that discovery survived the gloom, and shone forth all the brighter for its temporary obscurity.

We now come to a different stage in the History of Geology, which may be termed the Descriptive Period, and which was inaugurated by the formation of the Geological Society, and indeed chiefly caused by it. This stage is nearly coincident with the period over which the publication of the First Series of the Transactions of that Society extended; and is characterized by the absence of all attempts at theorizing, the necessary reaction consequent on the prevalence of hypothesis in the period that went immediately before it.

This was succeeded by the Second Classificatory Stage, coinciding in duration, roughly, with that over which the publication of the Second Series of the Transactions of the Geological Society extend, and which differs from the former Classificatory Stage chiefly in the fact that, while that was Mineralogical in character, this was Palæontological, or occupied with Fossils. But in this period we have also a revival of Theory, for, as Dr. Whewell has remarked, 'conjectures and reasonings respecting the causes of the phenomena force themselves upon us at every step, and even influence our classification and nomenclature.' The particular theory, of a general nature, which then occupied the minds of Geologists was that of the Uniformity of Geological Causes, commonly called the 'Doctrine of Uniformity;' and, although there must have been a beginning when the causes in operation were different in degree (if not in kind) from those now in action, yet we may consider the doctrine to be probably true for that portion of time represented by the stratified and metamorphic rocks (being, indeed, all with which Geology has properly to deal); thus we may legitimately add the *Idea of Uniformity* (which we owe to Hutton and Sir Charles Lyell) to those other ideas to which we have already alluded.

We now come to the present epoch in the History of the Science. It will be seen that during the first stages of that history Geologists had mainly but one or two great objects in view; but in what we have termed the Second Classificatory Stage, although we have cited but one great event as characteristic of the period, yet at the same time many men occupied themselves in ascertaining the causes of local phenomena. Such theories as they put forth are perfectly legitimate; and such theorists have increased in number and importance during the present period. Nevertheless our Science is eclectic, and has been so since the formation of the Geological Society. One of the greatest benefits to the Science produced by that event was, indeed, the impression of this eclectic character upon legitimate geological investigation. Prior to the formation of that body every hypothesis, however crude and wild, was considered legitimate, because there was no code of philosophical laws by which it could be tried; but the uncompromising exclusion of hypothetical memoirs from the publications and meetings of the Society was the means of causing a broad sharp line of demarcation to be drawn between the legitimate and the unphilosophical.

The establishment of the Idea of Uniformity wrought, however, another change, as it enlarged the field of geological research. Through it theories were considered legitimate that did not require other causes than those seen now in action; but there has long been a tendency to encroach even upon this widened boundary. This is only what could have been predicted; for, in proportion as our knowledge increases, so does our ability to theorize. It is now rightly considered legitimate to call in the agency of forces which, though not seen in operation in nature, may be evoked in the laboratory; and we thus seem to be in a fair way of obtaining an insight into the causes of some of the most obscure physical phenomena.

These attempts to enlarge the legitimate field of geological investigation may, therefore, be considered to have been attended with results beneficial to the Science; and instead of the single line of research of a century ago, we have now a perfect labyrinth, each path being an avenue of thought paved with its fundamental ideas, and supported and lined by the facts that have been accumulated by Geologists during the last fifty years.

The present epoch in the history of Geology may also be said to be characterized to some extent by scepticism as to the exact truth of at least one of the fundamental principles to which we have alluded, namely, the contemporaneity of strata which contain the same or similar fossils, and which are geographically far apart. The late Professor Edward Forbes was the first to cast doubt on the general belief, and his opinions have been recently reiterated in a more or less modified form by several other geologists. Moreover there is a general tone of wholesome scepticism respecting other matters, noticeable in recent geological works; especially as regards the simplicity of several phenomena, which are thus apparently being shown to be much more complex than has been supposed, whilst some few others are being proved to be more simple.

Sufficient illustration of this scepticism will be found in the recent discussions respecting the origin of granite; the mode of formation of river-valleys; the excavation of lake-basins; the doctrine of 'homotaxis;' and the origin of species.

Discussions on Geological questions have been perhaps at no time so rife as at present, if we except the period when the various Theories of the Earth and the rival hypotheses of Werner and Hutton attracted universal attention. Thus our Journal makes its appearance at an opportune moment, when matters of vital importance to Geology are occupying the attention of our most able philosophers; when the links which connect our science to archæology, chemistry, and biology are being every day strengthened; and especially when the border-land (hitherto considered a desert) between the two sciences of ancient history—geology and archæology—is being traversed more and more frequently by the geologist and the antiquary, and is being cultivated and cleared by them, each on his own side, until finally there will be none but a conventional line of separation between the two great chapters in the history of the world and its inhabitants.

This Journal being exclusively, though broadly, Geological, our readers may reasonably expect that in its pages will be found good and reliable information upon most current topics relating to the Science, together with original memoirs, such as it contains in this its first number. Guided by the principles already alluded to in distinguishing loose speculations from true theory, we shall endeavour to select such memoirs as contain the results of enquiries into geological truths, facts, or theories; and such as exemplify the processes by which such enquiries have been carried out. In this manner, by taking a broad and firm grasp of all Geology, and excluding cosmogony, we hope to make our Journal perform the function we have described; and by getting the best work from the best men, we expect to ensure for it that measure of success which, as the only public Journal of Geology in Great Britain, it ought to obtain. Finally, by favouring no one school or theory more than another, criticizing fearlessly and uncompromisingly where it appears necessary, though laudatory where it is desirable, we hope to establish for the GEOLOGICAL MAGAZINE that independent character which will alone cause it to be regarded as an impartial tribunal, whose verdict will command respect by reason of its justice.

ORIGINAL ARTICLES.

I. On some Points in Ancient Physical Geography, illustrated by Fossils from a Pebble-Bed at Budleigh Salterton, Devonshire.

By J. W. Salter, F.G.S., A.L.S.

INTRODUCTION.—The contents of a Geological Journal form as miscellaneous a series as can well be imagined. In its pages all kinds of subjects meet the eye together: the analysis of an obscure mineral on one page; the correction of a stratigraphical error on another: here is a fresh reading of an old text; and there an uninviting catalogue with synonyms. Occasionally the Journal looks like the note-book of a naturalist; and the affinities of a genus, the migrations of species, and the 'theory of descent with modification,' are discussed with zealous care: and then, again, we get back to the old times and old subjects of geological thought; and Werner and Berzelius, and their followers, have it for a season all their own way. There is nothing to complain of in all this: it is just what it ought to be; for it shows how wide our subject-matter is. 'The earth and all that is therein'— that is surely wide enough; nor will pen, pencil, or graver, till the end of time, have done with it. It is not one of the least of the charms of our comprehensive science, that every one may add something to its stores. A sea-side walk, with a hammer in the pocket, may discover a new world by accident; for, as Darwin, Lyell, and Ramsay have told us, the unrepresented past times have been *far greater* than those of which we have a geological record, and fragments of the missing pages may turn up at any time.

It is hard to realize this, no doubt. If formations seem to be continuous, and are perfectly parallel to one another, it is hard to have to question every conclusion as it arises, and much more easy to say, 'there is a complete passage from stratum to stratum here.' Yet every now and then we alight upon new geological kingdoms; and still oftener on new provinces of old and well-established ones. An obscure, but novel, group of organic remains comes to light in some well-worked district, for which we have as yet no fixed geological place. Then the bed containing it is found to have a more extended range; it begins to be recognized by a local name; and, after undergoing the usual ordeal of doubt and disbelief attached to a new-comer, and being variously assigned as a local variation of some better-known *stratum*, it settles at length into its rightful position, and secures its hold of the public. And when this is done, we find it is no stranger after all,—that some twenty or thirty feet of shales, for instance, packed in with the base of our Lias, are really the representative of some great Alpine Limestones, which range from the Tyrol to the sources of the Ganges, and which are only not as important as the Dudley Limestone because they have been as yet less studied and described. The history of the Lower Lias and Upper New Red Sandstone for the last fifteen or twenty years may well make us believe, that, 'when the geology of a country is done, that is the time to begin it.' The 'Quebec group' in North America is another example of the same kind.

And so, as we do not know the real value of any new fact, we gladly welcome all; and, while we look with respect on complete monographs, systems of mountain-structure, and theories of internal heat, we feel no misgiving about small additions to our accepted data: they are always welcome, like the faces of fresh children at a feast; 'the more the merrier.'

Pebble-bed in the New Red Sandstone at Budleigh Salterton: the Derivation of the Pebbles from Silurian Strata, and the Geographical Conditions under which the Pebble-bed was formed. —For half a century and more the roadways in the South of Devon have been mended largely from the hard round pebbles of the shore under Budleigh Salterton, and from the conglomerate seen there in the cliff. A bed, one hundred feet thick, of quartzose pebbles, was not a thing to be neglected in a country of slate and marl, of watery atmosphere, and deep miry ways. Exeter has found these pebbles admirably suited to her wants; and the men who break them have learned the value of the 'cockles' and 'butterflies' within. It is only lately, however, that the contents have been critically examined; Mr. W. Vicary, of Exeter, leading the way, in a memoir, about to be published by the Geological Society, descriptive of the range and extent of the pebble-bed. Some thirty species of fossils have been already detected; all of them, without exception, being new to British geology.

I need not go into details, which will be given by Mr. Vicary and myself in the forthcoming No. of the Geological Journal; but I would call attention to the fact, that here, in a limited range of country, a single bed, not hitherto explored, has been found to contain a wholly new group of fossils — a fauna new to Britain, and of which we only find the parallel by crossing to the shores of France. It may be the Caradoc Sandstone under a new aspect; it may possibly represent an upper portion of the Llandeilo Flags; or lastly, though not quite as likely, it may be of the age of our Lower Llandovery rocks, —a formation of which, by the bye, we know very little indeed as yet. Between these limits (Llandeilo and Llandovery beds), the new formation must be placed; but for the present we can get no nearer to its actual horizon.

There is little doubt, that, while our Lower Silurian rocks (Llandeilo and Caradoc) were being deposited in the British area, a broad barrier separated their sea from that in which the contemporaneous French formations were accumulated, as Mr. Godwin-Austen has already shewn.* We know this, not only by the character of the rocks themselves, which indicate, on one side of this old barrier at least, that shingle-banks and sand-banks were accumulated, as along a coast-line; but the fossils alone would tell the same tale. There are abundant *Lingulæ*, shells which now only live in shallow seas; and numerous Bivalves, allied to the Horse-mussel, which resemble most those found a little way below tide-marks; and great vertical burrows of Worms in the sandy beds speak plainly of sandy shores, and not of deep water.

All this might have been, and would be, compatible with the existence of scattered islets in the neighbourhood, while the seas might have been of continuous extent. The fact, however, that a wholly distinct fauna occupied the French area, while that of Wales and the Border Counties was filled with our own British types, is clearly not to be so explained. The dark earthy slates of Normandy are just like the dark slates of Wales; and, on comparing the fossil contents of the two regions, we find *kindred* species in both: but the Trilobites and Shells which crowd the famous slate-quarries of Angers are only *similar* to those of Llandeilo and Builth; they are not identical in any case. The shingle-banks and gravel-beds among these ancient beds of ooze contain similar, but not identical species on the two sides of the Channel. So of the quartzose rocks which overlie them, and which, as above said, may represent our Caradoc or our Llandovery sandstones (we know not which as yet); their fossils are not the same as those of our own area.

Subject no doubt to the same general movement of elevation which converted the bed of the deep 'Llandeilo' sea in Britain into shallows and bays during 'Caradoc' times, yet the Normandy area has barely a single fossil identical with those so widely spread over our own region; the Trilobites are different;

* Quart. Journ. Geol. Soc., vol. xii. p. 44, &c.

the Brachiopod and other Bivalve Shells are not the same; and, in order to identify them as belonging to one and the same period, we are compelled to the belief, strengthened as it is by many considerations, that a land-barrier of some extent, indented by bays and inlets, ran across in an east and west direction, separating what is now Wales from what is now the peninsula of the Cotentin and the promontory of Brest.* One or more of these inlets ran deep into the Cornish region, and another, doubtless, ranged up to the Exeter district. For we

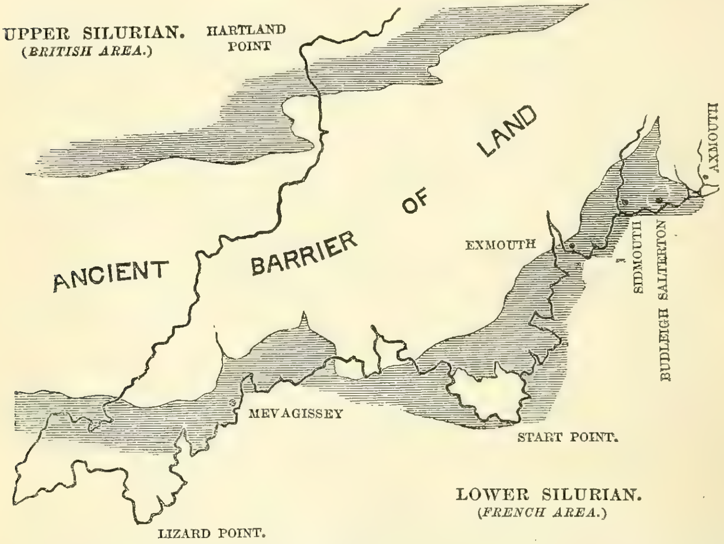

Fig. 1. Sketch-map of the Cornish and South-Devon region during the 'Lower Silurian' times.

find that the pebbles of Budleigh Salterton, now arranged in the New Red Sandstone, and originally derived from Silurian rocks, which could not be far off, contain French and not British species; not a shade of difference can be detected between the Silurian fossils from May and Jurques, near Caen (and some from Rennes), and those from the Devonshire beach.

There is yet more perfect evidence of this, which, as it has

* I do not know that the Welsh marine area extended so far south as in this sketch. Mr. Godwin-Austen draws the barrier along the line of the Bristol Channel (Quart. Journ. Geol. Soc., vol. xii. pl. 1); but the Llandeilo and Caradoc rocks of South Wales were certainly accumulated in tolerably deep water (the Caradoc especially so); so that the north shore of the barrier was probably further to the south than his sketch would lead us to suppose. The correction is comparatively trifling; the main point is the *existence* of this barrier-line of old land separating the northern from the southern sea.

not yet fully come to light, must be reserved for a future communication. There is a small Silurian district near Mevagissey and Veryan, in Cornwall, first made known by the collections of Mr. Peach, and afterwards traced in detail by Professor Sedgwick, and this seems to be the counterpart of the Normandy rocks, and to contain several of their characteristic fossils.* We are not yet in a position to affirm that these beds, at Gorran Haven and the headland of the Dodman, are identical with those which supplied the Budleigh Salterton pebbles; but at least they belonged to the same French group, and are wholly unlike the Silurian beds of Wales and the Border Counties. Yet the distance of these Cornish and Devon localities from the nearest point in Wales where Lower Silurian rocks are known, is not more than 90 miles; while they are 150 or 160 miles (in a north-west line) from the fossil-bearing localities in Normandy.

Fossils from the Old Pebbles at Budleigh Salterton.—The fossils found in the pebbles of the pebble-bed under notice will not be fully enumerated here. They consist chiefly of Trilobites, large Bivalve Shells, allied to *Modiola*, *Arca*, and *Nucula*, and Brachiopods, of the ordinary genera known to us in Silurian rocks. The Trilobites are well-known French species; so are some of the most conspicuous Bivalves, and the great *Lingulæ* and *Spiriferæ*, though not at all like anything in Wales or Westmoreland: some of them have been already described by the French geologists, and particularly by M. Marie Rouault, of Rennes. It will be of interest to our brother geologists of France to see the fossils long familiar to them through their own research (though few of them have yet been figured), illustrated from specimens gathered from the shore of Devonshire. Leaving the bulk of the fossils obtained from these interesting pebbles to be described in the Geological Society's Journal, I subjoin a description and figures of one or two Sea-weeds (?) from the collection of Mr. W. Vicary, and of a new Crustacean, from that of Mr. R. H. Valpy, of Ilfracombe.† The latter is of peculiar interest, and well worthy of further search being made for the missing portions of the body.

* A different conclusion might be drawn from the lists given by Prof. Sedgwick and M'Coy (Quart. Journ. Geol. Soc., vol. viii. p. 13); but all the specimens that I have seen are of species distinct from the British; and some, at least, unnoticed by M'Coy, are true French species—*Calymene Tristani*, for example.

† This specimen is now in the British Museum, having been presented to the Geological Department by the discoverer.

Silurian Plants (?) *from the Pebbles at Budleigh Salterton.*—As in our memoir in the Geological Society's Journal there will be no figures of these *Algæ* (they are doubtful things at the best, but appear to be singularly characteristic of certain Silurian beds in Europe and America), I give them here; and they may serve to stimulate collectors to pay attention to these obscure fossils until we know more of them.

M. Rouault, the indefatigable explorer of the Normandy palæozoic strata, has described a dozen species of two distinct genera of Fucoids from thence. One group, which he calls *Vexillum*, has palmate fronds, with a stem and a lateral rib; and this may well belong to the same group of organic bodies

Fig. 2. *Vexillum*; a fossil Fucoid from the pebbles at Budleigh Salterton. Nat. size.

as the celebrated *Cauda-galli* or 'cock-tails' of American geology; the name is a homely one, but is expressive enough. No vegetable matter accompanies these casts of fossils, which were probably allied to *Pavonia* or *Acetabularia* (if indeed they were vegetables at all); there is a fringed edge to some of the *Cauda-galli* casts, which favours this reference; and with regard to *Vexillum*, M. Rouault has described a regular transverse, as well as longitudinal, ridging in all his species.

Dædalus of that author appears to be a group of irregularly crisped and curled fronds, without a midrib; putting us in mind of the *Ulvæ* and *Enteromorphæ* of our sandy shores. I confess I am in doubt about these fossils; they seem so like congregrated ripple-marks, confused with surf-ripples, and perforated by worms. Crowded over one another in all directions, and occupying great tracts of surface, they are at all events worth notice, and may be truly, as their describer supposes, marine vegetables.

Fig. 2 represents a *Vexillum,* and fig. 3 a *Dædalus,* so far as I understand these genera. In a rough section made by abrasion of the pebble, and shown at the right hand of fig. 3, we

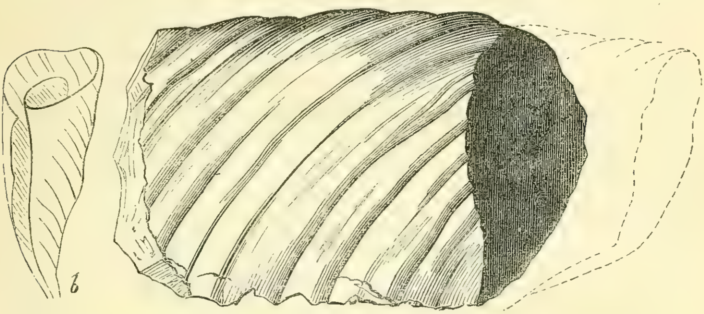

Fig. 3. *Dædalus*; a fossil Fucoid from the pebbles at Budleigh Salterton. Nat. size. *b* shows the probable shape of the entire frond.

see the incurved opposite surface of the cone or cup, for the frond was bent round much in the way a filter-paper is curved into a sugarloaf-shape (see the left-hand figure *b,* fig. 3). Neither apex nor base of the original cone is preserved; but in the section there is something like a decussating set of fibres, as if the walls had been held together by plates of cellular tissue. The oblique surface-ridges are far too regular to be accidental; but if I were obliged to choose between assigning to this group of fossils a vegetable origin, and considering them due to the movements of an animal in the sabulous matrix, I should be reluctant to deny the latter alternative.

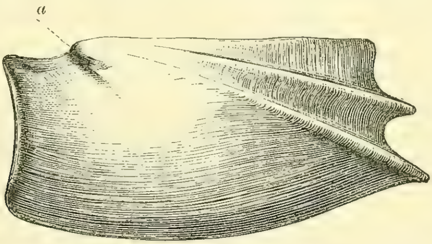

Fig. 4. Interior cast of the left carapace-valve of *Myocaris Lutraria,* from a pebble of Silurian Sandstone at Budleigh Salterton. Nat. size.

Myocaris Lutraria, new genus and species.—We have only the interior cast (in hard sandstone) of a single carapace-valve, which is transversely oblong, with square angles at back and front, $2\frac{1}{2}$ inches long, and more than an inch wide beneath the beak, which is abruptly prominent, and placed at the anterior fifth. In front and beneath the beak (fig. 4, *a*) a rather strong cervical ridge runs obliquely for a third of an inch; and behind the beak two strong ridges, terminating on the posterior margin in projecting spines, run down the posterior slope. Above these the posterior upper angle is perfectly square; beneath them the lower edge is strongly emarginate; the ventral margin arched; and the anterior angles both abrupt and square (the upper one even acute), from the deep emargination which truncates the whole anterior side. Surface marked with concentric ridges, not very closely placed, nor very distinct in all parts.

Though we have but a single valve of this curious fossil, it must not be neglected. It is strongly characterized; and in every part it seems to have the characters of the genus *Ceratiocaris* exaggerated. The subcardinal ridge is so much stronger than in any species of *Ceratiocaris* I am acquainted with, that I am compelled to give a new name.

I am indebted to R. H. Valpy, Esq., F.G.S., of Ilfracombe, for acquaintance with this fossil. He found it some time ago in the pebbles, on the banks of the Otter, and suggests the trivial name. It is not unlike a Bivalve Shell. Mr. Henry Woodward made the drawing from which our woodcut is executed, and I am indebted to him for again calling my attention to the specimen.

Ribeiria pholadiformis, Sharpe, Quart. Journ. Geol. Soc., vol. ix. pl. 9, fig. 17, may very possibly be a Crustacean of this group, with a remarkably thickened dorsal region and strong interior cervical ridge. It has been variously assigned to the *Anatinidæ,* among Bivalves, and the *Calyptræidæ,* among Univalves, neither of which groups seems very fit to receive it. I do not think we have quite got at the true affinity yet; but suggest the above, the more willingly in this place, as *Ribeiria* is a characteristic member of the mid-European Silurian fauna to which the Normandy fossils and the contents of the pebbles at Budleigh Salterton belong.

On the Recent and Tertiary Species of the Genus Thecidium.

By Thomas Davidson, F.R.S., F.G.S., &c.

THE object of the present communication is to review and compare the characters of the Tertiary and Recent species of *Thecidium,* the true characters of which have been discovered only within the last few years. The genus was first named

Thecidea by Defrance* in 1821, and corrected into *Thecidium* by George Sowerby† in 1823.

The shells of this genus are all small, none of the many species at present known being more than three-fourths of an inch either in length or breadth. Their shape is very varied, and they have existed from the Triassic period up to the present time. A single species only has been described from the Trias. The Jurassic forms are numerous, and have been fully described and illustrated by M. E. E. Deslongchamps,‡ Mr. C. Moore,‖ and myself.§ The Cretaceous forms have likewise been admirably described and figured by M. Bosquet,¶ Professor Suess,** and others; but the Tertiary forms have not hitherto received that full attention they deserve. The recent *Thecidium Mediterraneum* has been figured by several naturalists; and it is to M. Lacaze Duthiers that we are indebted for the most complete description of the animal we at present possess.†† It may, however, be as well to observe that nine years prior to M. Duthiers' researches, Mr. S. P. Woodward and myself had published an enlarged illustration of the interior of the dorsal valve, accompanied by the following explanation: '*Thecidium* has a calcareous loop, folded into two or more lobes, lying in hollows of corresponding form, excavated in the substance of the smaller valve. This loop, or apophysary ridge, supports the brachial membrane, whose thickened and ciliated (cirrated) margin is apparently attached to the inner sides of the grooves. The cilia (cirri) are very long, especially the outer series, which are directed inwards in the dried specimens.'‡‡ We were thus moreover enabled to show that D'Orbigny's supposition that *Thecidium* was unprovided with 'oral arms' was erroneous, and that consequently his term 'Abrachiopodes' could not be admitted.

The interior arrangements of the smaller or dorsal valve

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* Defr. in Fér. Tabl. Syst., 38, 1821. See also De Blainville, Manual Malac., 516, 629, 1825; Dict. Sc. Nat. liii., 1828; and Risso, Europe Mérid., 393, 1826.

† Genera of Recent and Fossil Shells. 1820–24.

‡ Mémoires de la Société Linnéenne de Normandie, vol. ix., 1853, and vol. x., 1855.

‖ Proceedings of the Somersetshire Archæological and Natural History Society, 1854. See also 'Geologist,' vol. iv. p. 193, pl. ii. 1861.

§ A Monograph of British Jurassic Brachiopoda, 1851.

¶ Monographie des Brachiopodes fossiles du Terrain Crétacé supérieur du Duché de Limbourg, 1859.

** Ueber die Brachial-Vorrichtung bei Thecidium, 1853; Sitzungsber. Akademie der Wissenschaften, vol. xi. p. 991.

†† Histoire Naturelle des Brachiopodes vivants de la Mediterranée, Annales des Sciences Naturelles, 4e Sec. Zool., vol. xv., 1861.

‡‡ Annals and Mag. Nat. Hist., 2nd series, vol. ix., May, 1852, p. 374; and Manual of the Mollusca, by S. P. Woodward, p. 221, 1856.

are extremely variable in the different species composing the genus; in some they are very complicated, while in others they are comparatively simple; but it is not the object of the present communication to review the whole genus, or to give a description of its many and varied species, these details having been published in the admirably illustrated memoirs already named; we will therefore at once proceed with the description of the two recent species, so as to be able afterwards to establish a comparison between them and the Tertiary forms hitherto discovered.

Thecidium Mediterraneum, *Risso*. Pl. I., figs. 1, 2, 3; and Pl. II., figs. 5 to 10. *Thecidea Spondylea*, Sacchi.—In external form this small shell is somewhat pyriformly ovate, very variable in shape, and in life it is attached to marine objects by a portion of the back of its beak. The dorsal or smaller valve is thin, semicircular, and slightly convex at the umbone, flattened near the margin; the hinge-line is straight and shorter than the breadth of the shell, a small triangular hinge-area being likewise observable. The ventral or larger valve is more or less regularly pyriform, very convex, thickened, and somewhat depressed longitudinally along the middle. The beak is much produced, callous, and, when well shaped, triangular; but more often somewhat irregular, on account of the position and extent of its attached surface. The area is large, triangular, and flat, with a slightly elevated, but flattened deltidium. Shell-structure punctate. The interior arrangements have been already described by several naturalists, but a glance at the accompanying illustrations will convey to the reader's mind a much clearer impression than words could effect. In the interior of the *dorsal valve* an oblong or squarish concave, prominent, cardinal process exists between the dental sockets (Pl. I. fig. 2, m); and outside of each of the socket-depressions is seen an oval muscular scar (w), which M. Duthiers attributes to his 'lateral adductor muscles' ('adjustors' of Hancock). A broad, thickened, sloping, granulated margin encircles the valve, and forms a bridge (h) over the small, deep, visceral cavity, and close to the basis of the cardinal process. The granulations are larger and most prominent as they recede from the outer margin. This inner denticulated or granulated margin follows in a parallel manner the margin of the shell from the bridge-shaped process (h), until it reaches near to the middle of the front at c, where it suddenly stops to become inflected upwards. At the point c the inner margin is again directed upwards, producing a second parallel curve, when at e, by another downward curve, it forms a third short parallel concave curve, until reaching the point (f) near the centre of the valve, where it combines with the similar inflections of the other half of the shell, so as to produce, on the median line, an upwardly produced tongue-shaped process (g), the angular extremity of which is directed towards the middle of the bridge-shaped process (h). These four symmetrically bent ridges or lobes constitute M. E. E. Deslongchamps' 'ascending apparatus,' the central portion (F and G) being likewise more elevated than the other parts, and overlie a portion of the visceral cavity.

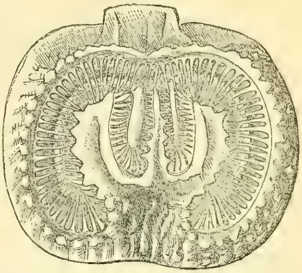
The parallel grooves, or spaces left between the ridges above described, are partially occupied by a lamella, in the shape of a double crescent (*i* and *k*), of which the larger branches (*i*) partly occupy the large cavities left between the first and second ridges; these being on their inner sides intimately united with the sides of the grooves; while the shorter branches (*k*) are freely suspended over the visceral cavity and occupy the spaces left between the third and fourth ridges of the ascending apparatus. To these crescent-shaped lamellæ M. E. E. Deslongchamps has given the name of 'descending apparatus.'

The interior of the *ventral valve* is concave and deep, with a small, longitudinal, rounded, mesial elevation; the hinge-line is straight, and on either side at the base of the deltidium are situated strong hinge-teeth for the articulation of the valves. The beak is hollow, but there exists on the median line, and far back in the cavity, a small elevated septum, to each of the sides of which is attached a very thin small concave plate (Pl. I. fig. 3 *b*), to which, according to M. Duthiers, the adductor muscle, or 'occlusor' of Hancock, was attached. On the bottom of the valve, a little lower down, and on either side of the mesial elevation, and partly under the cavity of the beak, a large pyriform scar is observable, to which the 'divaricator muscles' of Hancock were attached (*c*); and, lastly, outside of these on the bottom of the valve, and near the angles of the hinge-line, there exists a small oval scar (*a*), which is believed to have been produced by the 'ventral adjustor' of Hancock. The whole remaining surface of the interior of the shell is closely covered with numerous granulations or asperities.

Such are the principal shell-characters of the recent *Thecidium Mediterraneum*; and, although the comparisons we shall shortly endeavour to establish between these and the fossil species cannot extend to the animal itself, it will be as well to refer to some few observations upon the subject, especially in relation to the muscles, mantle, and oral arms, which we will in a great measure extract from M. Lacaze Duthiers' interesting memoir, as these details cannot fail to prove of interest to Palæontologists, and have not yet been alluded to in any English work.

Relative to the *muscles*, M. Duthiers informs us that there are three pairs, six muscles in all, possessing distinct directions and functions. Of these six muscles, two (Pl. II. figs. 7, 8, 9, *a*) are lateral, short, wide, and easily observable, and serve without doubt for the occlusion of the shell. These are M. Duthiers' 'muscles adducteurs lateraux ou externes,' and which, Mr. Hancock informs me, would represent his 'adjustors,' but that the function of this pair of muscles does not appear to be exactly similar to the 'adjustors' of *Waldheimia*, in which they move the shell upon the pedicle; for in *Thecidium* they assist at once in closing the valves, and in preventing any irregular or lateral movements, which, from the central position of the occlusors, might be liable to take place. In fact, he believes that the function of the 'adjustors' in *Thecidium* is modified much as it is in the same muscles of *Lingula*; and he is therefore inclined to conjecture that the two valves of the former are not so firmly hinged as they are in the other articulated forms. The second pair (*b* of the figures already named) are those nearest to the median line ; these are termed 'muscles adducteurs internes' by M. Duthiers, and correspond with, or are equivalent to, Mr. Hancock's 'anterior and posterior occlusors.' In the *ventral valve* these muscles would be fixed to the bottom of the valve, nearly under the extremity of the tongue-shaped 'ascending shelly process' already described, and be again attached to the two thin shelly processes (Pl. I. fig. 3, *b*) which we have described as existing in the cavity of the beak. The function of these muscles (as stated by M. Duthiers) would also be to effect a closing of the valves, but less efficaciously than the preceding pair. The third pair, which M. Duthiers designates 'muscles abducteurs' (Pl. II. figs. 7, 8, 9, *c*), are Mr. Hancock's 'divaricators,' and their function would be to open the valves. They form large impressions on the bottom of the ventral valve, on either side of the central septum (Pl. I. fig. 3, *c*), and have their other end attached to the extremity of the cardinal process of the dorsal valve. M. Duthiers has had the opportunity of studying a vast number of individuals of this *Thecidium* in the living state ; and he mentions that, contrary to what we find to be the case in *Terebratula*, the animal opens its shell very widely; the dorsal valve rising on its hinge at right angles to the ventral valve, as the lid of a snuffbox (Pl. II. figs. 9, 10). The animal is also sensible to light and darkness ; and it draws down its smaller valve with the rapidity of lightning at the approach of any danger. M. Duthiers observes that the *mantle* is exceedingly thin, and does not possess round its margin any of those long setæ which exist in *Terebratula* and *Lingula*, and that the genital lobe (the one which corresponds to the concave or ventral valve) is very different to the other, and possesses in its thickness, or in its central portion (that is to say, towards the deep and concave portion of the valve), very thick calcareous plates (Pl. II. fig. 6, *o*), the analogues of the plates and spicula occurring in the mantle of *Terebratula*; also that these plates in *Thecidium* participate in the character of the shell itself, being smooth on their under surface and covered on their upper side with asperities similar to those which cover the entire surface of the bottom of the valve. These plates are very thick, and form a ceiling or vault over the cavity which contains the organs of reproduction ; and they have been carefully described and figured by M. J. Bosquet, M. E. E. Deslongchamps, and myself, as seen in several fossil species, and in particular in *Thecidium vermiculare* from the Upper Cretaceous beds of the Duchy of Limbourg.

The so-termed 'oral arms' of *Thecidium* are stated by M. Duthiers to resemble those of other Brachiopoda, except that they are not free, but adhere in all their extent. He states that the swollen basis certainly presents a canal similar to that which exists in the other animals of the same group, and that this longitudinal canal is present in all their length, being almost confounded with the mantle, or with the margin of the body—for this last is located in the insertion of the arms ; that again these 'arms' insert themselves by their basis, not on the intermediate or internal lamella or 'descending crescent shaped processes,' but on the edge of the 'ascending apparatus.' Their direction is that of the lamina on which they are supported; and they arrive, after having described the inflections already indicated, at the median point of the tongue-shaped process (Pl. I., fig. 2, G), where we can see their two extremities located. This arrangement is shown in the annexed woodcut, which is the one published by Mr. S. P. Woodward and myself in the 'Annals of Nat. Hist.' for May, 1852. The cirri of the 'arms' are long and flexible.



Interior of the Dorsal valve of *Thecidium Mediterraneum*, with the animal; magnified.

We need not, for the purpose we have in view, follow M. Duthiers much further in his observations in connection with the anatomy of the animal of *Thecidium*, but conclude by stating that the French zoologist believes, together with some other naturalists, that the respiration was probably effected partly by the 'arms,' which bear a great analogy to the gills of other Mollusca ; and that he has not been able to discover any anal aperture—a fact strongly urged by Messrs. Huxley, Hancock, and Gratiolet, for *Terebratula* and *Rhynchonella*.

M. Duthiers is of opinion that the sexes are distinct, or in other words that there is a male and female animal; but Mr. Hancock still considers this to be uncertain, and is disposed to the opinion that the sexes are combined in the same animal.

Thecidium Mediterraneum occurs in large numbers in many parts of the Mediterranean from towards the extremity of the Gulf of Bône to near Cape Rosa, &c., living attached to corals and other marine objects, and ranging in a depth of between 40 and 80 fathoms. Mr. S. P. Woodward has detected the same shell in Sir Charles Lyell's collection of Miocene fossils from the Grand Canary Island ; and lastly, Mr. Barrett procured two living examples of *Thecidium Mediterraneum* at 60 and 150 fathoms near Jamaica, and of one of his specimens we give a figure (Pl. II., fig. 5).

2. Thecidium Barretti, *Woodward, MS.* Pl. II., figs. 1, 2, 3. —Shell small, somewhat pyriformly ovate, attached to marine objects by a portion of the back of its beak. Dorsal valve semicircular, flattened, and slightly convex at the umbone. Ventral valve somewhat pyriform, very convex, deep, and thickened ; beak moderately produced ; area triangular, but more or less irregular on account of the position and extent of its attached surface.

The interior of the dorsal valve is slightly concave, with an oblong, square-shaped, prominent, cardinal process, between the dental sockets. A broad, thickened, raised, granulated margin encircles the valve, and forms a bridge over the small, deep, visceral cavity, close to the basis of the cardinal process; the granulations are larger and more prominent on the inner margin. On reaching the front, near the middle, the margin suddenly curves upwards on either side, and unites so as to form a central Λ-shaped ascending process, the attenuated extremity of which is directed towards the middle of the bridge-shaped process already described. The descending apparatus consists of two oval pectinated ridges (Pl. II., fig. 2, *i*, *k*), united close to the extremity of the central angular ascending process, and following at a little distance the curves of the inner margin of the same ascending process. Proportions variable; length and breadth about two lines.

In external shape this *Thecidium* cannot be distinguished from the Mediterranean species; but its interior is very different, and resembles by its simple arrangements that of several Jurassic forms, such as *Thecidium Moorei*, *Th. triangulare*, &c.

Thecidium Barretti was obtained by the late Lucas Barrett at 60 fathoms on the north-east coast of Jamaica, and was found by him fossil in the newest Pliocene beds of the same country.

TERTIARY SPECIES AND VARIETIES OF THECIDIUM.

Three so-termed species have been found in the Tertiary strata; one of these was discovered by Sign. Michelotti in the Middle Miocene of the hills near Turin; and this he designated *Thecidea testudinaria.* The same shell was also found by Sign. Meneghini in the Miocene beds of Parlascio in Tuscany. Another, *Thecidium Adamsi*, Macdonald, occurs in the Miocene beds of Malta; and a third, not yet described, was found by Ad. von Koenen, in the Lower Oligocene beds (next above the London Clay) at Latdorf, near Bernburg, in the North of Germany.

Having obtained by the kindness of Sign. Michelotti several specimens of the Turin shell, also many examples of the Maltese *Thecidium* from Dr. Adams, and a few specimens of that from Latdorf from Messrs. von Koenen and Bosquet, I have been enabled to study and compare all their external and interior details with all possible attention, and of these I now offer carefully enlarged illustrations.

1. Thecidium Mediterraneum, var. Latdorfiense.
Pl. I., figs. 6–9.

In external shape, dimensions, and internal characters, this Thecidium so exactly resembles the recent species that a lengthened description would be only repeating what we have already written.

A glance at the carefully enlarged illustrations in Pl. I. will, I trust, bear out the view here taken. This *Thecidium* does not appear to be rare in the Lower Oligocene beds of Latdorf, near Bernburg, in North Germany. As far as we at present know, this would be the oldest type or representative of the Mediterranean species.

2. THECIDIUM MEDITERRANEUM, var. TESTUDINARIUM, Michelotti, sp. Pl. I., figs. 4 & 5; Pl. II., fig. 4.

Thecidea testudinaria, Michelotti: Annali delle Scienze del Regno Lombardo-Veneto, 1840; and Actes de l'Académie Hollandaise des Sciences, 2e sér. vol. iii., 1847, p. 79, pl. 2, fig. 26.

This *Thecidium*, by its external shape and interior characters, appears to bear so much resemblance to the Mediterranean shell that I doubt much whether we should be justified in considering it more than a variety. Its beak and area are at times considerably developed; but such is sometimes found to be the case with the recent type. In all essential points the interior resembles that of *Thecidium Mediterraneum.* A small and the only difference I am able to detect consists in the central (tongue-shaped) 'ascending process' being a little narrower, and commencing a little lower down, or nearer the front, than is usually seen in the recent shell. This *Thecidium* does not appear to be rare in the Middle Miocene beds near Turin; but it appears to be difficult to obtain perfect examples showing the interior of the dorsal valve.

3. THECIDIUM ADAMSI, Macdonald [variety of *Th. Mediterraneum* ?]. Pl. I., figs. 10–13.

Thecideum Adamsi, Macdonald; Quart. Journ. Geol. Soc., vol. xix. p. 517, 1863.

This shell does not appear to have attained the dimensions of the preceding two varieties of *Th. Mediterraneum.* By its general shape and interior arrangements, it so closely resembles the recent Mediterranean form that I feel doubtful whether it should be considered more than as a small race or variety of *Thecidium Mediterraneum.* Its exterior shape and characters have been correctly described by Mr. Macdonald, who does not fail to observe 'that its nearest ally is the recent *Thecidium Mediterraneum.*' *Thecidium Adamsi* has often, although not always, moulded a portion of the back of its larger valve upon slender stems of some concentrically ribbed coral, which has been reproduced in relief, with all the original markings, on the flattened dorsal valve (Pl. I., fig. 10, *a*, *b*,); but when the shell has been fixed to some flat or rugose marine object by a larger or smaller portion of the extremity of its beak, the dorsal valve exactly resembles that of the recent *Thecidium Mediterraneum* (Pl. I. fig. 11). The interior of the dorsal valve has not been quite correctly described or figured in the Journal of the Geological Society; I have therefore drawn this valve with great care from some perfect examples sent to me by Dr. Adams, of Malta; and these figures, I trust, will convey to the reader's mind the intimate resemblance this shell bears to the Mediterranean species; so much so indeed is this the case that the description we have given of the interior of *Thecidium Mediterraneum* will suit *Thecidium Adamsi* equally well. In none of the examples I have been able to examine could I find what Mr. Macdonald describes and figures as the 'outer simple loop,' following the contour of the shell, but lying a little within the granulated margin (see Pl. I., fig. 14, *e*), these 'intermediate half-loops or hook-like processes (fig. 14, *f*) should not be represented as 'free,' for they adhere to the shell by their inner margin, as we have described to be the case in the recent species. Neither is the central ascending tongue-shaped process, nor the descending process, correctly drawn in the woodcuts illustrating Mr. Macdonald's description. I am at a loss to understand Mr. Macdonald's figure (*op. cit.*, p. 518, fig. 2), for it would seem to represent at the same time the interior of the dorsal and ventral valves, which in such a position would be a material impossibility.

Dr. Adams has informed me that this little shell is abundant in the lower part of the Calcareous Sandstone and in the upper portion of the Lower Limestone of Malta, and is usually associated with *Orbitoides*, *Cidaris*, *Echinus*, *Scutella*, and other forms likewise characteristic of the situation, and never found in any of the overlying beds.

From the above it would appear that three of the four Tertiary so-termed species are constructed exactly on the same model; and of these we may look upon *Thecidium Mediterraneum* as the type, although the species appears to have first made its appearance in the Lower Oligocene period. Their structure is very different in detail from what we find in such shells as *Th. vermiculare*, *Th. digitatum*, *Th. hieroglyphicum*, *Th. papillatum*, *Th. Mayale*, &c., from the Cretaceous and Jurassic periods, in which forms the ascending and descending apparatus are much more complicated. The arrangement seen in the Mediterranean type did not, however, originate in the Tertiary period, for we find in the Cretaceous formation one or two forms, such as *Th. affine* (Bosquet), which partake of the same character. The second Tertiary type (*Th. Barretti*) we have already shown to be also recent.

EXPLANATION OF THE PLATES.

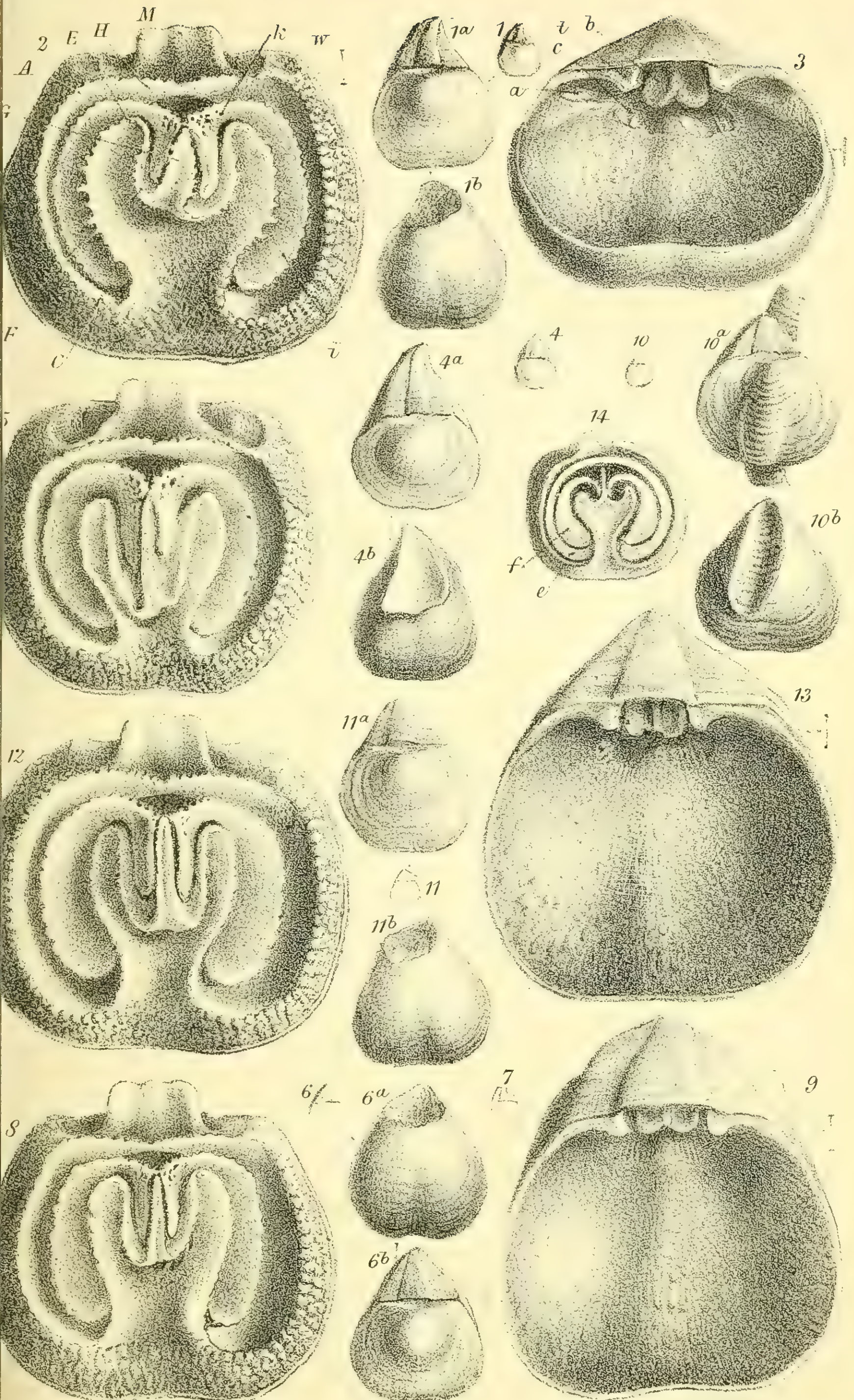
Plate I.

Fig. 1. *Thecidium Mediterraneum*, Risso, recent; Mediterranean; *a*, *b*, enlarged.

2. *T. Mediterraneum.* Interior of the *dorsal* valve enlarged. A, C, E, F, and G, 'ascending process;' H, bridge-shaped process; *i*, *k*, half-crescent or descending process; M, cardinal process; W, scar formed by the adjustors or 'muscles adducteurs lateraux ou externes' of M. Duthiers.

3. *T. Mediterraneum.* Interior of the *ventral* valve, enlarged, and a little turned up so as to show under the cavity of the beak; *b*, small concave plates ('coque' of M. Lacaze Duthiers) to

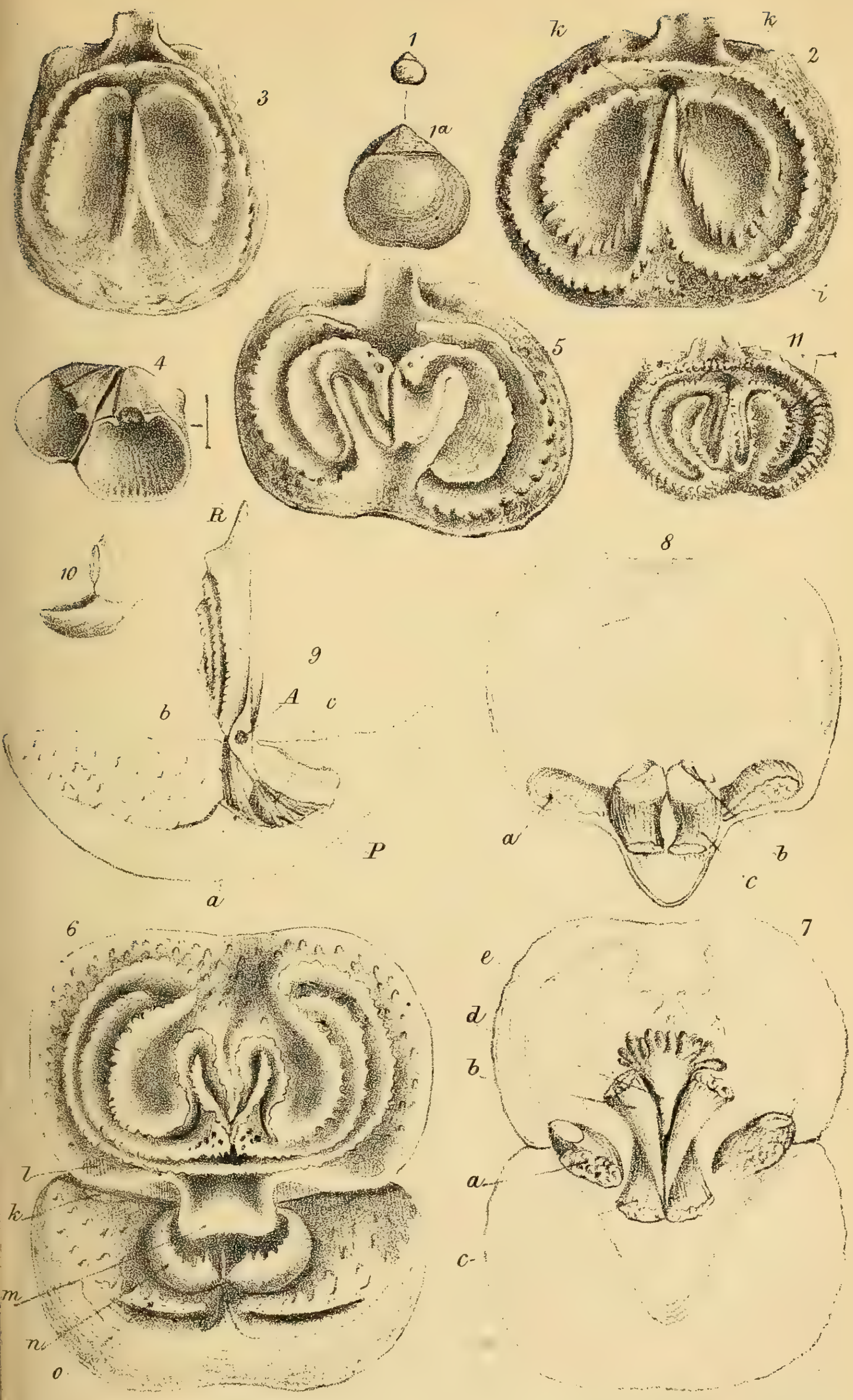
Plate I



Thos Davidson del. et lith.

THECIDIUM: RECENT & TERTIARY.

W. West imp.



Thos. Davidson lith.

THECIDIUM: RECENT & TERTIARY.

W West imp

which were attached one extremity of the adductor or occlusor muscles; *c*, large scars produced by the divaricator muscles of Hancock, 'muscles abducteurs' of Duthiers; *a*, oval scars left by the 'ventral adjustor' of Hancock, 'muscle adducteur lateral' of Duthiers.

4. *T. Mediterraneum*, var. *testudinarium*, Michelotti; *a*, *b*, enlarged; 5. interior of the *dorsal* valve, enlarged. Middle Miocene, Turin.

6, 7. *T. Mediterraneum*, var. *Latdorfiense*, from the Lower Oligocene beds of Latdorf, near Bernburg (6 *a*, 6 *b*, enlarged); 8. interior of the *dorsal* valve, enlarged; 9. interior of the *ventral* valve, enlarged.

10, 11. *T. Adamsi*, Macdonald: Miocene, Malta; *a*, *a*, *b*, *b*, enlarged.

12. *T. Adamsi*, interior of *dorsal* valve, enlarged.

13. *T. Adamsi*, interior of *ventral* valve, enlarged.

14. *T. Adamsi*, interior of the *dorsal* valve, after Macdonald's woodcut, Journ. Geol. Soc., vol. xix. p. 518, fig. 3. This illustration is not correct, as may be perceived by comparing it with fig. 12.

Plate II.

Fig. 1. *Thecidium Barretti*, Woodward, MS., *a*, enlarged. Recent, Jamaica.

2. *T. Barretti*, interior of the *dorsal* valve, enlarged; recent.

3. *T. Barretti*, interior of the *dorsal* valve, enlarged; fossil.

4. *T. Mediterraneum*, var. *testudinarium*, interior of the *ventral* valve, enlarged, Turin.

5. *T. Mediterraneum*, interior of the *dorsal* valve, enlarged; recent, Jamaica. This and specimen figs. 1, 2, were dredged off Jamaica by the late Mr. Barrett.

Figs. 1, 2, 3, and 5 are from drawings by Mr. S. P. Woodward.

6. *T. Mediterraneum*, after M. Lacaze Duthiers' figure. This is the interior of the dorsal and part of the ventral valves; *l* and *k*, impressions produced of his 'muscle adducteur lateral;' *m*, cardinal process; *n*, concave plates ('coque' of M. Duthiers), to the inner surface of which were fixed his 'muscles abducteurs;' *o*, lamellæ developed in the mantle of the ventral valve.

7. *T. Mediterraneum*, after Duthiers. Animal of which the lobes of the mantle have been spread out, and viewed from the side of the shell so as to exhibit M. Duthiers' (*a*) 'muscles adducteurs lateraux,' Hancock's adjustors; *b*, Duthiers' 'muscles abducteurs medians,' Hancock's 'occlusors,' of which one extremity passes between the 'muscles abducteurs' (*c*) and the other is directed outwardly to make room for the intestine (*d*), which is the continuation of the lobes of the liver (*e*); *c* is Mr. Hancock's divaricator.

8. *T. Mediterraneum*, after Duthiers. Animal separate from the shell and seen on the face which corresponds to the concave valve. *a*, lateral adductor muscle of Duthiers; *b*, median adductor muscle, of which we can see the extremity only which attaches itself to the bottom of the lamellæ under the beak of the ventral valve; *c*, abductor muscle, slightly curved, of which the two extremities can be seen.

9. *T. Mediterraneum*, after Duthiers. Longitudinal section of a *Thecidium*, to give an idea of the manner in which the median muscles act: *a*, curved lamellæ, which are supported by and attached to a small septum under the beak in the ventral valve; *b*, 'median adductor muscle' of Duthiers = 'occlusor' (Hancock); *c*, 'abductor muscle' of Duthiers, which is attached by one

extremity to the bottom of the ventral valve, and by the other end to the extremity of the quadrilateral cardinal process of the dorsal valve. M. Duthiers states that one can thus establish the mechanism of the opening and occlusion of the shell; that when the animal wishes to open his shell, the power P is represented by the muscle (*c*), its point of application being at the extremity of the cardinal process of the ventral valve: the resistance R is the weight of this valve which has to be raised; the point of support is found in A; we have, therefore, a lever of the first kind. If it were required to close the shell, the same analysis would be applied to the lateral muscles, by reversing, however, the power and the resistance, the point of support being always in the articulation A.

10. *T. Mediterraneum*, after Duthiers, twice the size of life, with its valves open.
11. *T. affine*, Bosquet. Interior of the dorsal valve enlarged, from the Upper Cretaceous formation of Limbourg.

III. On some Special Indications of Volcanic Action in the Carboniferous Period at Burntisland, Firth of Forth.

By Archibald Geikie, F.R.S.E., F.G.S.

On the northern margin of the Firth of Forth, opposite Edinburgh, a line of steep craggy slope sweeps round from behind the village of Burntisland to the shore about half a mile eastward. The highest and most precipitous portion rises to a height of 631 feet; and the space between its base and the shore is so short that when seen from a short distance, the hill seems to shoot almost directly out of the sea. Hence these heights form conspicuous landmarks all over the Lothians. Their scarred fronts and verdurous slopes bear all the characteristic features of the minor hills in the lowlands of Scotland — a union of brown mouldering crag, often steep and bold, with soft green hollows, and with shelving sides that are either cumbered with ruins from the cliff overhead, or dotted with bushes of golden gorse. Such scenery is to a geological eye eminently 'trappean;' it at once suggests beds of greenstone, basalt, and ash, with the other concomitants of ancient volcanic eruptions. And truly amid all the rich development of volcanic phenomena in these Lowlands, the rocks of the Burntisland shore deserve to stand up as conspicuous landmarks. They have been laid bare by rains and frosts and the waves of the Firth along some miles of the coast-line, where they can be studied, bed after bed, in the minutest detail. I know of no such section in any other part of the kingdom.

Just beyond the eastern outskirts of Burntisland the high grounds curve round to the shore, which they reach in a line of cliff known as the King's Craig,—one that has a melancholy interest in Scottish history, for it was over its mist-covered edge that Alexander III. lost his life. This cliff consists of various greenstones, basalts, ashes, shales, sandstones, and thin coal-seams; the whole, as proved by fossil contents and geological position, belonging to a low part of the carboniferous system. Viewed from the westward or from the sea, the stratification of these crags can be distinctly followed with the eye, since the hard lava-beds vary in colour and in their mode of weathering, while the softer sedimentary strata that lie between them are marked in the distance by grassy slopes. Brown and greenish ledges of rock, rising in parallel bars to a height of 300 feet above the beach, form the upper part of the crag, the lower portions sinking beneath blown sand, coarse bent-grass, and gorse. That single crag, therefore, furnishes us with the record of a long series of submarine volcanic eruptions, each separated from those that preceded it by a longer or shorter interval, during which sandy or muddy sediment was deposited over the hardening lava or ash. One little episode in this history is worthy of notice, partly because interesting in itself, and partly because, as a sample of geological evidence, it tells its own story with singular clearness. In descending order the beds which form the upper part of the west end of the King's Craig are as follow: —

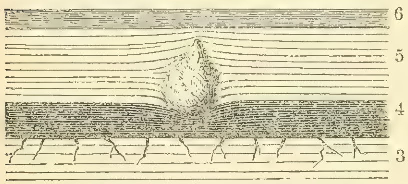
12. Basalt, *about* 15 *feet thick.*
    11. Green shales, *with Cyprid cases* and fragments of Plants;* 4 *feet.*
    10. Blue shales, *with thin limestone-seams made up of Cyprid cases* and fragments of Plants*; $1\frac{1}{2}$ *foot.*
    9. Green ashy shale and thin ash-seams, *with similar fossils; about* 14 *inches.*
    8. Green ashy sandstone, *with similar fossils;* 6 *inches.*
    7. Green ashy shale and ash, *the same fossils very abundant in some layers; about* $3\frac{1}{2}$ *feet.*
    6. Dark greenish and black fissile shale, *with Plants, &c.; about* 6 *inches, passing down into*
    5. Green crumbling fireclay; 1 *foot.*
    4. Coal; 5 *or* 6 *inches.*
    3. Brown shaly fireclay, *with rootlets; about* 5 *inches.*
    2. Black carbonaceous shale; *an irregular layer.*
1. Greenstone; *about* 15 *feet.*

The greenstone marked No. 1 in this table is one of the most remarkable beds in the cliff. Its light-green colour makes it visible a long way off, and chiefly aids in giving the cliff the conspicuous stratified appearance it has when seen from a

* Probably the co-called *Cypris* (*Leperditia?*) *Scotoburdigalensis.*

distance. Along the upper surface of the bed the vesicular and scoriaceous character of a lava-flow is well shewn, while the texture throughout is exceedingly irregular, varying from a loose slag to a firm compact lava. The basalt (12) must at one time have been a rough, porous slaggy lava. Even now the disappearance of the mineral matter which subsequently filled up the cavities has gone far to restore the original aspect of the mass. No one who looks at these two beds can doubt that they must have been poured out, probably over the bottom of a shallow sheet of water, as streams of molten rock. Between the eruption, however, of the greenstone and that of the basalt, it is evident that a considerable interval must have elapsed, in order to admit of the gradual deposition of the ten intervening groups of strata, which have a united thickness of from ten to fifteen feet. This interval was chiefly passed in the transport and deposition of fine muddy sediment over the greenstone. Yet it was marked too by the growth of a mass of peaty vegetation (now the coal-seam, No. 4) which must have flourished on the spot, for its rootlets can be seen branching out into the clay below. It would appear either that the water had been so shallow that the fifteen feet of greenstone nearly sufficed to reach its surface, or that some upheaving movement, connected with the volcanic phenomena of the district, had at this place raised the bottom to the level of the upper surface of the water. In either case the water was almost dispossessed, for the thick peaty accumulation which supplanted it, and which is now represented by the coal-layer, in all likelihood had at least its larger plants waving green in the air. Nevertheless a slow subsidence was the predominant movement during these ages. Hence after a time the peat-bed, carried beneath the water, was covered with new muddy deposits mingled with small crustacean valves and drifted fragments of plants. It is in the clay lying immediately over the coal that the incident occurs which is the occasion of this paper.

In the summer of 1862, when making a detailed investigation of the Burntisland district for the Geological Survey, I found the following section near the top of the west end of the King's Craig. The lowest bed (3) is the same brown shaly fireclay marked 3 in the table; No. 4 is the coal-seam; No. 5 the green crumbling fireclay by which the coal is overlain. It will be noticed



Section of King's Craig, showing the position of the Volcanic Stone in the ancient mud-bed.

that in the upper fireclay a large angular stone is stuck in a vertical portion. With this single exception there were no stones of any kind observed in the bed, which continued throughout a fine-grained fireclay. The intruded block was of a pale felspathic greenstone, different from any of the beds of the cliff, and weighed perhaps six or eight pounds. It rested on the surface of the coal-seam, or at least was separated from it by an extremely thin layer of the clay. The part of the coal-seam immediately below it was considerably compressed, but did not appear to be otherwise altered in texture. Moreover the laminæ of the fire-clay, for perhaps a couple of inches from the bottom, were bent sharply downward along the sides of the stone, in the manner shewn in the figure, while a little higher in the bed, instead of being turned down, they rose slightly upward, and seemed to be heaped up around and over the stone. The layers above the stone shewed no trace of disturbance. Now it is plain that this greenstone block is something abnormal and extraneous in the fireclay, and not a part of the ordinary sediment of that deposit. It is clear also that the block must have been introduced into the clay when the latter was soft and yielding, and even before the underlying coal-seam had hardened into stone. Indeed the time of its introduction is exactly fixed by the evidence from the stratification of the fireclay. The block must have come into its present position after the deposition of that portion of the fireclay which it squeezes down, and before the accumulation of the part which is heaped up over it; in other words, just when the bed of fireclay was about half-formed. It is further evident that as no other stones are visible, and no change takes place in the nature of the sediment composing the fireclay bed, the introduction of this greenstone block cannot have been brought about by the agency of currents of water. On the contrary, from the vertical position of the stone, the compression of the coal-seam, and the sharp depression of the layers of fireclay, we cannot but infer that the stone must have dropt upon the muddy bottom, and from some considerable height, to enable it to squeeze its way so markedly down through the clay upon the underlying coal. Had such a solitary block occurred in the heart of a deposit like the Carboniferous Limestone of Ireland, or the Chalk of Surrey,* its introduction might have

* See Jukes' Manual of Geology, 2nd edit. p. 146, for an account of blocks of granite, schist, and other rocks, in the Carboniferous Limestone of Dublin; also a paper by R. Godwin-Austen, F.R.S., F.G.S., 'On a Granite Boulder found in the White Chalk near Croydon,' in Journ. Geol. Soc., vol. xiv. p. 252.

been attributed to its having dropt in mid-ocean either from the roots of some floating tree, or from a raft of earth-laden ice. But in the present instance, the water was in all likelihood very shallow, and there is therefore not much probability that either drifting wood or ice had anything to do with the transport of the greenstone boulder. There is only one supposition which will satisfactorily account for all the phenomena, viz., that the stone is a true volcanic bomb, which was ejected from some neighbouring crater, and fell with force through the shallow marshy water, burying itself deep in the half-formed fireclay bed. Nor is this the only evidence of the continued activity of the volcanic forces in the Burntisland district during the interval between the outpouring of the greenstone (No. 1), and the basalt (No. 12). Many of the intervening strata are charged with fine green ash, shewing that showers of ash continued to be thrown out intermittently during the whole of the interval between the emission of the two lava-streams. And yet during that time, notwithstanding the igneous agencies—indeed, perhaps as a consequence of their activity—the conditions for the development of life seem to have been eminently favourable. Plant-remains are abundant, and the cases of the little Entomostracous Crustaceans occur in such multitudes as actually to form of themselves layers of stone.

When I saw the stone in 1862 it was ready to fall out of the fireclay matrix; but to preserve it as far as might be for the inspection of geologists, my colleague, Dr. Young, and myself built it round with loose stones. Perhaps it is still intact, but I have not seen it since, and the frosts of every winter help to alter the face of the cliff.

The whole of the district from which this illustration is taken affords admirable studies in trappean geology. The student will learn more of the details of palæozoic volcanic phenomena from an attentive examination of that coast-line in the course of a single day, than he will be likely to gain from books alone during a week of hard reading. I am tempted to quote one or two additional sections from my note-book, but as these will shortly appear in greater detail in the 'Memoirs of the Geological Survey' I refrain. The illustration given in this short paper is a fair sample of the kind of evidence which the Fife Coast affords of the abundant though local display of volcanic action during the earlier portions of the long Carboniferous period.

TRANSLATIONS AND NOTICES OF MEMOIRS.

The Sahara and its Different Types of Deserts and Oases. By E. Desor, Professor of Geology, &c., Neufchâtel.*

[Translated, with notes, by A. C. Ramsay, F.R.S., F.G.S., &c.]

THE following memoir, by Professor E. Desor, of Neufchâtel, is only partly geological, but the greater portion of the remainder is so intimately connected with those questions of physical geography with which modern geologists are so much occupied, that I have thought it would be interesting to geologists in general, especially those parts that treat of the origin and nature of the Sahara, the Oases, and the underground sheets of water supplying the artesian wells. I have therefore translated the sketch in full. The Sahara, its salines, and other features, as well as the artesian borings, have formed the subject of several memoirs, by MM. Desvaux and Ville, in the Annales des Mines, 5^{me} Série, vols. xiv. and xv., 1858–59.—A. C. R.

I cannot pretend to describe all the aspects of the great Desert of Sahara. Such a district would require repeated journeys, and prolonged visits under conditions but little favourable to study, and necessitate a perseverance and devotion to science not often met with. Now, my travelling companions and myself have only seen a little corner of this strange country, in a rapid excursion as far as the limits of the French possessions. If, however, putting together our experiences as travellers and naturalists, we are able to present some new features of this unique country, interesting equally in a geographical, botanical, or geological point of view, our success is in a great measure owing to the protection and encouragement so kindly showed us by General Desvaux, Governor of the Province of Constantine, as well as to the enlightened solicitude of Captain Zickel, Director of the artesian borings in the desert.

Those parts of the desert which we visited are—the zone which borders the chain of the Aurès, comprising the Oases of Zibans, the route from Biskra to Tuggurt across the little desert, Wady Rir, and its oases, the Oases of Souf, and the route from Souf to Biskra, passing the Chott-Melrir.

In this itinerary the observing traveller will recognize three types of desert to which three types of oasis correspond: 1st. The desert of the plateau; 2nd. The desert of erosion; and 3rd. The desert of dunes.

The Desert of the Plateaux, between Biskra and Wady Rir, presents a plain stretching as far as eye can reach, strewed with pebbles

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* Le Sahara; ses différents types de Déserts et d'Oasis; par E. Desor. (Extrait du Bulletin Soc. Scienc. Nat., Neufchâtel, 1864.).—Several paragraphs, not relating to the geological part of the memoir, have been omitted.—Edit.

covering a crust of gypsum, which forms a true geological horizon. Some of these pebbles, small and well-rounded, are of chalcedony, others of limestone, and others of opaque silicates. They do not extend beyond the Chott, and are consequently limited to the neighbourhood of the mountain. This pebbly plain is not completely bare, for tufts of various plants grow here and there, which appear to accommodate themselves perfectly to the soil and the climate. Amongst these are *Ephedra fragilis*, the connecting link between the *Equisetaceæ* and the *Coniferæ*, and which appear to play, in the desert, the part of the *Pinus mugho* in our Alps. As a common plant, robust and sturdy, its creeping roots, finding little vegetable soil, search for it at a distance by extending to an extraordinary length from the stem. Besides Brooms, Pistachios, and Tamarisks, we frequently observed a large Grass, a species of *Stypa*, several feet in height, known among the Arabs by the name of 'Alfa.' This is a useful plant, serving not only for food for horses and camels, but for the manufacture of besoms, mats, hats, bowls, and basins for holding milk, water, &c. For the traveller the Alfa is a wearisome vegetation at a distance; and, as M. Fromentin remarks, it looks like an immense harvest which does not ripen, and withers without turning to gold colour; while near, it is a maze of endless zig-zag meanderings where the traveller stumbles at every step. The soil is greyish, sandy, and averse to all other vegetation, except when refreshed by occasional rains; for we found on our return, after some days of rain, that the plateau between Wady Rir and Biskra was covered with a quantity of young plants; vegetable life was awakened, and, though it was December, the country wore the aspect of spring.

Desert of Erosion.—This phase of desert is characterized by enormous erosions, and a soil saturated with salt. I may cite as an evidence of these erosions, a river near Biskra, Wady Djeddi, the bed of which is many kilometres in width, though in ordinary circumstances the water is almost entirely wanting. But when the water is high, for want of a defined channel, it diverges and spreads to right and left over an immense surface, and produces the most extraordinary erosions. This is owing to a bed of gypsum, which near the surface forms a sort of flooring, and, being hard, prevents the water from scooping a deep bed. The ground has all the appearance of excellent arable land, but in fact it is absolutely barren. Nothing will grow on it, owing to the salt which is mixed with the soil to an extraordinary degree; and this is connected with the neighbourhood of the Lakes (*chotts*), which are themselves the remains of an ancient sea. The salt-lands can at once be recognized by the fact that the horses' hoofs raise no dust; and a numerous troop may trot over it as if it were the swept floor of a barn. This is especially striking after riding over a sandy district where the traveller has suffered from the dust: all at once it disappears, and he finds himself on the salt desert. The quantity of salt is so great, and it absorbs so much water during the night, that the soil retains its humidity the greater part of the day. In those spots where the salt is not in such excess as to exclude all vegetation, there is a growth analogous to that of a salt-marsh—salsolas, salicornes, tamarisks, brooms, &c.

Desert of the Dunes.—The soil of this desert is incoherent moving sand, without vegetation, and where the camel alone can walk with ease. A day's march to the west of Biskra there is a good specimen of this species of desert. There the dunes recall those of Holland; but it is between Tuggurt and Wady Souf that the desert of the dunes shows itself in all its aridity. It is the desert *par excellence*, which in all times has produced on all people an impression of awe and terror. The yellowish white plain is deeply undulated, these undulations being the dunes raised by the wind. Their height is very variable, sometimes attaining to 50 feet; and the two slopes are unequal, that which is opposed to the wind being steeper than the other, which is a gentle declivity. The sand is sufficiently firm to bear walking without sinking much. When the wind rises, the blown sand produces a kind of mist, which, of course, becomes thicker in proportion as the hurricane is severe. Consequently, as might be foreseen, these dunes are not permanent, for they change their places, though slowly; and in fact the sand does not move far from its starting point. It is not here as on the sea-shore, where the winds, being uninfluenced by local circumstances, are more constant and more intense, impelling the dunes always in the same direction. In the desert the wind frequently changes its direction, and the dunes change their forms, undergoing every kind of reconstruction. The general aspect preserves, nevertheless, its principal features so long that guides can still recognize their way. But guides being rare, and it being easy to lose one's self in this labyrinth of dunes, the French Government has established landmarks, to guide the caravans, like those planted in winter among the snows of the Alps and the Jura.

Origin of the Sand of the Dunes.—What is the origin of this sand? Does it come from the sea, as has been long supposed, or is it produced in place? M. Vatonne, mining engineer, in his journey to Rhadamis, has settled this question, having demonstrated that the dunes are the result of sandy formations decomposed in place. In Tunis, sands of the Cretaceous epoch generally provide the materials; and in Souf the Quaternary deposits. Between Guemar and Chott-Melrir, along the route followed by the caravans, relics of the original surface exist, unconcealed by the dunes; these surfaces being preserved by a crust of gypsum which prevents their destruction. These unburied relics consist of stratified friable sand, which, deprived of its protecting cover, easily disintegrates under the influence of atmospheric agencies and is driven along by the winds. Now, as this destructive action is carried on from year to year, and from age to age, it follows that the mass of the dunes is continually augmenting.

Age of the Sahara.—If the Sahara is the bottom of a vanished sea, it is interesting to inquire if this disappearance has been caused by a sudden upheaval or by gradual and successive elevations, and at what epoch this extraordinary phenomenon has changed the aspect of the African continent, and consequently produced serious modifications of the climate of Europe. There was a general impression that the Desert of the Sahara was of recent formation; but the opinions of geologists were divided as to the period to which it should be assigned, some considering it of Tertiary and others of Quaternary age. Our observations resolve these doubts, and definitely fix the age of the Sahara, by the help of a little shell, the *Cardium edule.* This shell was known to exist in the neighbourhood of the Caravanserai of Om-Thiour, near Chott-Melrir, and it had been found at a depth of about 23 feet in the artesian wells of that place.* From this it might have been supposed that it belonged to the Chott (or Lake) Melrir. But, on the other hand, we met along with it a species of *Buccinum,* from stage to stage, at a great distance from the Chott (even near Guemar in Souf), always in the same geological position, in a bed of sand distinctly stratified underneath the superficial gypsum. It thus became evident that the shells did not belong to the Chott, but to a lower stratum indicating a sea far more extensive and older than the salt lakes. These shells, therefore, not only attest the existence of a sea in those regions, but also that that sea belonged to our own epoch. Further the *Cardium edule* is, in the Mediterranean, a species inhabiting brackish waters at the mouths of rivers; and we may conclude that the Sahara, before being dried up, was an inland sea—a kind of brackish Baltic—and this amongst other things explains the small number of the species; for it is known that the faunas of inland seas are poor in number and debased.†

To sum up, when all communication with the ocean had ceased, and the gulf became a lake, the saltness of the waters would by evaporation increase so much as almost to destroy all animal life; the Chott-Melrir would become like the Dead Sea; and, in fact, it is affirmed that it is completely destitute of life.

This idea of a slow but recent elevation of the Sahara had already been mooted as a theory by M. Escher, and it was a source of lively satisfaction to him to find his hypothesis confirmed on the spot. The presence of this sea was referred to by M. Escher to explain certain phenomena in our country (Switzerland) connected with the Glacial period which ended when this sea disappeared. Is it possible to form an idea of the climatal conditions imposed on Europe by this vast extent of water? We may do so when we consider the influence exercised by the burning winds which come from the Sahara, and which are so justly called '*snow-eaters*' and '*glacier-destroyers.*' While the Sahara was covered with water our mountains never felt the burning breath of the 'fœhn' and the 'sirocco;' the winters, never opposed by a lukewarm breeze, could accumulate their snows

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* See Memoir by M. Ch. Laurent, Bullet. Soc. Géol. France, vol. xiv. p. 615, 1856–7.—A. C. R.

† See observations made by Rev. H. B. Tristram, M.A., F.L.S., &c., in his work on 'The Great Sahara' (1860, Murray); also Appendix to 3rd edition of Lyell's 'Antiquity of Man' (Dec. 1863), p. 28.—A. C. R.

and their ice and extend the borders of their empire.* But when the desert was dry, what an effect must have been produced by the first visit of the 'fœhn' to the enormous glaciers of our Alps! What torrents!—what deluges of water!—what ravages, especially on the southern slope! and now how easy to comprehend the erosion of the mountains and the levelling of the plain of Lombardy subjected to these rude assaults and covered with erratic débris! †

The Oases.—Wherever in the arid burning Sahara a thread of water appears, a precious tree, the Date-palm, grows and prospers. An Arab proverb says 'the Date must have its feet in water and its head in fire.' Wherever water moistens the soil the date-palms raise their graceful columns, waving in the wind their plume of verdure and promising to man shelter from the sun and food for his subsistence. These trees are the wealth of the desert, and the Oases are merely forests of palms rendered possible by the presence of water. This water may have a triple origin; it may be furnished either by springs or by artesian wells, or from having been dug out from a water-bearing stratum. Hence the three types of oases—1st. Those watered by streams from the mountains; 2nd. Those supplied with water from the artesian wells, the products of a very ancient industry; 3rd. The Oases without water, of which those of Souf are an example.

The oases of the first category are fed either by the streams from the mountains, or from subterranean springs, which are found in great and almost constant abundance, like the Reuss, the Noiraguc, and the Serrières, which are produced by the same cause, namely, the infiltration of the rain-water through the fissures of the limestone in the mountains. They are found at the foot of the Aurès, where they form the Oasis of Zibans; and some of them are warm, their temperature rising to 30° Centigrade.

Oases of Artesian Wells.—At a depth of about 160 feet, there is a sheet of water which springs to the surface when the intervening soil is pierced. Many of the oases, and particularly that of Tuggurt, have no water but that of the wells; and these appear to be very ancient. It is indeed no light undertaking for the Arabs to dig a well. They club together, and employ forced labour; but notwithstanding, it often happens that years pass before they reach

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* See Prof. E. Suess on the evidences of a post-pliocene sea on the site of the Sahara; Trans. Roy. Imp. Geol. Institute of Vienna, Jan. 1863.—A. C. R.

† In 1851 I published a paper in the Journal of the Geological Society on glacial phenomena, only part of which was printed, the remainder having been considered by the Council as too wild for publication in the Journal; and I therein stated, on the authority of the late Professor E. Forbes, that the Sahara 'formed an extension of the sea in which the Sicilian Pleistocene beds were formed;' but I am at this distance of time unable to recollect on what data he grounded this opinion. The diminution of the Alpine glaciers, both on the south and north sides of the chain, is however connected with phenomena of a much more general kind, which accompanied or caused the close of the 'Glacial Period' in both hemispheres, and we suspect of a kind not necessarily connected with any local phenomenon like the formation of the Sahara, however important that might have been in modifying part of the general result.—A. C. R.

their wished-for goal. The chief difficulty is the casing of the pit-walls. Having no other wood than palm, which is neither strong nor durable, it often happens that the frame-work gives way, and the sand falling in, overwhelms the work of years. Then, again, when they have arrived at the lowest bed, that which rests on the water, those who pierce it are exposed to extreme peril, for the water rushes upwards with such force that they cannot always get up in time.

The sand is at all times liable to drift in, and fill up the wells by degrees; and from time to time it is necessary to scour them out. This is a task devolving on certain families, and is hereditary. One can hardly believe the process they employ, it is so primitive and so dangerous. An unfortunate wretch, holding in his hands a basket or coffer, dives into the well, fills the coffer with sand, hastily returns to the surface, and the sand is drawn up by a cord. If any obstacle keeps the diver at the bottom of the water, a comrade is bound to jump in and disengage him. I have seen as many as three of these poor men drawn up by a fourth more fortunate than themselves. It is remarked that these divers seldom live long; the occupation is evidently too laborious; and they are usually attacked by complaints on the chest.

Notwithstanding the drawbacks to the Arab method of boring, nothing will induce the natives to change it; they cling with incredible obstinacy to their old customs. Some years ago, General Desvaux, visiting the Oasis of Sedi-Rached, was struck with the misery of the inhabitants; water was beginning to fail, the oasis was in a perishing state, and the Arabs resigned themselves to their fate with a fatalism truly Mahometan—'it was written.' But the General resolved to falsify the eastern proverb: he sent for an engineer, furnished by the house of Degousée and Co. of Paris, who brought with him the complete apparatus for the most approved style of boring, and wells were rapidly bored and proved an entire success. They yield 4,000 litres a minute; in fact an actual river. Captain Zickel has even profited by the jet of water so far as to make a fall and a water-mill, to the great admiration of the Arabs, who still crush their grain with the small hand-mills used from the time of the patriarchs. The abundance of the water would, it might be supposed, entirely renovate the oasis, and increase the extent of cultivated ground. Unfortunately that cannot be done without washing away the salt with which the soil is surcharged; and as the water itself is more or less brackish, it is easy to foresee this would be a work of time.

The water of these wells is rarely cold; at Tuggurt it is 30° Centigrade, and the inhabitants cool it by nocturnal evaporation, hanging out the pitchers in which it is contained on the top of the perches with which every house is furnished.

Fish of the Artesian Wells.—It is now three years since Captain Zickel, having bored a well at Aïn-Tala, remarked some little fish struggling in the sand that had been thrown up with the water from the mouth of the well. This appeared to him so extraordinary, that he resolved to wait till he saw it again before he published it. He had not long to wait, as the fish were by no means rare. The country being so devoid of water for a great distance, how came they there? M. Zickel communicated his discovery to some of his scientific friends, who treated it as fabulous. Now, however, it is a fact established beyond dispute. We have collected several specimens of these creatures from the Canal of Aïn Tala. They are remarkable for the shortness of their ventral fins; so short, indeed, that some have adopted the erroneous idea that they are altogether wanting.*

The eyes are well formed; and we assured ourselves of the fact that the fishes see perfectly. The largest did not exceed two inches in length. They are malacopterygious, resembling our *Bravan*, but differ in the absence of pharyngeal teeth, and the presence of fine tricuspid teeth in the jaw. They are of a clear colour; the under part of the body an iridescent blue. They belong to the family of the *Cyprinodontes*, and are probably identical with the *Cyprinodon cyanogaster* described by Dr. Guichenot, and coming from the fresh water of Biskra.†

These fish are, however, not confined to the streams from the artesian wells, but are found in neighbouring pools at Ourlana. Now these pools, from whence flow tolerably abundant streams, are probably only superficial vents of the great subterranean waters which lie beneath this country, and which are inhabited by strange creatures, and it is possible that from time to time these fish may stray into these pools.‡ This is the reason why they have such perfect eyes, which one cannot conceive that they would have had, if before their entrance to the upper world by the waters of the well, they had been condemned to live in total darkness. It is well known that the animals which pass their lives in complete darkness are devoid of vision, and only preserve the mere optic nerve, the last vestige of the eye, which itself has completely disappeared.

Waterless Oasis of Souf.—Here the culture of the palm is of the most simple description, but requires incessant labour. At a depth of eight or ten metres they reach a moist bed, and, planted in this, the dates, from ten to twenty in each hole, develop themselves perfectly. But these cavities, called *Ritans*, are frequently invaded by the sand, and they require constant attention. This compels the inhabitants of Souf to employ the utmost activity, which, giving

* A little fish strongly resembling the above, if not identical with it, has been described by M. Gervais under the name of *Tellia apoda* (Annales des Sc. Nat. 1853, vol. xix. p. 14). It unites all the characteristics of our fish, with the exception of the ventral fins. It is said to be a native of Tell, south of Constantine.

† Revue et Magasin de Zoologie, 1859, tom. xi. p. 377.—E. D. See also Mr. Tristram's work on 'The Great Sahara' (already referred to). Mr. Tristram obtained specimens of *Cyprinodon dispar*, Lin., from the hot springs near Biskra; and Dr. Günther described them in a paper in the Zool. Proceed., 1859, p. 469. —A. C. R.

‡ But is it not possible that the fish, before rising in the waters of the wells, have been first carried down from the outer surface at a distance to the underground reservoirs that contain the waters underneath the surface of the Sahara?—A. C. R.

them habits of industry, has resulted in procuring them not only competence but wealth. All the houses were built of crystalline sulphate of lime, and were roofed with cupolas; from a distance a village looking like a collection of bee-hives. This singular custom is explained by the paucity of wood in that country: in the absence of beams to support the planking of a roof, they substitute a vault or a cupola, using the mid-rib of the palm-leaf for centreing.

It is a curious trait in the inhabitants of Souf, that having no other water than that of the wells, and this water never remaining on the sandy surface of the soil, they have no idea of a brook, or a river, or any other kind of running water.

ABSTRACTS OF BRITISH AND FOREIGN GEOLOGICAL PAPERS.

On the Eskers of the Central Plain of Ireland. By G. H. Kinahan, Esq. (Read before the Geological Society of Dublin, Nov. 11, 1863.)

ATTEMPTS to determine the mode of formation of a deposit from intrinsic physical evidence have lately become much more numerous than they were formerly. It was in this way that Mr. Sorby determined, some years since, the mode of formation of the sand-beds of Hastings, Isle of Wight, Yorkshire, &c., and last year the origin of certain mica-schists, through the occurrence in them of the structure he has designated 'Ripple-drift;' and in a similar manner, Mr. G. H. Kinahan has recently discussed, in a paper read before the Geological Society of Dublin, the nature and origin of the Eskers of the Central Plain of Ireland. His paper is important, chiefly on account of its containing a proposed nomenclature of Eskers, which we cannot explain better than by saying that it is nearly parallel to that of Coral-reefs proposed many years ago by Mr. Darwin; we thus have Fringe-eskers, Barrier-eskers, and Shoal-eskers, as parallel terms to those of Fringing Reefs, Barrier Reefs, and Atolls; but the relation of the last-named terms in each series is less evident than that of the others, and partakes more of the nature of antagonism than parallelism.

Mr. Kinahan thus defines the three classes:—'The Fringe-eskers occur fringing high ground; the Barrier-eskers stretch from one high ground to another; or run out as a spit or bar from high ground; and the Shoal-eskers have been so called, as they seem to be similar to shoals and shifting banks of the present day.'

In case any of our readers may ask the question, What is an Esker? we may define it as a ridge, or rarely a mound, of sand or gravel, heaped up by the action of water, and derived from masses of the same material in close proximity to it. These masses, though they occur elsewhere, are most abundant in Ireland, where they have received the name of 'Esker;' they are analogous to the sand-banks, harbour-bars, shoals, &c., now in process of formation, through the antagonistic action of tides and currents causing the accumulation of bottom-material at particular points.—H. M. J.

Sur la Craie glauconieuse du nord-ouest du Bassin de Paris. Par M. Hébert (Comptes Rendus), 7 mars 1864.

THE author proposes to describe this deposit as it occurs in a triangular area, the base measuring about 37½ miles, from Fécamp to Trouville, and the perpendicular 81 miles, from Trouville to Vernon. The lower member of the deposit rests on the Gault, or on the Neocomian conglomerate, and is distinctly marked by the occurrence of the characteristic sand; in the former case the Gault concretions are mixed with the bottom Greensands. There are eight horizons, with a total thickness of 82 yards. They form two divisions, the lower being separated from the upper by a slight stratigraphical break. The various subdivisions are connected by common fossils and similarity of mineral character. The upper limit of the Upper Greensand in this district is also sharply defined; the beds being separated from the Chalk-marl by a break, indicating an intermediate elevation of the sea-bottom. A characteristic species, however, of the upper beds of Upper Greensand, *Pseudodiadema variolare*, has been found by the author, with *Hemiaster Verneuilli* (a Chalk species), in the Chalk-marl on the right bank of the Seine.

The Upper Greensand is found on the northern coast of Calvados, near Trouville, at the height of about 330 feet, capping first the Jurassic rocks, and afterwards the ferruginous sands of the Lower Cretaceous rocks. Dipping ENE., it is seen about half-way up the cliff at Havre and Honfleur; the dip throughout being from one to ten in a thousand. Dipping continually in the same direction, the upper beds, at first denuded, are gradually brought into view; and the beds are buried under the overlying deposits, and lost sight of at the surface about a mile and a quarter to the west of Étretat. They reappear, by a fault, at Lillebonne.

Besides the known disturbances by which this formation has been affected, the author describes a fault at Villequier, on the right bank of the Seine, where the sands are brought up to 264 feet above the sea. This very considerable upheaval forms an amphitheatre round the village of Villequier, and the beds are on a NW. and SE. anticlinal, dipping away about 45° to SW. and 30° to NE.—D. T. A.

Die Stadt und Umgebung von Olmütz. Eine geologische Skizze zur Erläuterung der Verhältnisse ihrer Wasserquellen. Von Heinrich Wolf. [The Town and Vicinity of Olmütz: a Geological Sketch in Explanation of the Conditions of their Water Supply.] (Jahrb. k. k. geol. Reichsanst. vol. xiii. 1863.)

GREAT difficulty having been experienced within the last thirty years in obtaining drinking water for the garrison and town of Olmütz, attempts were unsuccessfully made from time to time on a large scale to discover a supply by boring in the artesian method. These attempts were made without any idea of the geological conditions. The author submits an account of the geology to prevent future experiments, the failure of which may be readily predicted.

The tower of the Rath-Haus in Olmütz is 810 feet above the sea, the wooded heights to the west are 1,386 feet; and these heights extend southward for some distance. To the east we have the

Heiligenberg (1,200 feet, the source of the Oder), and Na-Wartie (984 feet). To the north is the Bradlstein (1,884 feet), connecting the district with the Moravian mountains, which are structurally the same. The heights of the plateau within this ring appear, from the map accompanying the author's memoir, to vary from 720 to 850 feet. The valleys with which the plateau is intersected, and in one of which Olmütz is built, are about 650 feet above the sea.

The author considers that an elliptical boss of granite, a little to the south of the town, is the geological cause of the want of success in boring for water. The hills around are covered for some distance with loess, beneath which Miocene beds, Culm-schists, Devonian limestone and sandstones, clay-slate and granite exist, coming out on both sides; but lines of disturbance, connected with the presence of the granite, are traceable. Thus the Devonian rocks are thrown off to the east at Na-Wartie, and to the west at Kosirzberg, while midway they dip on the north side to the north, and on the south side to the south. A succession of crystalline metamorphic rocks, forming zones of quartzite, clay-slate, and mica-slate, conduct to the granitic axis. The correctness of this view, which is very imperfectly illustrated by surface-geology, is proved by the borings made at various points.

There is a considerable thickness of marine strata of the Miocene period in the neighbourhood of Olmütz; the important deposits of the Danube Valley, belonging to this part of the Tertiary epoch, extending in a narrow tongue a little beyond the town up the valley of the March. At more than 850 feet above the sea, lying on Devonian limestone, and not unfrequently faulted, there are sandy limestones, from one to four feet thick, containing *Cerithium rubiginosum*, *Tapes gregaria*, *Panopœa Menardi,* and *Anomia costata.*

D. T. A.

Sulle Piante fossili del Trias de Recoaro, raccolte dal Prof. A. Massalongo Osservazioni del Barone Achille de Zigno. (Memorie dell' I. R. Istituto Veneto di Scienze, Lettere, ed Arti, vol. xi. 1862.)

THIS memoir consists of thirty-one pages of descriptions of species of Plants collected by the late Prof. Massalongo from the Triassic strata of the Recoaro district, and is illustrated by ten plates of figures of the species. The species described, thirteen in number, twelve of which are new, are the following:—

Equisetites Brongniarti (?), *Unger.*
Caulopteris? Maraschiniana, *Mass. MS.*
C. Læliana, *Massal. MS.*
C. Festariana, *Massal. MS.*
Æthophyllum Fœtterlianum, *Mass. MS.*
Echinostachys Massalongi, *Zigno.*
Taxodites Saxolympiæ, *Massal. MS.*
Araucarites Recubariensis, *Mass. MS.*
A. Massalongi, *Zigno.*
A. pachyphyllus, *Zigno.*
Haidingera Schaurothiana, *Mass. MS.*
Taxites Massalongi, *Zigno.*
T. Vicetinus, *Massal. MS.*

The author arrives at the following conclusions:—

1. That in the Trias of the Basin of Ricoaro there exist two different floras, one characterizing the 'Lower Sandstone' overlying the mica-schist, and the other peculiar to the 'Upper Sandstone, Marl, and Limestone.' The first is distinguished by the remains of

Equisetites, Caulopteris, Æthophyllum, Haidingera, and *Taxites*; the second by that of *Araucarites* and *Taxodites*; and species of one fauna are not found in association with those belonging to the other.

2. That the genera *Taxites* and *Araucarites*, species of which have not hitherto been found below the Lias, occur also, and very abundantly, in rocks of Triassic date.

3. That the occurrence of the genera *Æthophyllum* and *Haidingera*, characteristic of the Bunter, in the 'Lower Sandstone' of Recoaro, leads to the inference that all the rocks between the mica-schist and the Jurassic strata, in the valleys of the Leogra and of the Agno, belong to the Trias.—H. M. J.

Discovery of a New Geological Epoch in the Quaternary Formations.—MM Garrigou and L. Martin have forwarded to the French Academy a long paper upon the epoch of the Aurochs, and that of the Reindeer, as established by their attentive study of the cave of Lourdes, in the Hautes-Pyrénées. Two years ago this cave was the subject of an interesting and detailed investigation by M. Alphonse Milne-Edwards, of which the results were published in the 'Annales des Sciences Naturelles.' M. Lartet and A. Milne-Edwards visited this Quaternary formation, studied its fossils with great care, and described it as belonging to the age of the Aurochs; and they have proved in a very satisfactory manner that man inhabited this cavern during that palæontologic epoch. MM. Garrigou and L. Martin have recently visited the same locality, and the results they now make known are very singular. The careful examination of the bones collected at the upper part of the cavern already explored by the naturalists above-named gave results identical with those of MM. Edwards and Lartet. The presence of bones of the Aurochs, the existence of bones of domestic animals, some bones that had been gnawed by a dog, the presence of nearly the entire normal amount of gelatine in these bones, their comparatively light colour, the discovery of a bone delicately sculptured, all prove that the authors were dealing with the *epoch of the Aurochs*, of which man must have been a contemporary; and also that this *upper portion indicates a geological epoch essentially different from the lower strata in the cave.* As regards the lower portions of the cavern, the presence of bones of the Reindeer in abundance, great quantities of its horns, *coarsely* ornamented objects, flint implements, &c., the reddish-brown colour of the bones, the entire disappearance of their gelatine, and their property of adhering to the tongue, all indicate a more ancient epoch than that alluded to above. This epoch, according to MM. Garrigou and Martin, is *that of the Reindeer*,* which the authors formerly discovered in the cavern of Izeste. The cavern of Lourdes thus furnishes us with the first example of the superposition of two successive palæontologic ages belonging to the Quaternary epoch.—T.L.P.

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* See M. Lartet's determination of the 'Reindeer Period,' in his account of the Aurignac Cave, Ann. Sc. Nat. vol. xv. p. 231.—Edit.

REVIEWS.

The Dolomite Mountains. Excursions through Tyrol, Carinthia, Carniola, and Friuli, in 1861–3. By Josiah Gilbert and G. C. Churchill, F.G.S. 8vo. Longman, 1864 : pp. 576.

THE Carinthian Alps have remained hitherto almost as unknown to English tourists as in the days when Goldsmith wrote the couplet which serves for motto in this sumptuous volume. The great highway of the Splugen commonly forms the eastern boundary of the Briton's wanderings. Few reach the Stelvio, or the line of railway from Verona to Trent and Botzen, though they lead to Innspruck, the heart of the Tyrol ; and fewer still devote their holidays to the magnificent solitudes of the Eastern Alps.

The geological party—if we may so term the two gentlemen, accompanied by their ladies—whose excursions are now commemorated, have devoted the leisure of three or four successive summers to this comparatively unfrequented region. The field of their observations extends from the upper valley of the Adige eastward along the Drave, and among the mountains bounding it, to the cathedral town of Klagenfurt, and so on to Laibach, where the railroad from Trieste to Vienna forms the furthest and most important route to the Austrian capital. But the region of the Dolomites—that in which they form the prominent features of the scenery—is more limited, not extending much beyond the valley of the Piave. Some might think that the company of ladies must have proved an impediment in their wanderings ; as the curé of Saas told his visitor, 'If he had only left his mother at home, they might have done something.' But our authors found the travelling teapot and umbrella more useful than the alpenstock, and not only vindicate their policy but gallantly assert that the book itself would have been much better if the ladies had written it.

We must admit that we have found the narrative of Mr. Gilbert much more readable than Mr. Churchill's chapter on geology. But in this Magazine it will be more appropriate to refer the reader to the original work for all its tales and legends, of prince-bishops, dukes, and saints ; of mansions plundered by the French, and castles destroyed by the Turks ; the Rosengarten, and the Dragon of Klagenfurt ;* of modern hostelries, good and bad ; and of roads and passes, subjects of the highest interest to those about to visit a country for the first time. The narrative is illustrated by six chromo-lithographs and twenty-seven woodcuts, representing some of the principal mountain-groups and objects described by the visitors.

There is a geological map of the Eastern Alps, by MM. Sedgwick and Murchison, in the 3rd vol. of the Geological Transactions, from

* The inhabitants of Klagenfurt have preserved in the Rath-Haus a fossil skull of the Tichorhine Rhinoceros, which many of them believe to be a remnant of their old enemy, whose bronze effigy adorns their public square. We have been told by Professor Suess that a skull of the same kind of Rhinoceros, and a large fossil rib and thigh-bone, are suspended by a chain in the Cathedral of Cracow.

which we may still obtain a good general notion of the physical structure of the region. The central chain or 'axis' of Plutonic and Metamorphic rocks—gneiss and syenite and granite—runs west and east, from Bormio and Glurns on the Stelvio, to the Glockner, and along the northern side of the valley of the Drave, passing by the silver-mines of Gmünd, and dividing into two branches as it approaches Gratz. This range is flanked by regions of old slaty rocks and calcareous beds (near Bleiberg) full of *Producta Martini*; with zones of Trias and Alpenkalk, 'Quader' and Hippurite limestone. The great escarpments of the limestone on either side of the Alps are found to face the central masses along the borders of which they run.

The regularity of these zones is interfered with by the great beds of porphyry and volcanic tuff, which are older than the Trias. The porphyry forms enormous plateaux in the neighbourhood of Botzen, averaging 4,000 feet in elevation, intersected by narrow 'cloughs' whose walls rise 2,000 feet above the streams, with sometimes a stair-like outline. Above these is placed the tuff-plateau, 2,000 feet in thickness, and still higher by thousands of feet rise here and there the masses of Dolomite.

The authors of the Memoir on the Eastern Alps supposed the Dolomites to be of Oolitic age; their serrated peaks are conspicuous in the sections accompanying the paper. They observed that at Bleiberg,* the metalliferous Dolomites rested on red sandstone and gypseous marls, but they were not aware that the overlying rock was older than the Lias. The geology of the district has now been more completely explored, and is graphically given in the work of Baron von Richthofen (4to. 1860, with geologically coloured map and sections), to which Mr. Churchill acknowledges himself indebted for the materials of his sketch. The order of succession of the Triassic beds may be briefly stated:—

1. Lower Lias; 'Dachstein' (Dolomite).
2. Upper Trias or 'Keuper;' 'Raibl beds' (fossiliferous).
   Schlern Dolomites, 3000—5000 feet thick.
   St. Cassian beds, a local member of the sedimentary volcanic tuff, 2,000 feet thick.
   Mendola Dolomite (with *Ammonites globosus*, &c.).
3. Muschelkalk; Campil beds, Seiss beds, &c.
4. Bunter sandstein; Groeden sandstone.

The Lias forms plateaux, with the 'Raibl beds' at its borders. Sometimes these latter appear as sloping ledges on the perpendicular walls of unbedded Dolomite, and are again surmounted by a series of short escarpments of Lower Lias Dolomites, forming a ledge between the upper and lower precipices which resembles a 'stratus' cloud

* The lead-mines of Bleiberg, near Villach, are the most extensive in Austria, yielding annually 1,600 or 1,700 tons of metal. The roof of the workings is formed of a dark brown marble, full of Ammonites, polished sections of which exhibit the most brilliant iridescence. This is the famous Lumachello, or 'Fire-marble.'

crossing the mountain summits, and adds greatly to the sublimity of their aspect. There are no fossiliferous equivalents in England of the deposits of St. Cassian and Hallstadt. Our White Lias is supposed to represent some higher beds, which have been called 'Rhætic,' after the Alps that divide Carinthia from the valley of the Inn.

In the last pages of this substantial volume we come to their most important geological topic, the origin of the Dolomites. Von Buch asserted, and most geologists have since believed, that they originally consisted of carbonate of lime, and he attributed their conversion to the influence of magnesian vapour evolved from the augitic porphyries beneath, during a period of depression. Unfortunately, it is no easy matter to vaporize magnesia; and, although it is highly probable that water has done more to metamorphose rocks than even the Plutonic fires, yet it is difficult to accept theories requiring that the sea should remain for ages at the boiling point. Mr. Sterry Hunt has made some observations on the action of solutions of bicarbonate of soda upon sea-water, by which hydrated carbonate of magnesia might be produced, and afterwards converted, with the aid of heat and pressure, into Dolomite. Sir R. Murchison and Prof. Harkness have still more recently suggested that the frequent association of gypsum with Dolomite supports the notion that the magnesia originally existed as a sulphate (Geol. Journ. May 1864). Some portions of the English magnesian limestones may have been originally deposited in the form of sediment derived from the waste of Dolomite mountains; but the concretionary beds, and the magnesian carboniferous limestone of Breedon, are probably metamorphic. The question is one for the chemist, and all the geologist can do is to set the facts rightly before his fellow-worker.

The peculiar *form* of the Dolomite mountains presents another question, admitting of a more satisfactory solution. Dr. Richthofen has called attention to their remarkable resemblance to coral-reefs, such as we know them to be from soundings, and theoretical considerations. The wood-cut (for the use of which we are indebted to the publishers) will give an idea of the outline of a group of Dolomite mountains, but a more vivid impression is conveyed by Mr. Churchill's comparison of them—scattered over the porphyritic platforms—to *icebergs stranded*; so little connection did they appear to have with the associated rocks. Sir R. Murchison observed traces of bedding on some of their precipices, seen in a favourable light; but they usually appear devoid of stratification, and are deeply divided by vertical fissures. There is an unromantic view of the Dolomitic Podoigebirge, forming the frontispiece to Dr. Klipstein's work on the fossils of St. Cassian,* which even more strongly than Mr. Gilbert's views brought to mind a rude outline of a Red Sea coral-reef made by the engineer who erected the lighthouse on the Uschruffee Islands. On cutting down the reef, he found that the coral was not solid, but formed of irregular columns, which expanded their summits laterally as they reached the limit of growth at the low-water line, leaving fissures and

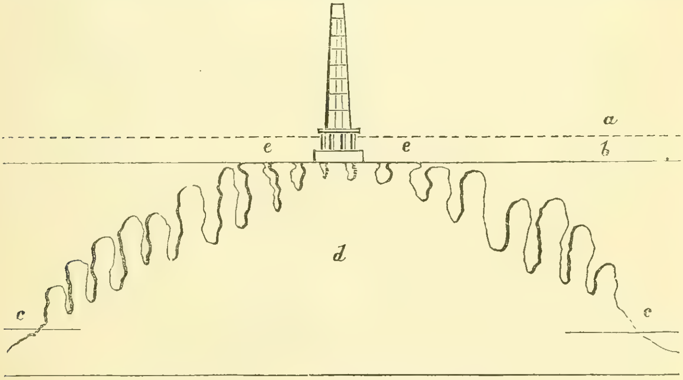
* The collection made by Dr. Klipstein is in the British Museum.

caverns that were open or only filled with mud. Beyond twenty-five fathoms there was no living coral, but a bottom of coral-sand.

Ehrenberg, when describing the corals of the Red Sea, compares them to forest-trees. The huge brain-corals (*Mæandrinæ*) as old as

Monte Civita and Caprile (p. 136).

the Pharaohs, grow upwards like living pillars, crowned with verdant summits, and leave a dead and petrified mass below. For it appears that not only do these corals fill up their own cells and cavities more or less, but they are further solidified by the infiltration of crystalline carbonate of lime, as Mr. Darwin has described in his celebrated



Lighthouse on Uschruffee Island, Red Sea.

a Level of high water. *b* Low-water line. *c*, *c* Coral-sand, at twenty-five fathoms. *d* Coral-rock. *e*, *e* Masses of coral expanding laterally as they approach low-water-mark.

Journal. Mr. Churchill suggests that the formation of Dolomite may be going on in coral reefs at the present day ; for the specimens of coral rock brought home by Dana from the raised island of Matea, or Aurora, were found to contain in one case 5 per cent., and in another as much as 38 per cent., of carbonate of magnesia.

And if we suppose the Dolomite mountains of Carinthia to have been formed on a gradually subsiding basis, they may have grown up like the low islands of the Pacific, till the sea attained the depth of a thousand fathoms, preserving their original contour from first to last, the groups of corals, like a forest of tree-trunks without tops, rising upwards together, and becoming partially solid by lateral growth, or by filling up with sediment.

We have no fossil coral-reef in England wherewith to compare the Dolomite Mountains. Our Magnesian limestone affords only *Bryozoa*, for it has not been suspected that the remarkably concentric and radiated concretions are metamorphosed corals. In our Silurian coral-reef of the Wenlock Edge and Dudley there may be masses of branching coral a yard across, and convex *Stromatoporæ* (which are not corals) of nearly equal size. But the coral-beds are separated by clay partings, and never attain a great thickness. The Devonshire marbles have much the appearance of coral-reefs, so far as respects the scattering of small masses over a region of argillaceous schists. In the Carboniferous Limestone layer above layer of branching corals may be seen in the lofty cliffs of Cheddar and the weather-beaten shores of Lough Erne. There the corals are slightly silicified, and stand out in relief, while the mass of the rock is composed of sediment with Foraminiferal and Encrinital débris. The Coral-rag forms a reef in some parts of Wiltshire, but it is rarely seen in section ; the corals are usually obtained as stones from the ploughed fields.

The conversion of a limestone coral-reef into *Dolomite* becomes comparatively easy of belief, since Mr. Sorby has shown that coral (like nacre) has the constitution of aragonite, a much less stable compound than calcareous spar.

Pearly shells are never preserved in calcareous rocks, unless in a metamorphic condition. And the corals of the Oolite formation are usually silicified, like those of Tisbury in Wiltshire and Nattheim in Germany, or replaced by structureless calcite full of sparry cavities. It is now also well-known that the masses of annulated chalcedony, called 'Beekite,' found in the neighbourhood of Torquay, are Devonian corals more or less completely replaced by silica, for they are sometimes hollow, and in other instances contain a nucleus of fossil coral.

REPORTS AND PROCEEDINGS.

THE GEOLOGICAL SOCIETY OF LONDON.

THE following communications were read, May 25, 1864 :—

1. 'On the Geology of part of the North-western Himalayas.' By Captain Godwin-Austen. With Notes on the Fossils ; by Messrs. T. Davidson, R. Etheridge, and S. P. Woodward.

The geological formations occurring in these regions were stated to be (1) a fluvio-lacustrine series, (2) a Siwalik series, (3) Nummulitic Limestone, (4) Jurassic rocks, and (5) a Palæozoic series. In reference to the fluvio-lacustrine strata, the author gave a résumé of the conclusions respecting their physical features and mode of formation at which he had arrived in a former paper,* and in addition gave some details respecting their position and stratigraphical characters, especially describing the mode of occurrence in them of some land and freshwater Shells, which were referred to in a Note by Mr. S. P. Woodward, as being all recent British species. The lakes in which the lacustrine deposits were formed were supposed by Capt. Godwin-Austen to have been produced in consequence of the mouths of valleys, into which rivers run, becoming blocked up by means of glaciers and otherwise, as now often happens in the same region. Stratigraphical details of the other series of rocks were then given, the Jurassic formation being supposed to belong to the Middle Division of the Oolites, and the Palæozoic limestone being described as Carboniferous Limestone, both of which determinations were confirmed by Messrs. Etheridge and Davidson in Notes on the Fossils, in which their striking resemblance to those of the same age in Britain was shown. The age of the clay-slate and mica-slate was stated to be very doubtful; and the author concluded by describing the localities in which granite rocks occur, but chiefly as forming the axis of the North-western Himalayas.

2. 'On the Cetacean Fossils termed *Ziphius* by Cuvier, with a notice of a new species (*Belemnoziphius compressus*) from the Red Crag.' By Prof. T. H. Huxley, F.R.S., F.G.S.

The genus *Ziphius*, as originally constituted by Cuvier, contained three species described by him, namely, *Z. cavirostris*, *Z. planirostris*, and *Z. longirostris;* but it is probable that each of these really belongs to a distinct genus—the first to *Ziphius*, the second to *Choneziphius*, and the last to the author's genus *Belemnoziphius*. More recently M. Gervais has established a new species—*Ziphius Becanii*—from a specimen formerly considered to belong to *Z. longirostris*; and this species, with that described in this paper, and Professor Owen's MS. species in the British Museum, were also considered referable to *Belemnoziphius*.

Besides the foregoing conclusions respecting the affinities of the fossil *Rhynchoceti*, Professor Huxley discussed the relations of the recent genera and species of the same group, including the Cetacean of Aresquiers, which was considered by Gervais to belong to the genus *Ziphius*. He exhibited these relations in a tabular form, and concluded by stating that he had arrived at the following results:—

1. Unless the Cetacean of Aresquiers be identical with *Ziphius cavirostris*, all the *Ziphii* of Cuvier belong to *Cetacea* generally distinct from those now living.

2. If the Cetacean of Aresquiers be identical with *Ziphius cavi-*

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* Quart. Journ. Geol. Soc., vol. xv. p. 221.

rostris, it is not certain that the latter is truly fossil; nor, if it be so, have we any knowledge of its stratigraphical position.

3. Of the certainly fossil *Ziphii*, the stratigraphical position of *Belemnoziphius longirostris* is unknown; but all the other species of that genus, and *Choneziphius planirostris*, are derived from the English or Antwerp Crag, and are not known to occur out of it.

4. So that at present we are justified in regarding *Belemnoziphius* and *Choneziphius* as true Crag Mammals.

The following communications were read, June 8, 1864:—

1. 'On the Rhætic Beds and White Lias of Western and Central Somerset, and on the discovery of a new Fossil Mammal in the Grey Marlstones beneath the Bone-bed.' By W. Boyd Dawkins, Esq., B.A., F.G.S.

After describing the sections in the district, and showing the palæontological relations of the White Lias to the *Avicula contorta* series and the zone of *Ammonites planorbis*, the author enunciated the following conclusions:—(1) That the true position of the White Lias is immediately above the *Avicula contorta* zone of Dr. Wright, and at the base of the Lower Lias shales; (2) that it is entirely distinct from the Rhætic beds, lithologically and palæontologically; and (3) from the discovery of Rhætic fossils in the Grey Marls below the Bone-bed, that the latter belong to the Rhætic formation. He then proceeded to describe a two-fanged mammalian tooth, which he had found in the Grey Marlstones below the Bone-bed, and which he considered to be the analogue of the trenchant four-ridged premolar of *Hypsiprymnus*, of the section to which *H. Hunteri* belongs. Until additional remains be found, its affinities to *Microlestes* or to *Plagiaulax* cannot be determined; Mr. Dawkins has, therefore, named it provisionally *Hypsiprymnopsis Rhæticus.* In conclusion he traced the range of the Marsupials in space and time, showing that of the six families into which Van der Hoeven divides the existing Marsupials, two—the entomophagous and sarcophagous *Dasyurina*, and the phytophagous *Macropoda*—had been represented in England during the interval between the deposition of the Rhætic Marlstones and that of the Purbeck beds.

2. 'On the Geological Structure of the Malvern Hills and adjacent District.' By Harvey B. Holl, M.D., F.G.S.

The geological structure of these hills was described in detail, and it was concluded that the rocks hitherto treated of as syenite, and supposed to form the axis of the range, are in reality of metamorphic origin, consisting of gneiss (both micaceous and hornblendic), mica-schist, hornblende-schist, &c., all invaded by veins of granite and trap-rocks. It was then shown that the Hollybush Sandstone is the equivalent of the Middle Lingula-flags, and that the overlying black shales correspond with the Upper Lingula-beds, the whole being overlain, as in Wales, by Dictyonema-shales. These rocks, on the east of the Herefordshire Beacon, are altered by trap-dykes, which were shown to be of later date than those traversing the crystalline rocks before alluded to. Allusion was next made to the Upper

Llandovery strata which overlie unconformably the Primordial rocks just noticed; after which the several faults in the district were described in detail. Dr. Holl concluded with some remarks on the general relations of the rocks of the Malvern Hills with those of the surrounding districts, describing the successive physical changes supposed to have been consequent upon their deposition and their subsequent elevations and depressions.

The Severn Valley Field-club held their first meeting for the present season on 26th May, at Benthall Edge. An address was delivered by the Rev. W. Purton (one of the Vice-Presidents of the Club), upon the geological characteristics of the district. He described the various physical changes which had taken place from the deposition of the oldest Palæozoic strata to the period of the Glacial drift, and the erosion of the Valley of the Severn. They next proceeded to Benthall Hall, the seat of G. Maw, Esq., F.G.S., where the members and their friends, upwards of sixty in number, partook of luncheon. A large collection of flint and stone implements, from France, Denmark, and Switzerland, and many British localities (lent for the occasion by Messrs. John Lubbock, Evans, Christy, Tyndall, Wyatt, and others), were exhibited, and excited great interest. The Rev. A. T. Bonner (H. M. Inspector of Schools), gave an explanatory lecture upon the collection, recapitulating the evidence derived from the Drift-gravels, the Danish Peat-mosses, and the Swiss Lake-dwellings. The President described the Perigord caves explored by MM. Christy and Lartet. The Rev. T. Ragg considered that these weapons might have been in use at a less remote period than was generally supposed. Mr. J. Maw, sen., defended the antiquity of these interesting relics. The members next visited the gravel-beds near the Severn Valley Railway [described by Mr. George Maw, F.G.S., Quart. Journ. Geol. Soc., 1864, p. 131], on their way to Buildwas, where the Rev. W. H. Wayne read an interesting paper on the Abbey. From Buildwas the party adjourned to Severn House, the residence of the President, where tea was prepared. Soon after the meeting separated.—*Eddowe's Shrewsbury Journal*, June 1, 1864.

The annual meeting of the Dudley and Midland Geological Society and Field-club was held on Tuesday, May 24th. The Right Honourable the Earl of Dudley was elected President of the Society for the ensuing year, Mr. E. Hollier Hon. Curator, and Mr. John Jones Secretary. The columnar basalt of Rowley was visited during the day by the members of the club.—*Colliery Guardian*, May 28, 1864.

Berwickshire Naturalists' Club.—This club held a meeting at Greenlaw on the 26th May. After breakfast, the members proceeded to inspect the remarkable 'kaims' at Bedshiel, about the formation of which there has been considerable diversity of opinion.*

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* See the Report of the British Assoc., 1861, Rep. Sect. p. 115, for Mr. Milne-Home's views of their having been formed of marine shingle when the land was at a lower level than it is at present.—Edit.

After dinner, Mr. G. Tate, F.G.S., read a very interesting paper on the subject of the 'kaims,' in which he attributed their formation to the action of water at a remote period.—*Alnwick Mercury*, June 1.

THE Proceedings of the COTTESWOLD NATURALISTS' FIELD-CLUB for 1863 contains the first part of a monograph *On the Ammonites of the Lower Lias*, by Thomas Wright, M.D., F.R.S.E., F.G.S. An account is here given of the different zones into which the Liassic rocks are now divided; also of the classifications of the Ammonites, after Sowerby, Von Buch, and D'Orbigny.*

CORRESPONDENCE.

DISCOVERY OF ELEPHANT REMAINS NEAR DUDLEY.

To the Editors of the GEOLOGICAL MAGAZINE.

THE men who are engaged in digging clay for bricks in the pit belonging to a brickyard near Oldbury, came lately upon 'a lot of things like great stone bones, like as though a great big animal had been buried there.' The bones were in the marl under the soft clay, perhaps ten or twelve feet below the surface. One piece was described as being seven or eight feet long, a little curved, and as thick as one's arm. It was shown to a timber merchant, who pronounced it a piece of a tree, from the circular rings of growth. The brickmaker, however, was quite sure it was not any tree that had grown there within the last five-and-forty years ; he had tried one piece in the fire, and found it wouldn't burn. I succeeded in obtaining a portion of tusk, twenty-four inches long and thirteen inches round, and curving about three inches. It shows the alveolus at both ends,† and in drying contracts a good deal, separating into concentric layers of growth. I have resided more than forty years at Dudley, but never heard of fossil elephant bones being found in this part of the country before.

JOHN GRAY.

Hagley, June 6, 1864.

To the Editor of the GEOLOGICAL MAGAZINE.

SIR,—Allow me to suggest to the various scientific Societies and Field-clubs holding Field-meetings, the advisability of announcing their arrangements in the GEOLOGICAL MAGAZINE. By this means scientific men will be informed of their gatherings, and may often find it convenient to join any particular Society; and, moreover, there will not be so great a probability of the Meetings of one Club clashing with those of another. As things are now, we not unfrequently have two or three meetings of Midland Clubs in the same week.—I am, Sir, your obedient servant,

JNO. JONES,
Sec. Dudley Geological Society.

June 22, 1864.

* A fuller notice will be given of the papers contained in this and other Reports in a future number.—EDIT.

† The alveolus of an entire tusk of *E. primigenius* in the British Museum (dredged off Palling on the Norfolk coast) is 23 inches deep.—EDIT.

NOTICES OF RECENT DISCOVERIES.

Discovery of a New Species of Plesiosaurus.—E. C. Hartsinck Day, Esq., F.G.S. (our local correspondent for Charmouth), has recently obtained the most perfect *Plesiosaurus* ever discovered upon the Dorsetshire coast. It was found between Charmouth and Lyme Regis, in a bed of marl, intercalated between two of the uppermost beds of the Lower Lias Limestone. It comes, therefore, from about the middle of the zone of *Ammonites Bucklandi.* The specimen, 13 ft. in length, exhibits the entire dorsal view of the skeleton, with very few bones displaced. With a large head is associated a beautifully-preserved lower jaw filled with long curved teeth ; the cervical vertebræ exhibit well the characteristic pleurapophyses ; the dorsal vertebræ and the ribs are, as well as the other parts, brought out into strong relief, and even the pelvic bones of the under side are partly shown *in sitû* ; the tail, though less well preserved, is, as a whole, in position ; but the great perfection of the specimen lies in the completeness of the four limbs or paddles, of which not only are nearly all the numerous bones preserved, but they are all, excepting a few of the ultimate small ones, perfectly undisturbed from their original arrangement and relative position. It is gratifying to learn that this magnificent Enaliosaurian relic makes an addition to our knowledge of the Liassic fauna, as it is a new species of the genus, differing in important points from those hitherto known. This specimen has now, we understand, been purchased by the authorities of the British Museum, and will shortly be described by Professor Owen.

Organic Remains in the Laurentian Rocks of Canada.—Examinations by the Geological Surveyors of Canada during the past year have furnished additional evidence that the oldest known stratified rocks, constituting the great Laurentian system, are divided into two unconformable groups—the 'Labrador series' and the 'Laurentian series,' the former resting uncomformably upon the latter or the true Laurentian rocks.

In 1852 there were discovered in the Laurentian limestone of the Ottawa an organic form resembling the coral *Stromatocerium.* Last year there were detected in the serpentine-limestone of Grenville, of true Laurentian age, an organism which Dr. Dawson describes as that of a Foraminifer growing in large sessile patches, after the manner of *Carpenteria,* but of much greater dimensions, and presenting minute points which reveal a structure resembling that of other foraminiferal forms, as for example *Calcarina* and *Nummulina* ; and to which he has given the name of *Eozoön Canadense.**

Large portions of the Laurentian limestone appear to be made up of these organisms, mixed with other fragments, which suggest com-

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* Canad. Nat. and Geol., April 1864.

parisons with Crinoids and other calcareous fossils, but cannot be distinctly determined. Some of the limestones are more or less coloured by carbonaceous matter, exhibiting evidences of organic structure, probably vegetable. — *American Journal of Science*, March, 1864, p. 273.

New Cornish Mineral ('*Langite*').—Professor N. S. Maskelyne exhibited at the meeting of the Geological Society, on the 8th inst., some beautiful specimens of a new mineral recently discovered in Cornwall, which he proposes to name 'Langite,' in honour of Professor Victor von Lang, of the University of Gratz, and formerly of the Department of Mineralogy in the British Museum. It consists of a basic sulphate of copper, insoluble in water, and is disposed as an incrustation upon very soft 'Killas' slate in masses of a rich blue colour, accompanied by minute crystals belonging to the prismatic system. It was obtained from Mr. Talling, dealer in minerals, Lostwithiel, Cornwall.

New Ironstone Deposits in Yorkshire.—Ironstone has been found recently in several localities on the North Yorkshire moors; for instance, at Blisdale, and in the whole of the valleys opening to the Vale of Pickering.—*Colliery Guardian*, May 28, 1864.

MEETINGS OF THE FIELD-CLUBS AND GEOLOGICAL SOCIETIES.

Liverpool Geological Society.—Field-meeting at Llangollen on the 13th and 14th of July. The members of the Manchester Geological Society are expected to attend. (The field-meeting at Bidston Hill will be held soon afterwards.)

Cotteswold Naturalists' Field-club.—On July 21st, Ross; August 17th, Cheltenham; September 14th, Bath.

Teign Naturalists' Field-club.—July 22nd, Torquay, in conjunction with the Devon County Association and other scientific societies; August 16th, Buckland Woods and Holme Chase, near Ashburton; September 13th, Dunsford, Clifford Bridge, and Fulford Park.

Malvern Naturalists' Field-club.—July 21st, Ross, to meet the Cotteswold Club; August 17th, Cheltenham; September 14th, Bath.

Tyneside Naturalists' Field-club.—July —, Fern Islands and North Sunderland; August 19th, Stanhope; September 14th, Rosehill; October 6th, Marsden.

Berwickshire Naturalists' Field-club.—July 28th, Ancram; August 25th, Bamburgh; September 29th (annual meeting), Berwick.

Dudley and Midland Geological and Scientific Society and Field-club.—July 14th and 15th, Llangollen, to meet the Liverpool Geological Society, the Manchester Geological Society, and the Oswestry and North Wales Field-club; August 17th, Cheltenham, to meet the Cotteswold and Malvern Field-clubs; September 6th, Hagley and Halesowen; August 2nd (ordinary monthly meeting), Dudley; August 3rd, the Warwickshire Naturalists' Club will visit Dudley, and members of this society will be invited to meet them.

Severn Valley Naturalists' Field-club. — Thursday, August 4th, Stiper Stones; Thursday, September 8th, Linley.

Warwickshire Naturalists' Field-club.—August 3rd, Dudley, to meet the Dudley Geological Society.

THE

GEOLOGICAL MAGAZINE.

No. II.—AUGUST 1864.

ORIGINAL ARTICLES.

I. Remarks on the Bridlington Crag, with a List of its Fossil Shells.

By S. P. Woodward, F.G.S., A.L.S.

THE earliest, and almost the only published, notice of the 'Bridlington Crag' is contained in a single page of Loudon's 'Magazine of Natural History' for 1835, vol. viii. p. 355, entitled 'A Short Account of an Interesting Deposit of Fossil Shells at Burlington Quay, by Mr. William Bean.' Writing from Scarbro' on March 30th, Mr. Bean states that ten days previously he had made a geological excursion to 'Burlington Quay,' when Mr. Walter Wilson, an intelligent lapidary of that place, directed his attention to a deposit of fragile and broken shells, which the late high tides had exposed on the north side of the harbour, and near the pleasure-ground called the Esplanade. On arriving at the spot, he found a heterogeneous mass, only a few yards long, and as many high, composed of sand, clay, marine shells, and pebbles of every description, chalk and flint being most abundant. The colour and appearance of this shelly bed resembled London Clay, but the fossils had the character of those found in the Crag formation. It would be necessary to collect a greater number of species than he had then obtained, and to exercise much caution before the geological position of the bed could be truly determined; but of this much he was certain, that the shells were coeval with, if not of higher antiquity than the Crag. More than half of them could not be referred to any existing species. The writer concluded by mentioning that he had already made a second visit to the place, in company with Dr. Murray, and reaped an abundant harvest. He proposed shortly to publish a list, with figures and descriptions of the new species; but the intention was never fulfilled.

In Young and Bird's 'Geological Survey of the Yorkshire Coast,' published in 1822, it is stated (p. 22) that 'In 1811, with a view to the improvement of Bridlington harbour, the alluvium which forms its bed was bored through. It was found to consist of a bed of compact clay, 28 ft. thick, and a bed of cretaceous flinty gravel, 15 ft. thick, beneath which was the solid chalk.' But no mention is made of Tertiary shells.

Professor John Phillips, however, tells us that 'Professor Sedgwick, who examined the spot in 1821, discovered appearances on the north side of the harbour, which he supposed to indicate the presence of one of the strata above the Chalk.'* Mr. Phillips repeatedly searched, without success, for these beds, until July 1828, when he found, below the level of half-tide, an enormous mass of dark, shaly clay, having the appearance of Lias, and containing species of *Ammonites*, *Pentacrinus*, and *Avicula*, which he was 'at first disposed to think a portion of a Tertiary stratum.' He had seen specimens of *Pholas crispata* washed ashore, 'full of coherent sand, unusually solidified,' but to these he attached no importance.†

About the year 1850, Mr. H. C. Sorby visited Bridlington, and examined the Crag deposit for the sake of collecting *Foraminifera*. These were named by Professor T. R. Jones, and enumerated in Mr. Sorby's paper, read at the meeting of the Geological and Polytechnic Society of the West Riding of Yorkshire, in July, 1857.‡ (Proceedings, 1858, p. 559). He describes the situation and condition of the deposit much in the same terms as it was spoken of by Mr. Bean.

More recently the whole of the mass described by Mr. Bean and again by Mr. Sorby, has been entirely removed or built over during the construction of a pier, and it has been suggested that the only remaining chance of obtaining the fossils of the Bridlington Crag consists in dredging, or other operations in the harbour.

Mr. Leckenby, who formerly collected these shells more extensively than any one except Mr. Bean, considers the deposit to have been lower in position than the Boulder-clay,

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* Prof. Sedgwick informs me by letter (June 10) that his paper, in which the Bridlington shell-beds are mentioned, was published in the Annals of Philosophy for 1826. He collected a good many of the shells, and might have easily filled a wheelbarrow with them at the time of his visit in 1821. But owing to their extreme fragility, and bad packing, the specimens did not even get so far as Scarboro' in safety.

† Geology of Yorkshire, 1835, p. 40.

‡ See Appendix to this paper by Prof. T. Rupert Jones.

resting indeed upon the Chalk. The Bridlington fossils collected by Mr. Bean are, many of them, imbedded in an olive-grey sand, full of small brown and black pebbles of chert and flint, mixed with fragments of shells. Some of the pebbles are coated with fossil *Nulliporæ*, *Spirorbes*, and *Bryozoa*, or with basal plates of *Balanus porcatus* and *crenatus*. He also obtained some Sharks' teeth, bones of the *Platax*, like those found in the Norwich Crag, and an otolite resembling those of the Haddock.

In the letter before referred to, Mr. Bean enumerates twenty-two genera of shells, a few of which have not since been verified. These are *Corbula*, *Psammobia*, *Cytherea*, and *Turbo*.* He also mentions '*Pecten*, two species,' whereas both the fragments in his collection† belonged to *P. Islandicus*. The 'Tornatella' of Mr. Bean has proved, on strict examination, to be a distorted *Natica*; and the reputed *Arca tetragona* has been converted, by washing and clearing, into a smaller valve of *Rhynchonella*. The *Mactra solida* of the same collection appears to be a recent shell.

In Mr. Searles Wood's 'Monograph of the Crag Mollusca,' published by the Palæontographical Society in the years 1847–55, the Bridlington deposit is called 'Mammaliferous Crag,' and regarded as the equivalent of the Norwich beds. Forty species of shells are enumerated, and three varieties, which have been generally considered worthy of specific distinction. Two of these, *Natica monilifera* and *Mya arenaria*, I have not been able to confirm, and there appears to be no authority for the statement that they were ever found at Bridlington. A third shell, *Natica Bowerbankii* (Forbes) is only mentioned as being indeterminable; and the *Astarte* figured by Mr. Wood and described as a variety of *A. mutabilis* is regarded by Mr. Leckenby (with more probability) as a malformed example of *Astarte borealis*. Of the thirty-nine good species and varieties known to Mr. Wood, one is supposed to be a new species, and is described as 'Natica occlusa.' The specimens of *Buccinum* cannot be referred with certainty to the ordinary recent form, and the large *Fusus* is not identified with *F. gracilis* by Mr. Jeffreys. The *Cardita analis* (?) of Mr. Wood is perhaps a variety of the recent arctic shell (*C. borealis*); and his *Dentalium entale* is the form now distinguished as *D. abyssorum* by northern naturalists.

In a list of the Shells of the Norwich Crag contributed to

* Mr. Bean speaks of the *Turbo* as 'a fine pearly shell;' by which Mr. Leckenby thinks *Margarita elegantissima* was intended.

† The principal portion of Mr. Bean's collection is now in the British Museum; the rest is in the Philosophical Institution at York.

Mr. Gunn's Essay on the Geology of Norfolk, and printed in 'White's Gazetteer' last autumn, I adopted the Bridlington species from Mr. Wood's list with little alteration; but having been requested to revise and reprint that list, I commenced with the shells of Bridlington, as I had the opportunity of examining the materials used by Mr. Wood, and more ready access to some of them.

The following list has been prepared partly from a fresh examination of Mr. Bean's collection, and partly from a list supplied by Mr. Leckenby, who has also forwarded to me at various times such of the fossils as I wished to examine. All the specimens about which I entertained any doubt have been kindly examined by Mr. Gwyn Jeffreys, who has enabled me to compare some of the critical species with their recent analogues.

This investigation has led to the somewhat unexpected result that the Bridlington deposit can no longer be considered the exact equivalent of the Norwich Crag in age, or in climatal conditions. Of the sixty-three shells found by Mr. Leckenby and Mr. Bean at Bridlington, only thirty-five are common to the Norwich Crag. And while twenty-nine species—or one-half of those from Bridlington which are still living—are limited to the seas north of Britain, only one-sixth part of those found in the Norwich Crag have an Arctic character.

In order to compare the Bridlington Shells with those of the Northern Drift, I have prepared a list of one hundred and thirty-four species, chiefly from the Clyde Beds, and belonging to the close of the 'Glacial period.'* Of these only forty-two are common to Bridlington, a resemblance scarcely exceeding that of the Norwich Crag; while only twenty-nine of the Clyde Shells are Arctic, a proportion nearly the same as in the last-mentioned deposit. It follows that the Bridlington Shells are almost equally distinct from those of the last Pre-glacial and the first Post-glacial deposits, and is much more Arctic than either, as if formed during the climax of the last great age of cold in Britain.†

* The list by Mr. James Smith of Jordan Hill was not sent to me until it was in type, and although I did as much to it as was possible under the circumstances, it still retains many inaccuracies and obscurities.

† The shells found by the Rev. T. Brown at Elie, in Forfarshire, include five sorts not hitherto met with in the Clyde deposits. Nearly half these Elie shells are Arctic species.

LIST OF THE MARINE TESTACEA OF THE BRIDLINGTON CRAG.

A. *Arctic shells.* B. *Living in British Seas.* O. *Extinct.*

Genera and Species	Coralline Crag	Red Crag	Norwich Crag	Glacial	Living
Buccinum undatum?	?	?	?	?	B ?
Fusus carinatus		—	—	—	A
F. contrarius, var. carinatus				—	A ?
F. gracilis?		?	?	?	B ?
F. propinquus				—	B
*F. ventricosus					A
F. Sabini					A
Trophon scalariformis		—	—	—	A
T. Gunneri			—	—	A
T. clathratus				—	B
*T. Fabricii					A
Purpura lapillus		—	—	—	B
Columbella Holboellii					A
Mangelia turricula			—	—	B
M. Trevelliana			—	—	B
M. cylindracea?					A
M. cinerea (= Pingelii)					A
*M. elegans					A
M. pyramidalis					A
Admete viridula			—		A
Trichotropis borealis	—			—	B
Natica clausa		—	—	—	A
N. Groenlandica			—	—	B
*N. occlusa					O
N. Montagui				—	B
N. helicoides			—	—	B
Scalaria Groenlandica		—	—	—	A
Turritella erosa					A
T. communis			—	—	B
Litorina litorea		—	—	—	B
Margarita elegantissima					A
Puncturella Noachina				—	B
Dentalium abyssorum				—	A
Rhynchonella psittacea			—	—	A
Anomia squamula			—	—	B
Pecten Islandicus				—	A
Mytilus edulis		—	—	—	B
Modiola vulgaris			—	—	B
(*Continued.*)	1	7	17	24	

* The species marked with an * are in the cabinet of Mr. Leckenby; the rest are represented in the British Museum.

Genera and Species	Coralline Crag	Red Crag	Norwich Crag	Glacial	Living
*Pectunculus glycimeris . .	—	—	—		B
Nucula Cobboldiæ			—		O
*N. tenuis		—	—	—	B
Yoldia oblongoides		—	—		A
*Leda caudata		—		—	B
L. pernula				—	A
Cardium edule		—	—	—	B
C. Islandicum					A
Cardita analis?					O
Astarte borealis			—	—	A
A. —— var. semisulcata . .				—	A
A. elliptica			—	—	B
A. sulcata		—	—	—	B
*A. crebricostata				—	A
A. compressa			—	—	B
A. —— var. striata			—	—	B
Cyprina Islandica	—	—	—	—	B
Venus fluctuosa					A
Tellina calcaria		—	—	—	A
T. obliqua	—	—	—	—	O
T. solidula				—	B
Mactra elliptica		—	—	—	B
Mya truncata	—	—	—	—	B
Panopæa Norvegica		—	—	—	B
Saxicava arctica (sulcata) . .				—	A
Pholas crispata	—	—	—	—	B
	6	20	34	44	

Mangelia pyramidalis appears to be the northern representative of our *M. rufa.*

Columbella Holboellii is regarded by some as a boreal variety of the '*Mangelia*' *nana* of Forbes and Hanley. The Bridlington fossil is like the specimens from Finmark, Spitzbergen, and Greenland.

Turritella erosa, Couth. (= *T. polaris,* Beck), is found living in Greenland and Iceland, Spitzbergen and Newfoundland.

Margarita elegantissima is living on the coasts of Finmark and Greenland.

Nucula Cobboldiæ differs from the Crag Shell in exhibiting a tendency to become smooth when approaching its full growth.

Yoldia oblongoides, Wood. I adopt this name to signify that the species is identical with that of the Crag. It is not the same with the recent *myalis,* as stated by Mr. Wood, but is more like *limatula* (Say) or *hyperborea* (Lewin), which most conchologists will consider varieties.

Venus fluctuosa, Gould (*astartoides*, Beck), is found living in Behring's Straits, Greenland, Spitzbergen, and Newfoundland.

Montacuta bidentata. Prof. E. Forbes mentions 'a Bridlington fossil in Mr. Bowerbank's collection, which appears to belong to this species.'—Catalogue of Shells from the Glacial Beds, Mem. Geol. Survey, vol. i. p. 409. 1846. Mr. Searles Wood has not confirmed this reference.

Panopæa Norvegica. This shell is not found in the Norwich Crag, except at Chillesford, under exceptional circumstances.

Note on the Foraminifera of the Bridlington Crag.

In a collection of Foraminifera of the Bridlington Crag, made some years since by Mr. H. C. Sorby, F.R.S., and referred to in the foregoing paper, Messrs. T. Rupert Jones and W. K. Parker have observed the following species and notable varieties:—

Cornuspira foliacea, *Philippi.*
Biloculina ringens, *Lamarck.*
Triloculina oblonga, *Montagu.*
Quinqueloculina triangularis, *D'O.*
Q. Seminulum, *Linn.*
Lagena sulcata, *W. and J.*
L. squamosa, *Montagu.*
Dentalina brevis, *D'Orbigny.*
Dentalina communis, *D'Orbigny.*
Cristellaria cultrata, *Montfort.*
Polymorphina lactea, *W. and J.*
Cassidulina lævigata, *D'Orbigny.*
Truncatulina lobatula, *W. and J.*
Nonionina scapha, *F. and M.*
Polystomella striatopunctata, *Fichtel and Moll.*

These are such as are at present found in Northern Seas from the shore-line to about fifty fathoms; and, excepting *Cassidulina*, all occur in the Crag of Suffolk.—T. R. J.

II. Remarks on the Skeleton of the Archæopteryx; and on the Relations of the Bird to the Reptile.

By W. K. Parker, F.Z.S.

In Plate 1 of Professor Owen's invaluable memoir on the *Archæopteryx* (Phil. Trans. 1863), the fifth vertebra behind the *Acetabula* is seized upon as the first of the caudal series. In Pl. 3, fig. 5, of the same memoir, we have the delineation of a young Ostrich's pelvis; and in that figure the first post-femoral joint is marked as the commencement of the true tail; eight such joints being, even in the young bird, embraced by the posterior processes of the iliac bones.

Noting this discrepancy, I was led to examine the pelves of a large series of birds (see Zool. Proc. 1864); and this led me to see that the least number of post-femoral vertebræ embraced by the iliac bones is three; for instance, in the smaller *Raptores*, in some of the smallest *Insessores*, and in a few of the feeblest *Grallæ*.

In a very large proportion of typical perching and climbing birds, there are four joints thus clamped together behind the thigh-bones; in many of the walking and running land-birds five; whilst in the Swan, the Emeu, and the Diver (*Colymbus septentrionalis*), there are as many as eleven. Taking the average of the whole class, we shall find that the fifth post-femoral joint is—typically—the first caudal: and this agrees with Professor Owen's determination in the case of the *Archæopteryx.*

This enumeration gives us twenty-one caudal vertebræ for this remarkable creature; a number which, at first sight, appears very great as compared with what we see in existing birds. If, however, we examine the 'ploughshare-bone' of a recently hatched Duckling, we shall find that it is composed of ten segments; and then, counting the fifth post-femoral as the first tail-bone, we get twenty-two as really belonging to that category. Following the same plan in other birds, especially amongst the *Aves præcoces,* we shall, in many cases, get an equal result,—as many as twenty-four in the Swan, which, when young, has at least sixty-five vertebræ in all. I am not disposed to overrate the value of these remarks; yet it is well to be accurate even in detail; and it is highly interesting to see how little Nature has gone out of her way, after all, in the construction of this unlooked-for bird—the *Archæopteryx.*

The general relationship of the Bird-class to the true (abranchiate) Reptiles has still to be worked out; and it is difficult to say which Birds are the most *reptilian.* In some respects the Ostriches are, undoubtedly; and yet no living bird comes nearer the Mammal, in many important respects, than the Cassowary.

The excellent qualities and high intelligence of the arboreal Birds would seem to set them at a great distance from the Reptiles; and yet the skull of the Crocodile comes very much nearer that of the Mammal than what is to be seen in any typical Bird.

Moreover it is only in typical Birds (e. g. *Turdus*), that I have found any rudiment of that most characteristic *lacertian* bone, the *pterygoidean columella*; and in these very Birds the *palatine transverse bone* has its best development, a bone which is seen at its best in the *Crocodilia, Lacertilia,* and *Ophidia*: but which has no existence below these groups, nor above the Birds; and is either abortive, or quite absent in the greater number of birds having precocious young. There is a curious blending of the characters of the various reptilian groups in the Birds; there has been no exclusive adoption of the mode of structure of any one scaly type by these feathered vertebrates; those reptilian qualities and excellencies which are best and highest have become theirs; but how much more! This exaltation of the 'Sauropsidan' or oviparous type by the substitution of feathers for scales, wings for paws, warm blood for cold, intelligence for stupidity, and what is lovely instead of loathsomeness,—this sudden glorification of the vertebrate form is one of the great wonders of Nature.

III. On *Acrodus Anningiæ*, Agass.; with Remarks upon the Affinities of the Genera *Acrodus* and *Hybodus*.

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

[Plates III. and IV.]

FEW amongst the Fish-remains preserved to us in the Secondary rocks are more commonly met with than those of Sharks of the genera *Acrodus** and *Hybodus*;† yet, notwithstanding the frequency of their occurrence, we have but little exact knowledge of the form and affinities of the fish to which these remains belonged. Their cartilaginous skeletons have, excepting a few fragments, altogether perished; and it is quite impossible to guess at their outlines, undefined as these were either by scales or hard plates. Nay, more, the remains that are known of these extinct forms present such great differences from the corresponding structures of living fish, that, although a relationship to a single existing genus has long been indicated, the degree of that affinity is still very uncertain.

Of the two genera, the remains of *Acrodus* are the less frequently met with; and its structure is, in consequence, the less known. At the time that Agassiz wrote his celebrated work upon fossil fishes,‡ detached teeth and one or two incomplete palates, or groups of teeth associated in their normal order, and some traces of the shagreen, or skin of the shark, were all the materials at his disposal for determining the characters of the genus. Relying upon these, he referred *Acrodus* and *Hybodus* to different families, assigning the former to the Cestracionts,§ of which the Port Jackson Shark, *Cestracion Philippi*, is one of two existing examples, and making the latter the type of a new family, the Hybodonts.‖

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* Agassiz, 1838. † Ibid. 1837.

‡ The volume containing those that form the subject of the present paper was published 1833–43.

§ Agassiz, 'Poissons Fossiles,' vol. iii. p. 139. ‖ Ibid. p. 206.

The chief grounds upon which this separation was made appear to have been, firstly, differences of form of the teeth of the two groups; secondly, an assumed diversity, in kind, of their structure; and, thirdly, a difference in the degree of variation of the teeth upon similar jaws. The most important external character, given by Agassiz, of a Cestraciont tooth is its depressed and expanded form, fitted for crushing hard substances;* of that of a Hybodont, on the other hand, the characteristic is the presence of a greater or less number of cones, of which the median is the most elevated, adapting it to retain prey when seized.† These differences of form are associated with a different arrangement of the enamel which covers the teeth; and upon this, and a co-existent diversity in the internal arrangement of the dental elements, Agassiz lays much stress.‡ Such differences, however, as we now have proof, do not amount to differences in *kind*, but are merely of *degree*; and if it can be shown that the external characters of *Acrodus* pass gradually into those of *Hybodus*, when traced through a series of teeth from the same mouth, we may admit, even without a special examination, that the internal structure would likewise be graduated from the character of one extreme form to that of the other. The third argument is based upon the fact, that the teeth in the mouth of some *Hybodi* differ less amongst themselves than do those upon the palates of some *Acrodi*;§ but this reasoning is altogether useless, except to support the generic distinction, if it be proved that the teeth of the two groups are but modifications of the same type. Another item of negative evidence that perhaps influenced the judgment of Agassiz upon this point was that the dorsal spines, or 'Ichthyodorulites,' of *Acrodus* were still unknown;¶ the possibility of such spines showing a close affinity to *Hybodus* being thus ignored.

We have now fortunately sufficient evidence to justify us in attempting to form a clearer idea of the relationship that existed between these two genera; and this evidence lies in a complete

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* Agassiz, 'Poissons Fossiles,' vol. iii. p. 159. † Ibid. pp. 178, 179.

‡ Ibid. p. 139, and again at p. 207, where, after speaking of the internal structure of Hybodont teeth, he goes on to say: 'Cette structure des dents s'oppose comme on le voit, au rapprochement que M. Owen' (in his 'Odontography') 'a tenté entre les dents des Hybodontes et celles des Cestraciontes, en effet les couronnes plates qui distinguent les dents des Cestraciontes et qui font des instruments propres à broyer la nourriture n'ont rien de commun avec les couronnes élevées et coniques des Hybodontes, qui quoique obtus dans quelques, espèces étaient évidemment destinées à saisir et à retenir une proie.' It must be remembered, however, that, when Agassiz made this generalization, he had classed as a Hybodont *tooth* the cephalic spine of Hybodus. Ibid. p. 208.

§ Ibid. pp. 141 and 182. ¶ Ibid, p. 140.

palate of *Acrodus Anningiæ* and in a pair of dorsal spines, associated with teeth, of another individual of the same species. The palate (Pl. III.) consists of an almost complete series of teeth, retaining the position that they must have occupied upon the jaw during life. The bone upon which they were based has altogether disappeared; this fact and the absence of spines or any other remains anywhere near where the specimen was found, suggest the probability of its belonging to a detached lower jaw, of which the cartilaginous structures have perished. Counting from either extremity of the series to the middle, we have on each side eight transverse rows of teeth, with a central row resting where the symphysis, or line of junction, of the jaw-bone would have been. Two very small displaced teeth at the right extremity seem to indicate that there were originally nine rows upon each side. The two sides are not quite symmetrical, the right-hand series appearing more flattened and expanded than the left; and it is probably owing to this distortion that fewer teeth are discoverable in each row (excepting two) of the latter than in the corresponding ones of the former. Commencing from the extremities of the series, the first row on the right side is indicated by the two small teeth above-mentioned: all trace of this row is wanting on the left.

The second row	on the right	contains	4 teeth;*	ditto on the left	4	teeth
„ third	„	„	6 „	„	6	„
„ fourth	„	„	7 „	„	6	„
„ fifth	„	„	8 „	„	6	„
„ sixth	„	„	8 „	„	6	„
„ seventh	„	„	7 „	„	6	„
„ eighth	„	„	6 † „	„	5	„
„ ninth	„	„	6 ‡ „	„	5	„
And the central row contains			5 „			

Looking at the characters of the various teeth, thus grouped together, one at first feels doubtful whether the specimen should not be assigned to a *Hybodus* rather than to an *Acrodus*; for, although the teeth of the posterior rows are marked with the fine striæ characteristic of the latter genus, and are of a more or less depressed form, yet they all show some tendency to develop slight elevations, towards the apices of which the lines of enamel converge. In the more forward teeth we find, in the seventh row, the median elevations becoming more distinctly conical, and the ridges of enamel, which converge upon them, becoming coarser and more widely separated; and in the eighth, ninth, and central rows these characters are so strongly brought

* One of these is displaced to the outside of the third row.
† The single detached tooth outside these appears to belong to the central row.
‡ The sixth tooth of this row is scarcely visible.

out that, apart from the rest of the specimen, I should certainly have regarded these teeth as belonging to a small individual of *Hybodus Delabechei*, Charlesworth.*

Agassiz, however, has figured an incomplete series of similar teeth under the name of *Acrodus Anningiæ*;† but, though his representation is sufficiently clear to enable us to recognize the specific identity of the two specimens, the markings of the teeth are not shown well enough to render any exact comparison of their characters in the various rows possible. One remarkable discrepancy between his figure and mine is observable, namely, that in the series figured by Agassiz there are portions of as many rows of teeth upon a fragment as there are upon the entire of one side of my specimen. It may perhaps be that the two specimens belonged, the one to an upper and the other to a lower jaw, and that the number, arrangement, and size of the teeth differed upon the two, as I find they do in the recent Cestracions. In the Museum of Practical Geology there is a specimen that agrees very well with Agassiz's figure, and amongst the teeth there are many that are unmistakably similar to those now figured; the differences that are apparent may, in addition to the reason given above, be likewise partly due to the larger size of the individual to which they belonged. I am the more inclined to believe in considerable variations in the teeth of individuals from seeing in the specimen before us that the teeth of one jaw varied, without regularity in size and appearance, not merely according to position upon the same side, but even in the same relative position upon opposite sides. We may observe this especially in the fourth rows, in which the teeth on the right hand are considerably larger and longer than those on the left. In the right-hand teeth there are indications of five elevations, of which the most prominent is not the median, but the most anterior; hence these teeth have a peculiar aspect not observable in those of the corresponding row.

Regarded as a whole, this palate indicates that the mouth of this species was of an expanded form, exhibiting but the slightest tendency towards that contraction of the anterior portion, which is so characteristic of the jaws of the recent *Cestracion*.

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* I believe this species to be identical with *H. pyramidalis* of Agassiz.

† Some of the teeth answer likewise to his figure of *A. gibberulus*. Agassiz appears to have been acquainted with the latter teeth before he named the fragment of *A. Anningiæ*, which I cannot find that he has anywhere described. As the two species are, however, figured side by side, and were consequently, I presume, published together, I feel justified in taking my choice of the two names; and I prefer *A. Anningiæ*, as belonging to the best characterized specimen, and as preserving the name of one to whom Palæontologists are deeply indebted.

The dorsal spines which, by means of the teeth associated with them, we can assign to this species are in the British Museum,* and were formerly in my collection. Having personally taken part in the extraction of these remains, I can speak confidently of the authenticity of their association; and as they were not mixed up with Saurian remains, or those of any other species of *Hybodus*, &c., there is no reason to suppose that their juxtaposition was in any way accidental, as some such groupings undoubtedly are.†

In order to show conclusively the existence of teeth in this collection similar to those in the palate described, I have figured (Pl. IV.) four teeth which, perhaps not more so than the others, are easily referable to certain positions upon a similar jaw. Thus fig. 1 corresponds with those of our eighth row, fig. 2 with our seventh, fig. 3 with our sixth, whilst fig. 4 is a larger specimen of the curious teeth already mentioned as occurring in one of our fourth rows; fig. 5 is a still more remarkable variation from the general type.

The spines which accompany these teeth are the anterior and posterior dorsal, easily distinguishable from each other by good characters. The *anterior* (Pl. IV. fig. 6) is $17\frac{3}{4}$ inches in length, but the point had been broken off before it was embedded, so that it was probably from one to two inches longer when perfect; the part not inserted into the body of the fish measures along the anterior line $13\frac{1}{4}$ inches, leaving $4\frac{1}{2}$ inches for the inserted base. On comparing this spine with an anterior spine of similar dimensions (also now in the British Museum and formerly in my collection), and which is one of those usually confounded, by reason of the figures given by Agassiz, with *Hybodus reticulatus*, but which in reality belongs either to *H. Delabechei*, Charlesw., or to *H. medius*, Ag., we are struck with the resemblance that they have to each other. They are similarly proportioned and curved, and the ridges upon the sides and anterior face are very similar in depth and

* I take the opportunity of acknowledging the courtesy of G. R. Waterhouse, Esq., and of Dr. Günther, of the British Museum, as also of Professor Huxley, of the Museum of Practical Geology, in affording me every facility for the examination of specimens under their care, and in drawing my attention to several which were of much interest, as elucidating my subject, and which otherwise I might not have noticed.

† In Lord Enniskillen's magnificent collection, at Florence Court, there is a portion of a Saurian containing between the ribs two spines and many large teeth of *Acrodus nobilis*; and in the Museum of Practical Geology there is a smaller fragment of a Saurian 'interior' which displays teeth, two cephalic spines, and part of a dorsal, of *Hybodus reticulatus*, associated with teeth and part of a dorsal spine of *Acrodus latus* (?). These specimens are very suggestive of the destructive capabilities of the *Ichthyosauri*.

character. That of *Hybodus* differs, however, from that of *Acrodus Anningiæ* in being gently and regularly curved off from the sides to the centre of its posterior face, instead of this forming almost a right angle with the side; the ridges of the former are more numerous than in the latter; and a still better distinction is found in the largeness and fewness of the denticles upon that of *Acrodus*. Of the *posterior* spine (Pl. IV. fig 7) about an inch of the base is missing; the length of the spine, as it is, is about $11\frac{1}{2}$ inches, of which the fragment of the base measures $2\frac{1}{2}$ inches. The exposed part of the spine would thus have measured 9 inches, or $4\frac{1}{2}$ less than what is preserved of its anterior fellow. From the latter it differs also in its much stouter proportions; and it has moreover a slight angle at the upper part of the base, which gives a somewhat distorted appearance to the spine, and the effect of which doubtless was to give to the exserted portion a more backward inclination than that of the anterior spine; the inserted portions probably penetrating the body in parallel directions. The line formed by the termination of the polished ridges, at the upper edge of the base, in the smaller spine is not so sharply sloped from the posterior to the anterior edge, but takes a deeper curve than in the larger. In the squareness of the posterior side, and in the comparatively large size of the denticles, the two spines resemble each other.

After a careful comparison of several spines more or less closely resembling the one described with the figure of *Hybodus curtus* given by Agassiz, I am strongly of opinion that that is nothing more than the posterior dorsal spine of *Acrodus Anningiæ*; whilst the anterior spine is generally marked in collections as *Hybodus grossispinus*.

Since Agassiz published his work certain spines, obtained at Lyme Regis, have been assigned to *Acrodus*, having been found associated with teeth of the genus. One of these in my possession, and which appears to be an anterior, differs from those described in being almost smooth, the elevations being nearly lost, though the polished markings are preserved; in its shorter and stouter proportions, and moreover in being scarcely, if at all, curved. Such spines probably belonged to *A. nobilis* or to *A. latus*; but the differences between them and those of *A. Anningiæ*, or of undoubted Hybodonts, are clearly only differences of degree.

The fact that these two genera are more closely allied than supposed by Agassiz has long been admitted by many,* though

* Charlesworth, Mag. of Nat. Hist. 2nd ser. 1839, p. 245. Owen, 'Odontography,' as quoted above by Agassiz. Ibid. ' Palæontology,' p. 108. Mackie, The Geologist,

the grounds of the relationship have not, that I am aware of, been definitely stated.

From an examination of various remains of *Hybodus* now accessible, it is evident that, although the teeth in this genus do not differ so much, upon the posterior and anterior portions of the jaw, as they do in *Acrodus* or *Cestracion*, yet there is always some amount of variation;* and it appears to me that the more elongated the cones are, the less the variation in the entire series of teeth in any species; therefore this difference again is only one of degree. From heads of *Hybodus basanus*, Egerton, we learn that *Hybodus* possessed an expanded jaw, similar to that indicated by our figure of *Acrodus*; nor must much stress be laid upon the presence of cephalic spines with the former genus and their never having been found with the latter, since we have them positively associated only with a few species of *Hybodus*, of which the remains are far more frequently met with than those of any *Acrodus*. In fact, regarding these two genera as one group, such a group would be for convenience divisible by dental characters into three sub-divisions; the first, with very elongated cones, represented by *Hybodus basanus*; the second, with the cones more obtuse, by *H. Delabechei*; and the third, almost or altogether wanting conical elevations, by *Acrodus nobilis*; *A. Anningiæ* would then be intermediate in characters between the second and third groups, and, by thus intervening, would tend to show the artificiality of the whole arrangement.

Understanding now the close affinity between the two genera, I will add a few words upon their affinities to existing forms. Agassiz indicated a close affinity between *Acrodus* and *Cestracion*, from a consideration of the structure of their teeth; but as his own classification, viewed by the light now obtained, shows, the resemblance, somewhat close in typical *Acrodi*, becomes altogether lost as we pass to the true Hybodonts, which, on the same consideration, show a relationship to the ordinary Sharks. Again, the mouths of Hybodonts (that is, including *Acrodus*) were not only very different in form from that of the Port Jackson Shark, but they differed from the mouth

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1863, p. 243. On the other hand, Pictet, in his 'Paléontologie,' 1853–7, vol. ii. pp. 254 and 260, retains the error of classifying the two in different families; as is likewise done in Morris's 'Catalogue of British Fossils,' on the authority of Professor Owen's 'Lectures on Comparative Anatomy,' vol. ii. p. 47. A less comprehensible oversight occurs in Owen's 'Palæontology,' where a side view of the head of *Myliobates* is apparently copied from Agassiz and referred to in the text as that of *Cestracion Philippi*, p. 106.

* The most marked exception to this generalization is *Hybodus basanus*, described by Sir P. Egerton, Quart. Jour. Geol. Soc., vol. i. p. 197.

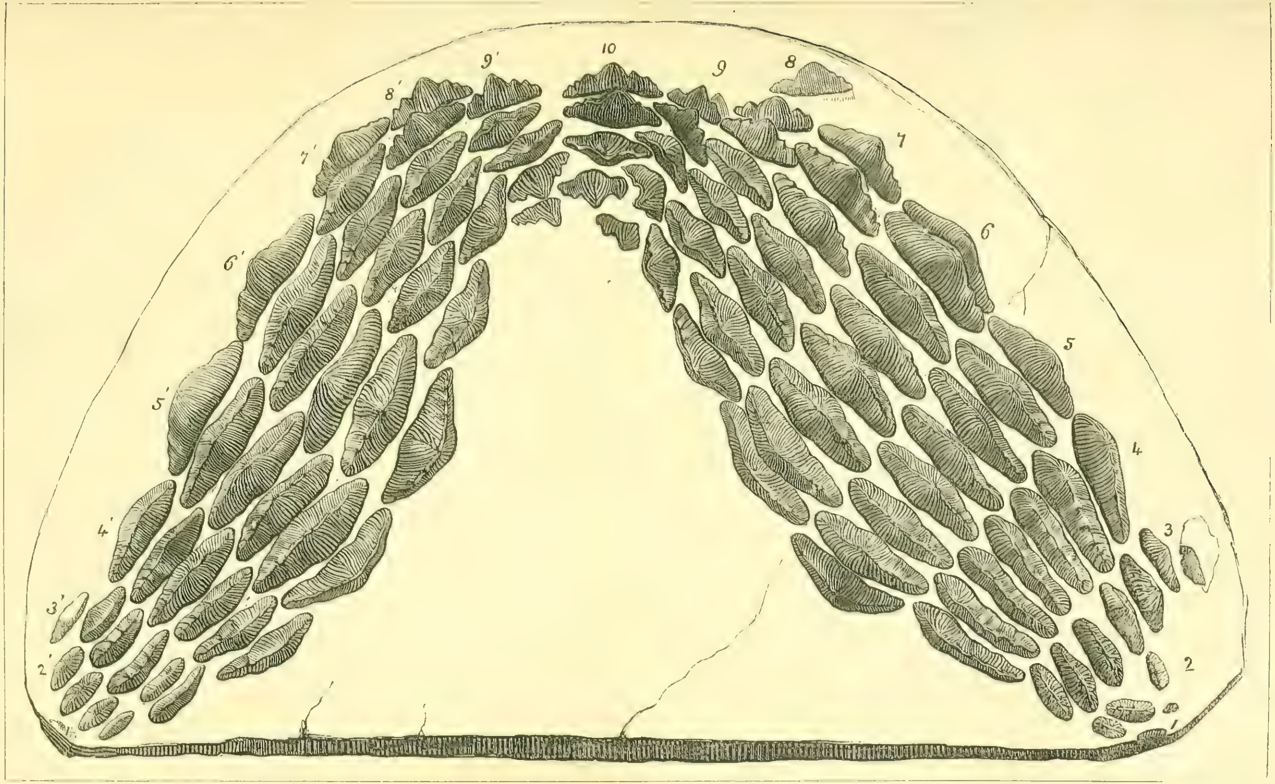
of the latter, which is situated at the extremity of the head, in position, being placed under a projecting muzzle, as is the case in the majority of Placoids. From various mistaken statements on the subject, there exists a very general impression that the nearest existing approach to the Ichthyodorulites of *Hybodus* is to be found in the spines of *Cestracion.* The former have, however, a far greater resemblance to the single spine of a *Chimæroid* fish; we see this, not only in the elongated form, but in the distinct prolonged tapering root and the two rows of curved denticles upon the posterior edges; and this spine, marked with fine longitudinal striæ, is so hollow that even in the recent specimen its slight walls are crushed in, just as we find the Ichthyodorulites of the Lias.* In all these points, as our figures (Pl. IV., figs. 8 and 9) show, the spines of both *Hybodus* and *Chimæra* differ from those of *Cestracion.* This similarity between the single spine of a Chimæroid and the pair of a Hybodont indicates not only an affinity between the orders to which they belong, but affords, I believe, a clue to the explanation of the disparity of size between the two spines of the latter; a disparity greater than obtains in any existing Sharks possessing such defences. Agassiz himself inferred a relationship between the Sharks and *Chimæra* from dental characters,† *Cochliodus* being one of the links (and *Cestracion* surely another?) which indicated the connection of forms whose teeth are otherwise so totally dissimilar in every character. Charlesworth, in 1839,‡ suggested 'an apparent analogy' between the single 'frontal spine' of *Hybodus* and the peculiar apparatus upon the head of the male *Chimæra*; and although *Hybodus* has, as we now know, at least four of these cephalic spines,§ yet I believe that Charlesworth's suggestion is a good one. An examination of a remarkably fine slab of Chimæroid remains from Solenhofen, now in the British Museum, showed me that the numerous hooklets, terminating the large cephalic spine there preserved, have a marked resemblance on a small scale to the enamelled portion of the '*Sphenonchi*,'‖ and it would thence appear that the one large bony support may be analogous to the four tricuspid bases. Considering the wide difference that there must be between *Hybodus* and *Chimæra*, we should not expect that the resemblance in structure of

* Is not the spine which Agassiz called *Leptacanthus*, and classed with the Hybodonts, that of a Chimæroid? At least, it has only occurred in strata in which Chimæroid jaws have likewise been met with.

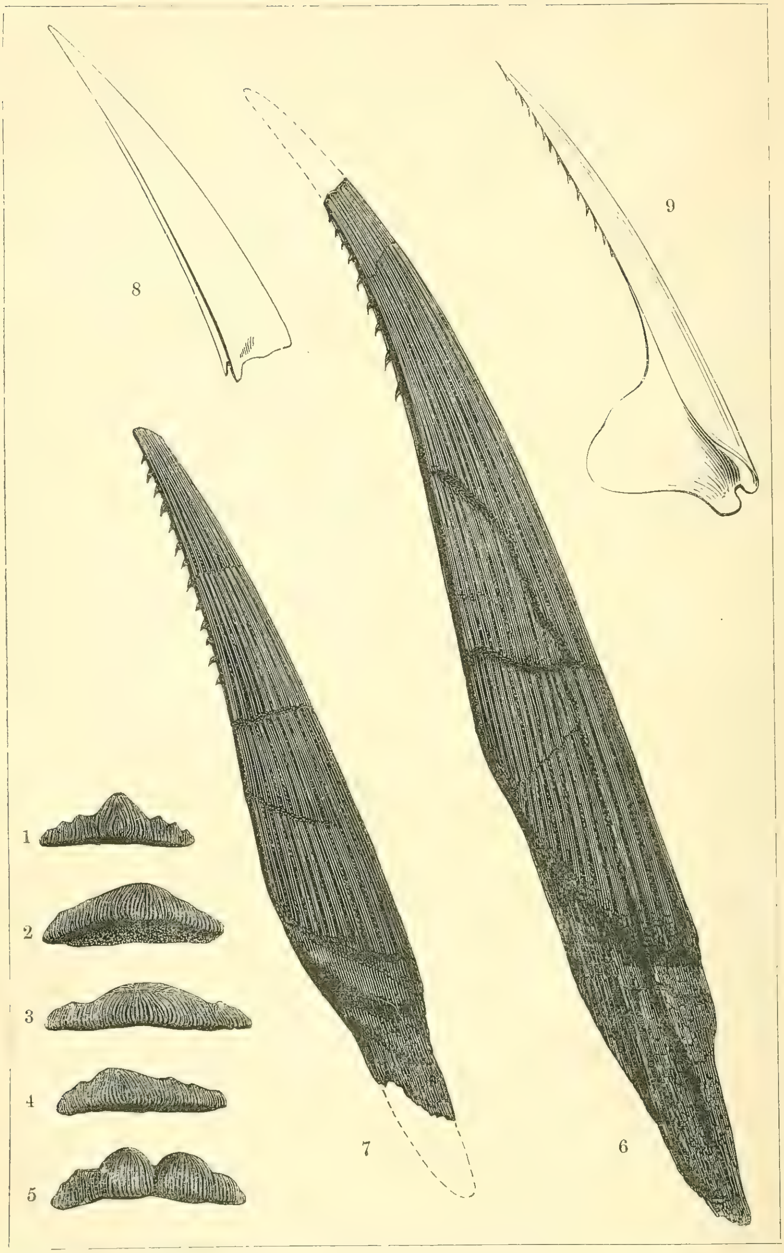
† Ag. 'Pois. Fos.' vol. iii. p. 336. ‡ Mag. Nat. Hist. 2nd ser. vol. iii. p. 245.

§ See note by Miss Anning, ibid. p. 605, and which statement I myself have been frequently able to verify.

‖ The name given by Agassiz to these fossils, which he considered to be the teeth of a Hybodont.



Lower Jaw of Acrodus Anningiæ, Ag. (nat. size). From the Lower Lias of Lyme Regis.



FIGS. 1–7. TEETH AND SPINES OF ACRODUS ANNINGIÆ, AG. FROM THE LOWER LIAS OF LYME REGIS. (FIGS. 1–5, NAT. SIZE; FIGS. 6 AND 7, $\frac{1}{3}$ NAT. SIZE).
FIG. 8. SPINE OF RECENT CESTRACION (NAT. SIZE).
FIG. 9. SPINE OF RECENT CHIMÆRA ($\frac{1}{2}$ NAT. SIZE).

organs destined for the same functions would necessarily be very great; and being quite in the dark as to what use the Chimæroid duplicate arrangement may serve (beyond that it is probably of a sexual character), we cannot say that the cephalic spines of *Hybodus* were not suited for a similar purpose.*

We thus see reason to believe that the Hybodonts were a family well distinguished from all now existing. They more or less resembled the Cestracionts in the structure of their teeth; but they agreed rather with ordinary Sharks in the form of the head and the position of the mouth; whilst the dorsal spines, not to mention the cephalic spines, point to a remote affinity with *Chimæra.* Nor is this conclusion other than we may well be prepared to receive; since in a single form of a distant geological period, we constantly find characters associated together, the analogies of which are now only to be found scattered in widely separated groups. It is therefore no more anomalous to seek for the nearest representative of the spine of *Acrodus* in *Chimæra,* and of its teeth in *Cestracion,* than it is to collect illustrations of the structures combined in a Plesiosaur amongst widely removed orders of existing reptiles.

EXPLANATION OF THE PLATES.

Plate III.

Lower (?) Jaw of *Acrodus Anningiæ,* Agassiz, from the Lower Lias of Lyme Regis. In Mr. Day's cabinet.

Plate IV.

Figs. 1–5. Teeth of *A. Anningiæ,* from the Lower Lias of Lyme Regis.
6. Anterior } spine of the same Fish.
7. Posterior }
8. Posterior spine of recent *Cestracion* from Japan.
9. Spine of *Chimæra monstrosa,* Linn.,† living on the west coast of Norway.

The specimens figured in this plate are all in the Geological and Zoological Collections of the British Museum.

IV. On the Copper-bearing Rocks of Alderley Edge, Cheshire.

By Edward Hull, B.A., F.G.S., of the Geological Survey of Great Britain.

THE age of the sandstones and conglomerates, containing copper and other ores, at Alderley Edge, has until lately been a matter of some uncertainty; and, as far as I am aware,

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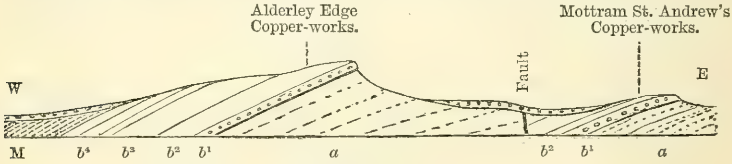
* The very rough shagreen with which *Hybodus* was covered is not so well exemplified by that of *Cestracion* as by that of *Centrina* (another genus of spined Sharks), in which the coarse, tooth-like asperities very much resemble those of the fossil.

† Dissected and drawn (from a specimen preserved in spirits) by Mr. Henry Woodward.

no detailed account of the formation has yet been published. Some few years since I made an examination, in company with Mr. E. W. Binney, F.R.S., of the beds in question, and on the first opportunity afterwards I hazarded an opinion, at a meeting of the Geological Society of Manchester, that the copper-bearing beds were referable to the age of the Lower Keuper Sandstone of the Trias. My brother-geologists, I had reason to think, received this opinion with some amount of distrust, as the rock, being in some places a quartzose conglomerate, and in others a soft whitish or yellowish sandstone, had much more the appearance of Bunter Sandstone than of the uppermost member of the Trias. My conjecture was not made, however, at hap-hazard, but was founded on evidence of position and petrographical characters, as the conglomerates, with their underlying bands of red shale, reminded me of the basement-beds of the Keuper division in the somewhat distant region of Alton Towers, and the Churnet Valley in Staffordshire.

A subsequent and more detailed examination of the Alderley Edge sandstones has entirely confirmed the view arrived at on my former visit; and, as the locality forms one of those rare examples of metalliferous beds in the New Red Sandstone, an account of it may not be without interest.

The 'Edge' or escarpment of Alderley rises from the eastern side of the plain of Cheshire gradually towards the east, but with a steep and abrupt ridge towards the north. This northern bank is richly wooded, and has a very beautiful aspect when viewed from a distance, as it contrasts strongly with the almost level plain which sweeps away to the northward and westward from its base. The ridge has here been upheaved along the line of a large fault, bearing east and west, throwing down at its base the Red Marl; and on the other side bringing up the soft sandstone of the Bunter, capped by a mural cliff of Lower Keuper Conglomerate, which often breaks out in conspicuous masses through the foliage. The beds rise from the plain towards the east at an angle of about from 5° to 10°, and the



Section from Alderley Edge to Mottram St. Andrew's.

escarpment is continued southward for some distance, facing the east. The general form of the Edge, and its component beds, will be understood from the woodcut.

Succession of Beds in Descending Order.

M Red Marl		Red and grey laminated marls.
b^4 *Waterstones*	Lower Keuper Sandstone. 500 feet.	Brownish flaggy sandstones and marls.
b^3 Freestone		White and brown freestone.
b^2 Copper-bearing sandstone		Soft white, yellow, and variegated sandstone.
b^1 Conglomerate		Hard quartzose conglomerate, underlain by bands of marl, forming the base of the Keuper series.
a Upper red and mottled sandstone	Bunter.	Soft fine-grained yellow and red sandstone, being the uppermost member of the Bunter Sandstone.

The beds in the above series which claim the greatest share of our attention are those at the base of the Keuper series (b^1, b^2); for in these occur the copper and other minerals. The basement-bed is, however, remarkable for its petrographical peculiarities. It consists generally of a white firmly cemented conglomerate, the pebbles of which are mostly rounded fragments of whitish and coloured quartz-rock, in all respects similar to those which occur so largely in the middle division (Pebble-beds) of the Bunter. They are certainly not derived from the Millstone-grit, as they are much larger than the pebbles which occur in that formation, whereas a second reconstruction would have tended to diminish their size. For a length of time I have been of opinion that this conglomerate base of the Keuper has derived its pebbles of quartz from the Bunter Sandstone, on account of the unconformity of the members of the Trias as proved by actual sections in other districts.* But however this may be, it affords a striking contrast to the fine-grained *pebbleless* sandstone of the Bunter, which supports it and forms the flanks of the hill.

Copper, in the state of green and blue carbonates, is disseminated in this conglomerate, to a small extent at Alderley Edge, but in a much greater degree at Mottram St. Andrew's, about a mile to the north-east of the Edge, down in the plain. Its position there, so far below, and beyond the base of its contemporaneous beds at the Edge, is due to the great east and west fault already alluded to, which throws down the beds to the north. The conglomerate is here exposed in a quarry, resting on the soft red sand of the Bunter. It is about 6 feet thick, lies between two bands of marl, and drops at an angle of 6° towards the west. It was in this place that the copper-ore

* See Professor Ramsay's Presidential Address, Geological Society, 1863.

was first discovered about six years ago. In the direction of the dip the rock is systematically mined by means of a series of shafts, of no great depth, worked by windlasses. The ores coat the outside of the particles of sand and the pebbles of quartz, and the metal is extracted by a chemical process in the same way as at Alderley, presently to be described. The miners are all Cornish men, and were, of course, greatly astonished when they found copper-ore lying in nearly horizontal beds of sandstone, instead of the nearly vertical lodes to which they had been all their lives accustomed. Together with the copper-ores, there occur here cobalt-ore, black oxide of manganese, and carbonate of lead. The percentage of copper-ore varies from $2\frac{1}{2}$ to $12\frac{1}{2}$.

The beds which are worked for ore at Alderley Edge lie above the Conglomerate, and are marked b^2 in the above list of strata. The rock is exposed in a large open work, which is traversed at the spot where the reservoir is made by a wide channel filled in with Boulder-clay. The open work has now been abandoned, and the richer portions of the rock are followed in underground tunnels, the trucks of stuff being drawn up to the works on tramways by a stationary engine.

The sandstone is of a very soft uniform texture, and presents a face of about 40 feet, though fully 60 feet is metalliferous. It is stained in a series of rudely defined layers, variously coloured green, umber, or black, according to the nature of the ore-dye, and, together with copper, there occur ores of cobalt and manganese, carbonate of lead, galena, barytes, and oxide of iron. The following is the general arrangement of the courses of rock:—

	ft.	in.
1. Yellowish sandstone	4	0
2. Shaley clay, with a band of copper-ore at the bottom	2	6
3. Ferruginous sandstone, with large nodules containing carbonate of lead	6	0
4. *Cobalt-bed.* Laminated sandstone, containing oxide of cobalt*	4	6
5. White compact sandstone, with carbonate of lead	5	0
6. Iron-stained sandstone, with cobalt, manganese, and iron	12	0

Of the above minerals four are extracted—namely, the lead, cobalt, copper, and iron. The carbonate of lead is in the form of crystals, disseminated thoughout the rock, and not very easily to be distinguished by the eye. It is separated from the matrix by maceration and washing, and is then ready for smelting. In quantity it varies from 30 to 40 per cent. of the rock. The cobalt and manganese are generally associated in the rock, and are scarcely distinguishable from one another.

* Earthy cobalt, or 'Asbolan,' for an analysis of which see Bristow's 'Glossary of Mineralogy,' p. 120.

These are also separated, I believe, by washing; and the water used in the process, containing a large quantity of yellow or red ochre, is collected in a reservoir, where the ochre subsides, and, when accumulated in sufficient quantity, it is smelted for iron in small furnaces on the spot. Hence it will be seen that nothing is allowed to run to waste; and on this, in some measure, depends the economic success of the undertaking.

The process by which the copper is separated from the sand, and thrown down in a metallic state, is very beautiful, and probably the only one by which the result could be accomplished successfully in a commercial point of view, as its average percentage of ore is not more than 2·5. The rock is macerated in a solution of muriatic acid, filtered, and 'the copper-liquor,' of a rich sap-green colour, is pumped into reservoirs of wood. Into these old scrap-iron is thrown, and the acid, leaving the copper, seizes the iron, which it dissolves, while the copper is precipitated in a metallic state. On the completion of the process, the residuum, consisting of 80 parts of copper and 20 of iron, is collected and sent in sacks to St. Helen's and Swansea to be smelted.

Alderley is not the only district where the New Red Sandstone produces copper; but it is the only place, I believe, where it has been worked in that rock with profit. The ore has been extracted along the east side of the Peckforton Hills, at Grinshill, and near Ashbourn; but in none of these places is there such a variety or richness of mineral products as at Alderley.

V. On some Evidence of there being a Reversal of the Beds near Whitecliff Bay, Isle of Wight.

By William Whitaker, B.A., F.G.S., of the Geological Survey of Great Britain.

In the well-known section at Whitecliff Bay the Chalk and the various Tertiary beds are seen to succeed one another in regular order northwards; and the dip, at first very high, so that the beds are almost vertical, decreases in that direction.

The Reading Beds, which here come next to the Chalk and consist wholly of brightly-coloured plastic clays of far more than the usual thickness, are followed by the brown London Clay, with its more sandy basement-bed. This last formation is also sandy towards the top, and indeed passes upwards into the grey loamy base of the Lower Bagshot Sand. Further up in the Lower Bagshot there is some brown finely bedded clay, not so stiff as the London Clay however.

This short description of part of the cliff-section is enough for my present purpose. Those who wish for details can find them, and in plenty, in the papers of Mr. Prestwich* and the Rev. O. Fisher,† and in the Geological Survey Memoir on the Isle of Wight by my colleague, Mr. Bristow.

When in the Island last autumn, after thoroughly observing the cliffs of Whitecliff Bay, I gave an hour or so to an examination of the new brickyard, but a little way inland, opened for the supply of the fort that is being built on Bembridge Down. I found that the pits were all small, and that none of them showed a perfect section of the beds worked: this, however, did not matter, as they were close enough to give a continuous section, and that at more than one part of the yard. The order of the beds thus shown was the same everywhere, and as follows, beginning from the south:—

A. Light grey buff and yellow sand, clayey at its northern boundary, where it is succeeded by

B. Brown sandy clay, passing up into

C. Stiff brown clay with *septaria* (roundish masses of clayey limestone with *septa*, or divisions, of crystalline carbonate of lime).

The bed A must belong to the Lower Bagshot Sand; for, as noted above, the Reading Beds are all clay here: indeed, by the lane just to the south, at the foot of the Chalk ridge, there were two small pits in the mottled plastic clay. The beds B and C, therefore, should be higher beds, for they are further to the north, the direction in which higher beds come on; but C is exactly like the London Clay, and not like any higher bed. Unfortunately, I could not find a single fossil, either in the clay or in the septaria, which again are not to be known from those so common in the London Clay. However, from a fairly long and close acquaintance with that formation, I could hardly feel any doubt that the bed C belonged to it: the mineral character and the general look would have settled the matter at once in other circumstances.

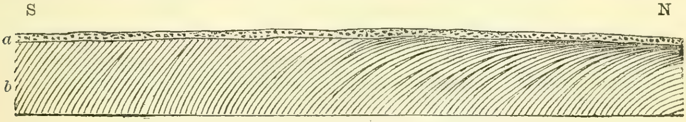
Moreover, the bed B is like the upper part of the London Clay, when it is passing up into the Bagshot Sand; and A is clayey towards B, just as the lowest part of the Bagshot Sand is mostly clayey in its passage down into the London Clay.

Now, if C, the most southerly bed, should turn out to be London Clay, as I think it is, there must be some disturbance here, and that hardly a mere fault, for the beds being nearly vertical, it would need a fault of very great upcast to bring a mass of London Clay to the surface within the outcrop of the Lower Bagshot Sand, and there is no sign of a fault in the cliff-section close by. I am led to think, therefore, that there may

* Journ. Geol. Soc. vol. ii. pp. 252–5. † Ibid. vol. xviii. pp. 70–73.

be a reversal of the beds, and that if there were a larger and clearer section, the Bagshot Sand would be seen to dip below the London Clay.

In the pits in that part of the brickyard nearer to the sea the clay c is rather sandy and finely bedded, perhaps because there the upper part only of the London Clay is shown. At one of



Section in Brick-yard, just West of Whitecliff Bay.
a. Soil. *b.* Bedded sandy clay.

them the shallow section is as in the figure, from which it will be seen that the thin beds of sandy clay are folded over and squeezed up to the north. It may be observed also that the dip is to the south, and therefore disagrees with that of the coast-section close by, which is to the north.

Further north from the section shown in the figure, there is light-coloured and iron-shot sand; then a little brown clay; then a little greenish-grey clay; and then brown and buff sand up to the northern edge of the brickyard. A line of pebbles near the southern boundary of the last bed, as well as sundry layers of pipe-clay, show the dip to be still slightly inclined southwards. All these beds of course belong to the Lower Bagshot.

There may now perhaps be some clearer section in this brickyard; and if so, it would be worth the while of any geologist who might chance to be in the neighbourhood to pay it a visit, and try to make out the arrangement of the beds.

ABSTRACTS OF FOREIGN MEMOIRS.

Mémoire sur la Distribution Géologique des Oiseaux Fossiles, et Description de quelques Espèces nouvelles. Par M. Alphonse Milne-Edwards. Paris, 8vo. pp. 133–176.

In the introductory remarks the author observes that it is very probable that both Mammals and Birds made their appearance on the earth for the first time during the Triassic period, although the only evidence in favour of the existence of the latter class at that time consists of the footprints of the Connecticut Valley.* He then discusses the probability of these footsteps being really ornithic, and notices the distinctive characters of the several genera—*Bron-*

* Dr. Emmons' fossil Bird-bone from the probably Triassic coal-beds of North Carolina should not be lost sight of.

tozoum, *Amblonyx*, *Grallator*, *Argozoum*, *Platypterna*, *Ornithopus*, and *Tridentipes*—into which the original group *Ornithichnites* has been divided by Dr. Hitchcock. The ornithic nature of the genera *Platypterna* and *Tridentipes* (the latter of which is remarkable for possessing four digits) the author considers extremely doubtful, the genus *Platypterna*, in fact, being characterized by a considerable enlargement behind the foot—a structure not known to exist in any recent Bird. Although the remaining genera really appear to M. Milne-Edwards to be the imprints of the feet of Birds, and although Professor Dana found a sufficiently large quantity of uric acid in a coprolite from the same strata to justify the conclusion that it might have been formed by a Bird, yet, in the absence of any bones of these animals, he thinks that their existence at this period cannot be considered perfectly established.

The author next adverts to the *Archæopteryx* of the Solenhofen Oolite, giving an analysis of the literature of the subject, and a résumé of the characters of the fossil, taken from the abstract of Professor Owen's paper in the Proceedings of the Royal Society; and concludes his observations on this subject by stating that the *Archæopteryx* was probably awkward in its gait, ordinarily perching, and a vegetable-feeder.

M. Alphonse Milne-Edwards then passes to the Cretaceous period, and admits that the bones, said to belong to Birds, found in the Cambridge Greensand (by the late Mr. Barrett and Mr. James Carter, of Cambridge), are really what they have been represented to be. He also considers the Bird-remains (*Scolopax*) cited by Dr. Harlan, from the Greensand of New Jersey, to be authentic; but with these two exceptions all the so-called fossil Birds from the Cretaceous and Wealden strata are considered to belong to other classes of animals.

The remains of Birds in Tertiary strata are stated to be extremely numerous, having been found in Eocene strata in the Isle of Sheppy * (*Lithornis vulturinus*, *Halcyon toliapicus*, and a Sea-gull, besides the *Lithornis* (?) *emuinus* of Mr. Bowerbank), and a bird of the Heron family at Primrose Hill, by Mr. Wetherell; in the Plattenberg schists at Glaris; besides impressions of feathers in the strata of Monte Bolca, and indeterminable fragments in the Lower Eocene of France. The Paris Gypsum has furnished bones of the following genera and species:—*Circus*; *Strix*; *Sitta*? *Cuvieri*, Gerv.; *Centropus antiquus*, Gerv.; *Coturnix*; *Perdrix*, Blanch.; *Scolopax*, Cuv.; *Tringa*? *Hoffmannii*, Gerv.; *Pelidna* ?; *Ardea* ?; *Numenius gypsorum*, Gerv.; *Pelecanus* (2 sp.); and at least seven kinds of imprints. In a similar manner the author discusses the ornithic fauna of the succeeding periods, giving the distinctive characters of twelve new species of Birds from the Miocene strata of the Limagne.

In conclusion M. Milne-Edwards remarks that the occurrence of remains of *Gastornis Parisiensis* in the Conglomerate of Meudon,

* Mr. Prestwich also mentions (Quart. Journ. Geol. Soc., vol. x. p. 157) the discovery by Mr. Delacondaminè, at Counter Hill, of a bone, which was determined by Professor Owen to be the first phalangeal bone of the foot of a bird.

and of the imprints of gigantic feet in the Paris Gypsum, shows that at the period of their deposition there existed an ornithic fauna at least as perfect as that of the present day; also that the Miocene Bird-fauna did not differ essentially from that of to-day; certain families, such as the *Phœnicopteridæ*, being, however, rich in genera and species then, though poorly represented now: finally, the Birds of the Quaternary period are all of recent species; those apparently extinct having probably been exterminated through the agency of man.—H. M. J.

COLONIAL GEOLOGY: NEW ZEALAND.

Geologisch-topographischer Atlas von Neu-Seeland, bearbeitet von Dr. Ferdinand von Hochstetter und Dr. A. Petermann. Gotha, Justus Perthes. 1863.

THIS book, which is published in a quarto form, consists of six chromo-lithograph Maps of the principal districts in the Provinces of Auckland and Nelson; and of twenty pages of descriptions and explanations by the authors, taken mostly from the scientific publications relating to the 'Novara' Expedition. The first map is a topographical one of New Zealand; but it contains also indications of the localities where certain useful minerals are found. The five remaining maps are purely geological, and tell much more of the geological structure of the provinces of Auckland and Nelson than was known before.

In the text of the work, Dr. Petermann describes the general topographical features of the Islands; and Dr. Hochstetter discourses (1) on the geological structure of the southern part of the province of Auckland, (2) on the extinct volcanos of the same region, (3) on the hot springs of Rotomahana (Auckland), (4) on the geology of the west coast of the same province, and (5) on the geology of the province of Nelson, in the Southern Island; these five chapters being, in fact, full explanations and descriptions of the five geological maps already alluded to. A very useful table of the heights of hills in South Auckland, and detailed sections of the different formations in the same district, are also given.

Dr. Hochstetter has done his work remarkably well, and since his return the fossils he collected have been examined and described by some of the most able Austrian palæontologists (see the following notices), so that the Colonial Governments of these provinces will almost be spared the expense of geological surveys.—H. M. J.

Fossile Mollusken und Echinodermen aus Neu-Seeland, bearbeitet von Dr. Karl A. Zittel. Nebst Beiträgen von den Herren Bergrath Fr. Ritter von Hauer und Prof. E. Suess. 10 Plates.

THE oldest known fossiliferous rocks of New Zealand occur in the Southern Island, near Nelson, in the district of Richmond, and are probably of Triassic date, as they contain two species of Shells (*Monotis salinaria*, Bronn, and *Halobia Lommeli*, Wissm.) undistinguishable from known forms occurring in European strata of that age, although they are associated with a species of *Spirigera* and certain other fossils considered Palæozoic by Professor M'Coy.

The probably Jurassic strata of the Northern Island, near Waikato-Southead, and at the Kawhia-Haven, contain an Ammonite (*Ammonites Novo-Zelandicus*, Hauer) intermediate between the species of the group *Dentati* and those of the groups *Flexuosi* and *Angulicostati*, and a deeply grooved Belemnite (*Belemnites Aucklandicus*, Hauer) belonging to the *Canaliculati*, with shells of the genera *Aucella, Placunopsis*, and *Inoceramus*. Dr. Zittel states that the evidence of the Belemnite, the *Aucella*, and the *Placunopsis* is in favour of these beds being of Jurassic age; while that of the Ammonite and the *Inoceramus* points to the Cretaceous period.

Tertiary deposits, very rich in organic remains, occur in both Islands; they may be divided into two groups, one of which contains no recent species amongst its fossils, and may therefore be considered to belong to the earliest portion of the Tertiary period; while the other contains fossils, some of which bear a striking resemblance to species of the same genera now found in the neighbourhood, while others are identical with them: thus showing the same kind of relation that the Sub-Apennine fossils do to the recent Mediterranean species. Many of the genera represented have a very limited geographical range, and thus the whole fauna has a peculiar facies, making it difficult to ascertain the age of the beds by comparing their fossils with those from the Tertiary strata of Europe.—H. M. J.

Die Foraminiferen-Fauna des Tertiären Grünsandsteines der Orakei-Bay bei Auckland. Von Felix Karrer. (Novara-Expedition, Neu-Seeland: Abtheilung; Palæontologie.) 4to. Vienna, 1864.

THE fossil Foraminifera found at Orakei Bay (or Creek), near Auckland, in the North Island of New Zealand, have already been briefly alluded to in the appendix to a paper by Mr. C. Heaphy, published in the Geological Society's Journal, 1860, vol. xvi. p. 251; and this bed of fossiliferous green sand, or 'friable argillo-calcareous grit, full of green grains (the casts of small organisms, especially of Foraminifera),' has yielded the numerous beautiful casts of *Amphistegina* figured and described in Dr. Carpenter's 'Introd. Study Foram.' (Ray Soc.), 1862. These facts appear to have escaped Dr. Karrer's notice.

Dr. Karrer's nomenclature of Foraminifera permits nearly every difference of feature in individuals being taken as the basis for 'specific' distinction, as is still usual with some Rhizopodists; but, if his 'species' be more strictly correlated with known forms, according to the English plan (see Carpenter's 'Introduction'), we shall find many old acquaintances on his beautiful plate of fossil Foraminifera from Orakei Bay, although he admits but very few accepted names. With regard to generic relationship, we believe that he is mistaken as to fig. 9, which is *Lituola globigeriniformis* (not a new species of *Textularia*); fig. 10, *Orbitoides* (not *Orbitulites*), and probably, like fig. 21, the representative of *O. Mantelli*;

fig. 11, *Bigenerina nodosaria* (not *Clavulina*, n. sp.); fig. 12, *Pulvinulina elegans* (not *Rotalia*, n. sp.); fig. 13, *Planorbulina Haidingeri* (not *Rotalia*, n. sp.); fig. 14, *Rotalia Beccarii* (not *Rosalina*, n. sp.); and fig. 20 is a *Polystomella*, near some South American and West Indian forms, and not a new species of *Amphistegina*. Dr. Karrer met with no *Miliolæ* in his samples of the deposit; but *Triloculina* is noted in the appendix to Mr. Heaphy's memoir abovementioned; and *Rotalia Schroeteriana* and *Nodosaria Raphanistrum*, also included in that list, may be added to Dr. Karrer's, which, if named on the same plan, would comprise—

1. Foraminifers that Dr. Karrer met with, but has not figured :—

Nodosaria spinicosta (?).	Uvigerina pygmæa.
Cristellaria rotulata.	Polymorphina lactea.
Cr. cultrata.	Globigerina bulloides (rare).

2. Figured forms :—

Dentalina communis; fig. 1.	Bigenerina nodosaria; fig. 11.
Vaginulina Legumen; figs. 2 and 4.	Pulvinulina elegans; fig. 12.
Lingulina costata; fig. 3.	Planorbulina Haidingeri; fig. 13.
Cristellaria Cassis; fig. 5.	Rotalia Beccarii; fig. 14.
Cr. Vortex; fig. 6.	Polystomella macella; figs. 15 and 16.
Textularia agglutinans; figs. 7 and 8.	Nonionina umbilicata; fig. 17.
Lituola globigeriniformis; fig. 9.	Amphistegina vulgaris; figs. 18 and 19.
Orbitoides Mantelli; figs. 10 and 21.	Polystomella, sp. (?); fig. 20.

Looked at in this light, these little fossils from New Zealand will be seen to be, for the most part, very closely allied to Foraminifera now living, in warm seas, at depths of about thirty to fifty fathoms and more; and any peculiarity of *facies* they may possess, scarcely gives them even *subvarietal* characteristics. *Lingulina costata*, and the *Orbitoides* (which we think should be referred to *O. Mantelli*), are well known in Miocene strata; most of the others range throughout the later Tertiary formations, and still exist.—T. R. J. and W. K. P.

NOTES ON FOREIGN GEOLOGY AND MINERALOGY.

By Dr. T. L. Phipson, F.C.S., &c.

Distribution of the Mineral Springs of Belgium.—Devonian Fossils from Thibet.—Presence of the New Metal Thallium in Pyrolusite.—The Mineral Schorlomite in Europe.—The New Metal Cæsium a Constituent of Pollux.—On the Mean Density of the Earth.—A New Fossil Crocodile.

At a recent meeting of the Academy of Sciences, Paris, a letter was received from M. Dewalque, of Brussels, '*On the Distribution of Mineral Springs in Belgium.*' The author having made an excursion in the neighbourhood of Liége, in company of M. Ch. Ste.-Claire Deville, this geologist remarked to M. Dewalque that the thermal spring of Chaude-fontaine and the acidulated ferruginous springs of Spa and Malmédy lay upon the same straight line, a fact which appeared to indicate a line of dislocation. Following up the subject, M. Dewalque now addresses to the Academy details concerning seven of these mineral springs, giving the direction in which they lie and their respective distances from each other. The mean direction of the lines thus obtained is a little more than 122 degrees; it therefore only differs by one degree from the direction of the system of Thüringerwald and Morvan carried on to Liége.

The Bishop of Sinopolis, M. Thomine Desmazures, has forwarded to M. Élie de Beaumont *some fossils from Thibet*, together with a letter commencing in these terms: 'If a few petrifications which I have brought from Thibet can interest science, I am happy to offer them to you. . .' The fossils in question are from a place called Gouchouc, of which the bishop regrets that he was not able to determine the longitude and latitude, on a mountain-plateau, ten leagues from Kiang-kâ, and situated between the great Blue River (Kin-cha-kiang) and the River Lan-tzang-kiang. The species have been determined as follows, by M. Guyerdet:—

Rhynchonella cuboïdes (Sowerby), of the Carboniferous and Devonian strata;
Atrypa reticularis (Linnæus), of the Devonian strata;
Rhynchonella pugnus? (Martin), of the Devonian strata.

It results from these observations that the Devonian formation, already known to exist in numerous regions of the globe, is met with also in Thibet. The natives, says the author of the letter, make great use of these fossils, which they find in large numbers in the beds of streams and imbedded in the calcareous rocks; they know them to be a certain remedy for stomach-ache; they heat them red-hot in a fire and then plunge them into cold water, which they give to drink to the sufferers. It is certainly remarkable to find these savage people thus preparing caustic lime and administering it medicinally in the same manner that the medical man of more civilized regions prescribes magnesia.*

Herr Bischoff has discovered† that the mineral Pyrolusite may probably be found to be a new source of the rare metal *Thallium*. A sample of this mineral in his collection, but from what locality is not precisely known, was found, upon analysis, to contain as much as 1 per cent. of thallium. When this pyrolusite is introduced into the flame of a spirit-lamp, it immediately gives the spectrum of thallium—a single green line; and to isolate the metal, we have only to dissolve the mineral in sulphuric acid and precipitate the thallium from the solution by means of a piece of pure zinc.

Professor Claus‡ has analysed a black mineral obtained by Herr Fischer in small masses in a phonolite rock near Oberschaffhausen (Kaiserthal, Grand Duchy of Baden). It turns out to be *Schor-*

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* See Quart. Journ. Geol. Soc. vol. ix, p. 353, &c., for a paper by Mr. Davidson, on some Devonian Spirifers and other shells from China, where these fossils also are used as medicine. See also 'Notes on Chinese Materia Medica,' by Daniel Hanbury, F.L.S., 1862, where we find fossil teeth of mastodon, elephant, rhinoceros, horse, hippotherium, and other mammals, as well as two species of fossil crabs, are recorded as highly valued in the East for medicines.—Edit.

† Ann. der Chem. und Pharm., cxxix. 375.

‡ Ann. der Chem. und Pharm., cxxix. 213.

lomite, as Mr. Fischer supposed from its blow-pipe reactions and specific gravity. This species was originally described by Professor Shepard. Its specific gravity is 3·745 according to Claus (3·80 according to others), and it has given him the following composition :—

Silica	29·55
Titanic acid	21·18
Peroxide of iron	18·08
Lime	25·13
Magnesia	1·22
Soda and potassa	4·22
	99·38

This corresponds tolerably with the analysis of Whitney, Rammelsberg, and Crosseley, made with this mineral from Arkansas (Ozark Mountains).

Professor Pisani, of Paris, has made a very interesting discovery as regards the rare mineral Pollux from the Island of Elba.* We have hitherto only one analysis, by Plattner, of this mineral, and the addition of the analysis did not make up 100 parts, but only 92·75, although it was made with the greatest care. M. Pisani has found that this is due to the mineral containing the rare *oxide of cæsium* in place of potassa. This is the first mineral in which oxide of cæsium has been detected ; the metal, it will be remembered, was discovered by Professor Bunsen, in certain mineral waters, where its presence was ascertained by spectrum-analysis. According to M. Pisani's analysis, Pollux contains about 34 per cent. of oxide of cæsium, and merely a trace of potassa. The result was as follows :

Silica	44·03
Alumina	15·97
Oxide of iron	0·68
Lime	0·68
Oxide of cæsium (traces of potash).	34·07
Soda (with a little lithia) . .	3·88
Water	2·40
	101·71

In calculating Plattner's analysis for cæsium instead of potassium, the addition comes up to 100 parts. The specimen of Pollux of which the above is the composition was transparent like quartz, its breakage conchoïdal, lustre vitreous ; colourless; exterior worn, as if decayed, and having an aspect like gum ; hardness about 6·5 ; specific gravity = 2·901. Heated it loses its transparency ; and when heated on a platinum wire with fluoride of ammonium, and then moistened with hydrochloric acid, it shows in the spectroscope the two blue lines which are characteristic of the metal cæsium. Pollux is met with at the Island of Elba in granite, along with beryl, tourmaline, quartz, &c. It crystallizes in the 1st (cubic) system, and consequently exercises no action upon polarized light.

The *Density of the Earth* appears to be in as unsettled a state as our distance from the Sun. I will not discuss here the different

* Comptes Rendus de l'Acad. des Sciences, lviii. No. 16.

methods by which a figure representing the mean density of our globe may be obtained; it will be sufficient to remind our readers that the experiments formerly made at Schehallien lead to the figure 4·713, those at Mont Cenis 4·95, both of which were pendulum-experiments, while the results obtained by the torsion-balance of Cavendish have been, in the hands of various philosophers, 5·448, 5·440, 5·660, 5·577. It will be remembered, also, that the recent pendulum-experiments of Airy (1854) in the Harton coal-mine gave the figure 6·566,* with a probable error of 0·182. In a recent number of the Journal *Cosmos* (12 Mai, 1864), M. Babinet, of the French Institute, has published an ingenious paper, entitled 'Note sur le calcul de l'expérience de Cavendish, relative à la masse et à la densité moyenne de la terre,' in which the number arrived at is 5·50. We see, therefore, that experiments made with the torsion-balance coincide very much better than the pendulum-experiments hitherto made.

M. Valenciennes has lately presented to the French Academy the tooth of a fossil Crocodile of enormous dimensions. This fossil tooth was discovered in the Oolite formation of Poitiers; it is conical, regularly rounded off, and slightly curved; it is no less than 5½ inches long, and is covered with black striated enamel. In order to give some idea of the enormous size of this crocodile, compared with that of the species now living upon the globe, the veteran professor exhibited at the same time a tooth of the largest crocodile yet met with, taken from the anatomical collection of the Jardin des Plantes, when the members of the Academy found themselves obliged to exclaim with Molière,

"Hé! monsieur, un petit mulet!"

The remains of several great Saurians have been recently discovered in this Oolite of Poitiers by M. Raynal, and deposited by him in the Museum of that town. Professor Raynal promises a paper upon them, in which the new Crocodile will be described under the name of *Crocodilus formido.* It is impossible to confound this species with the *Megalosaurus*, the teeth of which have saw-edged summits, and are altogether distinct from those of a Crocodile.†

REVIEWS.

COURS DE PALÉONTOLOGIE STRATIGRAPHIQUE. Par M. A. D'ARCHIAC. Première Année. 2 vols. pp. 491 and pp. 616. With 3 Tables. Paris, F. SAVY, 1864.

STUDENTS of Palæontology have long stood in need of a book which should occupy in that science the place held in Geology by Lyell's 'Principles;' for though 'Manuals,' 'Elements,' and

* Corrected by Haughton, 5·48.—EDIT.

† The tooth of *Pliosaurus grandis*, in the British Museum, from the Kimmeridge Clay of Dorset, measures 12 inches in length!—EDIT.

'Handbooks' have not been wanting, without ever having been so abundant as similar aids to the study of pure Geology, yet a good exposition of the Principles of Palæontology—illustrating the fauna of each bygone age by means of that of the present day—has not yet been published, unless an exception be made in favour of the second part of the volume we are now about to notice. That this is the rôle assigned to it by the author is apparent from the following sentence, extracted from the advertisement to this portion of the work:—'The first part has been devoted to a *Précis de l'Histoire de la Paléontologie stratigraphique*; the second will embrace, under the title of *Connaissances générales qui doivent précéder l'étude de la Paléontologie et phénomènes organiques de l'époque actuelle qui s'y rattachent*, some very diverse subjects, all of which, however, assist in elucidating, completing, and explaining the past by the knowledge of the present;' and to this second part we shall confine our attention, merely mentioning that the first consists of a useful résumé of the progress of palæontology in different countries, being a kind of précis of the palæontological portion of the author's 'Histoire des Progrès de la Géologie,' arranged geographically.

The author's subject is one which offers many opportunities for a display of original ideas, both on the subject-matter itself, and more usefully, perhaps, in the mode of treating it; but although his arrangement is excellent, we cannot always admire the spirit of his criticisms: the plan is sufficiently philosophical; but the execution is not always so. We have looked for original inferences in vain, but though naturally disappointed, we remember that the first volume only is before us, and thus we may still hope that they will be found in some future portion of the work. Still it must be acknowledged that the author does not seem sufficiently alive to the importance of comparing the operation of the laws which regulate the distribution of existing animals with their presumed operation in geological periods, for which this volume seems to offer an opportunity; still, however, it is possible that he reserves all such considerations until after he has discussed each ancient fauna in the same manner as he now reviews that of the present epoch.

The chapter on the Distribution of Plants consists chiefly of excerpts from M. de Candolle's 'Essai sur la géographie des plantes;' but the remarks on the Distribution of Animals are culled from several sources—the Mollusca entirely from Woodward's Manual; and are interspersed with a few original observations, especially in the form of criticisms, of which Dr. Wallich comes in for a large share. In the chapter on the Distribution of Aquatic Animals, we find more references to organic laws than anywhere else in the book; but the principles enunciated, and the laws included in them, are familiar to us as having been put forward by the late Edward Forbes, and in reading these few pages we feel that he is the presiding genius, and that he, not M. d'Archiac, invests these scientific realities with a charm which makes us almost dream that we are in the regions of romance.

M. d'Archiac appears too unimaginative to treat of laws; he works with his pen rather than with his head; he revels in facts: facts that can be collected and arranged; useful to the student, but telling us nothing more than what was known before. Anything like a new idea is repulsive to him, as it opens out a path hitherto untrodden, strewn with thorns instead of flowers, angular boulders instead of well-worn sand. Thus we read nothing of Professor Huxley's 'Homotaxis,' nor of Professor Ramsay's 'Breaks;' but we hope to do so by-and-by, although the consideration of such novel, and, consequently, it may be, erroneous ideas, will doubtless interfere with his mental comfort and repose.

There is one subject, however, of which, notwithstanding its repulsiveness, M. d'Archiac has felt bound to treat, namely, the Origin of Species; and he almost atones for the omission of other matters, by his diffuseness on this. He takes each chapter of Mr. Darwin's celebrated book *seriatim*, and endeavours to refute the propositions contained in them, according to his notions of refutation, in the most uncompromising manner imaginable. We object strongly to the tone of his remarks and arguments, which are very unlike the results of a calm consideration of a scientific theory by a philosophical palæontologist.

That Mr. Darwin's hypothesis should have been received in France with less favour than in England is not astonishing. French palæontologists have less need of it than we have, the value of their 'species' bearing to that of ours almost the same proportion that a franc does to a sovereign. Where they divide, we connect; no principle is required for unlimited splitting; but when we mass together specimens differing to some extent from one another, we want a theory for the existence of the variation in order to justify our practice.

M. d'Archiac's notions respecting the principle of Natural Selection may be inferred from the tone of the following paragraph:—

'It is in the history of life at the surface of the globe that the secret of this succession of biological phenomena may be found. But to suppose that nature is obliged to perform for the duration of her work precisely that which man strives to perform to alter or to destroy her, is to have a strange idea of creative power! It would have been left to a farmer, to a horse-breeder, to a pigeon-fancier, to a florist, or to a gardener to detect thus her most profound secrets! The interest, chance, caprice, or amusement of the first comer would have carried him ten times further into the knowledge of the laws which govern the organic world, than all the naturalists who, for two hundred years, have studied, compared, and meditated with the scalpel and the microscope! *O vanité des sciences et des savants!!*'

Our author considers this kind of criticism profound, for at the beginning of the chapter, in a footnote, he complains that all the reviews of Mr. Darwin's book that he has read are too superficial. Whatever opinion different naturalists may hold respecting the truth or the probability of Mr. Darwin's hypothesis, we never before heard of one who doubted the scientific value of the book, or the candour of the author; but M. d'Archiac thinks otherwise; according to him, Mr. Darwin 'n'y parle que de lui et de ses amis,' his book is 'diffus, sans méthode, présente les faits sans ordre, des répétitions et des contradictions fréquentes,' and so on for several lines; all for the purpose of glorifying, by contrast M. Godron's work, 'De l'espèce et des races, dans les êtres organisés, et spécialement de l'unité de l'espèce humaine.'

M. d'Archiac has a passion for history; he calculates everything by means of an Historiometer; M. Godron's book is praised, avowedly, because it is historical, and Mr. Darwin's is denounced, apparently, because it is original. History and tradition, routine and red-tape, furnish the ruling principle of our author's criticism, and form the standard of excellence to which everything is reduced.

The bad taste and scientific worthlessness of the chain of invectives we have noticed are so apparent, that they will not deter us from recommending the book to a student, as a good preparation for the study of Palæontology; for it contains much that is valuable, though nothing, except the said invectives, very original. The chapter on Fossilization consists of a very useful résumé of known facts, as also do those on the Antiquity of Man, and on Coral-reefs and -islands: while the exposition of Professor Dana's system of isocrymal lines is particularly good, being both clear and concise.

M. d'Archiac's observations on geological nomenclature are, for the most part, very just; at the same time they are occasionally amusing, as he does not see that in always endeavouring to discover the faults and frailties of other authors, by subjecting their remarks to the test of a *reductio ad absurdum*, and in descanting on the vanity of sages and sciences, he not unfrequently exposes his own. The terms 'formation,' 'period,' 'epoch,' &c., have been used in a very loose manner by most writers, and the author endeavours to remedy this evil by giving to each a definite signification; he would thus speak of the Secondary epoch and rocks (terrains); of the Cretaceous period and formation; of the Neocomian group; and of the Atherfield stage (étage). This attempt is very praiseworthy, and we hope it may succeed; but it would have been much more admirable if he had not prefaced it with one of his tirades against everything and everybody, characterizing the ordinary Manuals as published for the purpose of reproducing only 'the discoveries and opinions of the author and his friends,' and where 'the science of the geologists of the five parts of the world is found concentrated in one single head—that of the author.'

We would fain have noticed this book more favourably; but the abundance of invective intermixed with his criticisms has compelled us to be more searching in ours than our politeness to the author of such a work, new in scope, and likely to prove of immense value to students, would otherwise have allowed us to be. It is these personal remarks, which are far too frequent among us, that have inculcated the idea, so prevalent with the general public, that the science of geology rests on no certain basis, and that geologists themselves do little else than quarrel about what none of them can prove.

Instances of the Power of God as manifested in His Animal Creation. By Professor Richard Owen, D.C.L., F.R.S. London: Longman & Co., 1864, pp. 64, with illustrations.

THIS lecture, originally delivered before the Young Men's Christian Association at Exeter Hall, was published in a separate form under the auspices of that Society, but excluded from their annual volume of lectures. To the geologist it affords many points of interest.

Professor Owen, in a lecture replete with the most elegant diction, the most conclusive arguments, and the most powerful array of facts in favour of the doctrines which the vast majority of scientific men have long accepted, declares his belief that the periods of time during which the earth can be proved to have existed, to have been clothed with verdure, and peopled with hosts of animals, and ultimately by man himself, are in their duration as well as in their nature, incapable of being compressed into the narrow limits of the short chronology in which a jealous, and frequently an ignorant theology has endeavoured to force them.

Such evidences as those afforded, e. g., by the existence of serpents then, as now, gliding prone on the belly, and endued with poison-fangs,—by the frequent evidences of death, disease, and every form of physical corruption, ages before the advent of man,—by the facts of the geographical distribution of animals in the Upper Tertiary beds—are pointed out by Professor Owen to be wholly 'incompatible with the notion of the divergence of all existing, air-breathing, or drownable animal species from one Asiatic centre within a period of 4,000 years.'

There are those geologists who will chide Professor Owen for the over-delicacy with which these facts are brought forward by him. In these days of Büchner and Vogt, no doubt Professor Owen's opinions will be unsatisfactory to the ultra school of developmentalists. Others there are with whose opinions they may more closely accord; and we cannot sympathize with the authorities of the Institution who have interposed obstacles to the publication of Professor Owen's lecture, after it had been well received by the great body of its members.

Such extended views as are held by Professor Owen and the majority of geologists need not necessarily destroy man's faith, or be subversive of his highest and holiest aspirations; but every fresh vista which natural science opens before his intellectual gaze should rather conduce to strengthen and cherish his belief, and none of those points of faith which are considered essential to Christianity are, or ever can be, shaken by our knowledge of any scientific fact. To those who, ignorant of the real motives which actuate a truly scientific man, possess an idea of religion so little reverential that they consider it dependent on any scientific fact, we would, with Professor Owen, ask, 'what, if any, sacred doctrine, rests upon our cognizance of a geological fact, or could be shaken by the new interpretation of a palæontological discovery?' But to those whose daily path in science it may be (and it is often one forced on them contrary to their own wishes) to labour onward, making known the purely scientific facts which come before them, recollecting that the personal honesty of each observer is the stake for which he plays in the great game of science, recollecting also that, as Benedict Spinoza has demonstrated, 'neither philosophy nor theology is subordinate, but that each holds sway in its own sphere without prejudice to the other'—we would say that it was their duty to go on stedfastly, unwaveringly, '*ohne Hast, ohne Rast*,' conscious that they interpret to the best of their finite ability their conception of the truths of science, and equally conscious that whatever may be the immediate result of their labours, or whatever obloquy or misrepresentation they accept as their necessary inheritance, they must eventually fulfil the aspiration which tends *ad majorem Dei gloriam*.

THE QUARTERLY JOURNAL OF SCIENCE for July advances our knowledge of geology by original articles, retrospective summaries, and notices of published works. Mr. Jenkins's memoir of the characters of fluviatile, lacustrine, and estuarine formations, specially elucidated by some brackish water fossils from Crete, treats of the geology of the Eastern Mediterranean Region, especially as to the relative age of the marine and freshwater strata of Lycia and Crete, pointing out that the Lycian freshwater beds are really older than the marine strata, instead of being newer, as they were formerly regarded by Professor E. Forbes and Captain Spratt. The palæontological distinctive characters of deposits formed in lakes, rivers, and estuaries are discussed, and the malformation of shells is taken as a guide in the determination of the nature of the Cretan deposit, from which the author describes several fossil shells, including six new forms. Some of these are curiously malformed, especially a spiniferous *Neritina* and a reversed *Melania*. The plate is well executed; but a mistake occurs in its numeration. Professor Ansted gives an interesting description of the copper-vein in Tertiary volcanic rock, worked at the celebrated Monte Catini in Tuscany, showing points of similarity and of difference as regards other copper-lodes, and ascribing its origin to currents of water and vapours, leaving deposits in fissures formed by modern volcanic agency.

The quarterly résumés of the progress of geology and other sciences are satisfactorily continued; that of geology and palæontology, as well as that of mining, mineralogy, and metallurgy, seem to be as comprehensive as space will allow; and several other articles will be found to interest geological readers.

THE EARTH'S CRUST: A Handy Outline of Geology. By DAVID PAGE, F.R.S.E., F.G.S. Edinburgh, 1864. 8vo. pp. 128.

THE deservedly popular elementary works of Mr. Page are sure to give this useful and compact little volume a fair introduction to the public. Mr. Page has conceived an ambitious scheme. From the stores of his own mind he proposes single-handed to enlighten the enquiring public on Natural Science, Geography, History, and

General Literature. He here puts his best foot foremost, and gives us a specimen outline. On the whole his plan is well executed, but we are surprised to find some slips which show an unexpected carelessness. Thus *Sigillaria* and *Stigmaria* are always referred to as distinct organisms; *Diatomaceæ* are characterized as animalcules; and *Equisetum* is spoken of as an ally of *Hippuris*. But such slips are unimportant compared with Mr. Page's strange confusion about the lowest stratified rocks; for while he accepts Murchison and Geikie's determination of the Hebridean rocks as Laurentian, he still retains the Metamorphic strata as an azoic series inferior to the Cambrian, and unites the Laurentian strata to the Cambrian, though separated by the whole of his 'Metamorphic system,' because the fossils are closely akin or identical! We wonder where he found this information.

Proceedings of the Geologists' Association, vol. i. No. 10. 1863–4.

THE communications made to this Association may be grouped as—1st, those in which the authors go over old ground, pointing out, more or less clearly, the various subjects of interest; and under this heading the visits made by the Associates to special localities, and to geological museums, are not the least in importance; and, 2ndly, those, less numerous, which offer original information. Of the latter group, Mr. J. Rofe's paper 'On some Recent Marine Shells found in the Excavations for Railway-works near Preston,' is the best in the present number of the Proceedings. Its object is to enquire with regard to Lancashire and the Penine Chain, 'whether the upheaval of the parts most distant from the sea has not been continued even since the elevation of that nearer the sea: that is to say, that Mottram has been further elevated since Preston emerged; and, indeed, whether that process may not be going on in our own times.' Mr. A. Bott's account of the strata exposed by the excavations for the 'Southern High-level Sewer Main Line,' and Mr. C. Evans's paper 'On the Geological Distribution of *Pitharella Rickmani*,' are useful additions to the history of the 'Woolwich Beds.' Mr. C. Evans leans to the opinion that the *Pitharella* is allied to the *Ampullaridæ*, rather than to the *Limnæidæ*, and that the known variations in its form are not of specific value. Mr. C. Evans's paper, also, on the sections now being exposed by railway-cuttings near London is well-timed, and likely to influence the Associates and others to visit the works and collect facts before the opportunities are altogether lost.

REPORTS AND PROCEEDINGS.

THE GEOLOGICAL SOCIETY OF LONDON.

The following communications were read, June 22, 1864:—

1. 'On the Fossiliferous Rocks of Forfarshire and their contents.' By James Powrie, Esq., F.G.S.

Referring to his former paper for a detailed description of the lower members of the Forfarshire Old Red Sandstone, the author now gave a general sketch of the relations of the several beds, and then descriptions of the species of Crustacea and Fish occurring in them. The latter belong to five genera, two of which (*Ischnacanthus* and *Euthacanthus*) are new. After discussing the nature of *Parka decipiens*, and shortly noticing the genera of Crustacea that occur in the same rocks, Mr. Powrie concluded his paper with a short synopsis of the distribution of the members of the Old Red Sandstone in Forfarshire, and a discussion respecting the subdivision of that formation, in which he stated that *Pterygotus*, *Parka decipiens*, and *Cephalaspis*, are always associated in the same beds, and extend through all the fossiliferous rocks of Forfarshire, instead of the latter characterizing a higher horizon than the others.

2. 'On the Reptiliferous Rocks and Foot-print Strata of the North-east of Scotland.' By Prof. R. Harkness, F.R.S.L. & E., F.G.S.

The author showed that the foot-print sandstones of Ross-shire constitute the upper portion of the Old Red Sandstone formation, and that the strata embraced in a line of section from the Nigg to Cambus Shandwick, from above the gneiss to the foot-print sandstones of Tarbet-ness inclusive, are conformable throughout, and are referable to each of the three divisions of the Old Red Sandstone, namely, the conglomerates and yellow sandstones (of a thickness of 1,500 feet) belonging to the Lower Old Red Sandstone; the grey flaggy sandstones and shales of Geanies—the equivalent of the Caithness flags—containing *Osteolepis*, *Coccosteus*, and *Acanthodes*, and thus referable to the Middle Old Red; thirdly, conformable strata, consisting of conglomerates, and print-bearing and other sandstones, appertaining to the higher members of the system. The print-bearing sandstones have a thickness of 400 feet, and represent the reptiliferous sandstones of the Elgin area, though not overlain by Cornstones as in that district.

The author, in conclusion, remarked that though *Stagonolepis* is decidedly Teleosaurian in its affinities, it does not consequently mark a Mesozoic group of rocks; for *Mastodontosauria*, which abound in the Trias, occur in the Coal-measures; and stratigraphical evidence now shows us that Teleosaurian crocodiles have a wider geological range, since they are met with in the Old Red Sandstone.

3. 'On some Bone- and Cave-deposits of the Reindeer-period in the South of France.' By John Evans, Esq., F.R.S., F.G.S.

The deposits to which the author particularly called attention in this paper are those which have been, and are still being, explored under the direction of MM. Lartet and Christy, and which were visited by him under the guidance of the latter gentleman, and accompanied by Mr. Hamilton, Prof. Rupert Jones, Captain Galton, Mr. Lubbock, and Mr. Franks.

Mr. Evans first gave a detailed description of the physical features of the valley of the Vézère, and of the contents of the caverns of Badegoule, Le Moustier, La Madelaine, Laugerie-Haute, Laugerie-Basse, the Gorge d'Enfer, and Les Eyzies, giving a list of the animal remains discovered, which are for the most part of the same species from all the caverns.

The author then discussed the antiquity of the deposits according to four methods of inquiry, namely, from geological considerations with regard to the character and position of the caves; from the palæontological evidence of the remains found in them; from the archæological character of the objects of human workmanship; and from a comparison with similar deposits in neighbouring districts in France; and he came to the conclusion that they belonged to a period subsequent to that of the *Elephas primigenius* and *Rhinoceros tichorhinus*, but characterized by the presence of the Reindeer and some other animals now extinct in that part of Europe.

4. 'On the Carboniferous Rocks of the Donetz and the Granite Gravel of St. Petersburg.' By Prof. J. Helmersen. (In a letter to Sir R. I. Murchison, K.C.B., F.R.S., F.G.S., &c.)

This letter relates (1) to the discovery in the Donetz Mountains of additional beds of coal and of iron-ore; (2) to the proposed use of this coal for steam-purposes on the Volga; (3) to two geological expeditions to be sent out in 1864 for the purpose of surveying the Permian basin of Russia; and lastly, to the successful completion of an artesian boring at St. Petersburg. In this well the following beds were passed through:—Alluvium, 88 ft.; Silurian clay, 300 ft.; sandstone, 137 ft.; bed of gravel, the result of the degradation of granite.

5. 'On a supposed Deposit of Boulder-clay in North Devon.' By George Maw, Esq., F.G.S., F.L.S.

A deposit of brown clay which occurs near Fremington, in North Devon, and has been worked for several years, was described by the author in this paper, and referred by him to the Boulder-clay formation. The smallest amount of subsidence necessary for the deposition of this clay at its present highest level would place a large area of Devonshire under water.

Mr. Maw considered the raised beach at Croyd as being a much more recent deposit than the gravel just described; and in connection with the question of the former submergence of Devonshire during the glacial period, he discussed the relation of the latter to a deposit of granite-drift gravel at Petrochstow, concluding that it could only have been transported thither during the submergence of the high ridges which intersect at right angles the country between the two deposits.

6. 'On the former existence of Glaciers in the High Grounds of the South of Scotland.' By J. Young, M.D., F.R.S.E. Communicated by Archibald Geikie, Esq., F.G.S.

The heights bordering the counties of Peebles and Dumfries are stated by the author to contain well-preserved remains of a group of Glaciers belonging to a later period than the Boulder-clay, and some of which have been already alluded to by Mr. Geikie and Mr. Chambers. Dr. Young then describes the physical geography of the region, grouping the several hills into three ranges—the Broad Law Range, the White Coomb Range, and Hartfell—from which certain glaciers formerly descended into the valleys; and he further divides the glaciers into two classes, which he terms respectively the 'Social' and the 'Solitary.' The author then describes the form and extension of the masses of detritus which he considers to be glacial débris, contrasting their characters with those of the patches of Boulder-clay occurring in the neighbourhood.

Many indications of glaciers are shown to be much obscured by the prevalence of peat in the district; but, in addition to the moraine-matter, smoothed surfaces and *roches moutonnées* are occasionally seen.

7. 'On the Formation and Preservation of Lakes by Ice-action.' By Thomas Belt, Esq. Communicated by Prof. Ramsay, M.A., F.R.S., F.G.S.

During a residence of two years in the province of Nova Scotia, the author observed the remarkable number of lakes, great and small, occurring there, sometimes in connected chains and sometimes on the sides and tops of hills. The lake-basins are stated to be, chiefly, in extremely hard quartzites and metamorphosed schists, irregularly studded with masses of Boulder-clay, beneath which are seen scratches, grooves, &c., that have been produced by ice-action. The author then describes all the phenomena in detail, and gives a *résumé* of the theory of their glacial origin, as propounded by Professor Ramsay, coming to the conclusion that in this way only can the facts be consistently explained.

8. 'A Sketch of the Principal Geological Features of Hobart, Tasmania.' By S. H. Wintle, Esq. Communicated by Sir R. I. Murchison, K.C.B., F.R.S., F.G.S.

The hills upon which Hobart is built, as well as those in the vicinity, are mostly composed of New (?) Red Sandstone, capped with greenstone of a variable composition and of great thickness in some places.

The Carboniferous Limestone (?) is stated to be very extensively developed throughout the island, and to be very fossiliferous; the author describes its lithological characters, as well as those of the Devonian rocks and the Silurian slates of Mount Wellington, which last, as yet, have proved unfossiliferous; but he states that Mr. Gould has found a *Calymene Blumenbachii* in similar rocks in the interior. He then, after describing the Coal-formation of the island, and remarking upon the anthracitic nature of the coal, passes on to the 'Boulder-drift' (?), which consists of immense boulders, principally of felspathic trap and greenstone, imbedded in stiff clay in some parts, and in loam in others. The boulders are also associated with fragments of New Red Sandstone and nodular masses of Dolomite.

The author concludes by describing the mode of occurrence, in the Valley of the Derwent, of a marine deposit, which he considers of Post-pliocene age, and which is found at an elevation of upwards of 100 ft. above the sea-level, and at a distance of from 50 to 100 yards from the water's edge; thus showing that the Valley of the Derwent and the neighbouring country had recently been upheaved.

The next meeting of the society will be held on November 9, 1864.

The First Summer Meeting of the Warwickshire Naturalists' Field Club was held at Broadway, in Worcestershire, on May the 24th. Ascending the hill, the attention of the geologists was attracted to a roadside section of Lias, consisting of the sandy and highly fossiliferous beds, immediately below the Marlstone, which are rarely exposed. The view from the summit of the hill is very extensive, comprising the Liassic outliers of Stanley and Dumbleton and the more distant hills of Bredon, the Malverns, and May Hill. Several large quarries of Inferior Oolite were visited, shewing the Upper and Lower Freestones, not very rich in fossils, the latter affording an excellent building stone, as at Birdlip, Chene, and Leckhampton, near Cheltenham; the pisolite and oolite-marl being absent. The most abundant fossils were some *Terebratulæ* and *Rhynchonellæ*, and one specimen of *Hyboclypus agariciformis*. Higher up these Freestones are overlain by the Ragstones, which abound in organic remains, among which the following were noticed: *Nautilus*, *Belemnites brevis*, *Ostrea Marshii*, *Corbula*, *Astarte excavata*, *Gervillia Hartmanni*, *Modiola*, *Serpulæ*, and casts of *Trigonia costata*, and *Cucullæa*, but no Gryphites. Descending the hill, about two miles from this point, the Upper Lias was observed with numerous fossils — *Ammonites communis* and *Inoceramus dubius*. Below this a slip has taken place, and brought down masses of Oolite which have filled up hollows in the Upper Lias. The Rev. P. Brodie gave a general sketch of the geology of the district, pointing out the extension of the same strata into Gloucestershire.

The second meeting was held at Cleobury Mortimer, in Shropshire, on June 20th, extending through the week, the Club always holding one distant meeting in the year for several days. Excursions were made to Clee Hill, Oreton, Farlow, and Wyre Forest. The more special points of interest were the trappean upthrow of the Clees bursting through the Coal, the fine sections of Mountain-limestone near Oreton, abounding in remains of Cestraciont fishes, and the yellow sandstone of Farlow, from which the first British *Pterichthys* was obtained not long since. The railway through the forest from Bewdley to Tenbury affords some interesting sections of the Coal-measures. The geologists of the party obtained several characteristic fossils from the latter, and some teeth of *Helodus*, *Orodus*, *Psammodus*, and *Cochliodus*; also shells and corals from the Mountain-limestone, and portions of *Pterichthys* and *Holoptychius* from the Yellow Sandstone, the equivalent of the beds at Dura Den in Scotland, and well worth a careful examination. The botanists obtained some rare plants, of which the Rev. G. Henslow furnished a copious list. This was a joint meeting of the Warwickshire Club with the Severn Valley Club, and in the course of the excursion addresses were delivered on the geology of the neighbourhood, by the Rev. W. Purton and the Rev. P. B. Brodie. Mr. Weaver Jones, the only local geologist, kindly invited the Clubs to view his choice collection of fossils, which is especially rich in fish-teeth and spines, from Oreton; and he is always ready to shew it to any one who may wish to inspect it. On this occasion the Club experienced much hospitality and kindness from him and the Rev. S. Lowndes, the curate of Cleobury.—P. B. B.

Berwickshire Naturalists' Club.—The first field-meeting for the year 1864 of this the oldest Naturalists' Club in the kingdom was held, on the 26th of May, at Greenlaw, in the central part of Berwickshire. The field-explorations of the day were chiefly directed to the geology of the district. Greenlaw stands on the upper beds of the Old Red Sandstone, which are well seen in great cliffs, 150 feet in height, on the banks of the Blackadder, in Greenlaw Dene. About a mile eastward of Greenlaw a railway-cutting has exposed a broad trap-dyke, composed of amygdaloids, basalt, and trap-tufa, and having a direction of NE.–SW.; abutting against this dike on the east side, are impure limestones and calciferous sandstones and shales, belonging to the Tuedian or lowermost group of the Carboniferous formation, lying between the Mountain-limestone and Old Red Sandstone. Hume Castle, three miles southward of Greenlaw, was visited, and a long range of columnar basalt, with an E.–W. direction was examined. These columnar rocks are not less than 50 feet in height; in mineral character and external form they resemble the basalt of the great Whin-sill, ranging through Northumberland; but whether, like that sill, it has been intruded as a lateral dike among stratified rocks, or was a vertical dike, could not, during the limited time of the survey, be determined. It is 20 miles westward of the northern termination of the basaltic whin-sill at Kyloe; and, whether or not connected, very probably both have been erupted at the same period.

But the most interesting objects examined were the *Kaims*—peculiar elongated ridges of sand and gravel, standing up like huge defensive earthworks above the general surface of the country. Bedshiel Kaim, the most important of them, is three miles northward of Greenlaw; it stands on elevated moorland, between six and seven hundred feet above the sea-level. The Kaim is from 30 to 60 feet above the level of this moor; and, when viewed from its highest point, it seems a wonderful object, winding its way, like a serpent, a distance of three miles across this elevated moorland. The top is about 10 feet wide; and the inclination, which is nearly the same on both sides, varies from 15° to 33°; where steepest, the sides are covered with heather; but where the inclination is less, they are clothed with grass. There is a gap in one part of the ridge, where it is cut through by the Fangrist Water. From diggings made into the Kaim in different parts, so as to expose sections, it was found to be composed of gravel and sand, *distinctly* but irregularly stratified. Three-fourths of the gravel consisted of greywacke, from the Cambro-silurian formation of the Lammermuir Hills; mingled with these were rocks of Old Red Sandstone, of porphyry-amygdaloid, and a very few of basalt; all were rounded and smooth, so that they must either have come from a distance, or more probably been repeatedly rolled over each other. Most of them must have come from the N. and the W., where, at no great distance, those rocks occur *in situ*.

On the moors on both sides of the Kaim, in certain parts, are deep deposits of peat, which was formerly dug, dried, and conveyed by asses to Greenlaw, and there sold. The introduction of coal put an end to this traffic, and from the subsequent growth of peat in the abandoned peataries, it has been calculated that there is a vertical growth of about one foot in a century.

Much speculation there has been as to the origin of the Kaims. Dr. Buckland thought they were moraines of a glacier; but the water-worn materials of which they are composed, and their distinct stratification, as well as the alternations of coarse gravel and fine sands, upset this notion. Similar but much smaller ridges occur in Northumberland; and there they are connected with the Boulder-clay, and contain polished and scratched blocks. Similar instances of ice-action will probably be found in the lower deposits of the Kaim, which have not yet been sufficiently examined. There were found, however, in a railway-cutting, eastward of Greenlaw, gravel and sand deposits similar to those in the Kaim, and among these was detected one large block distinctly polished and striated. These Kaims, therefore, may be of the same age as the Boulder-clay; but it is difficult to account for their ridge-form, as seen in Berwickshire.

A paper on these Kaims, by Mr. William Stevenson, president, was read after the examination in the field was finished; and he is of opinion that they were formed of materials deposited under the waters of the sea, when it stood relatively about 700 feet above its present level, these materials having been subsequently shaped into their present form by the action of tidal and other currents during the emergence of the land.

Another paper by Mr. William Stevenson, on traces of a formation of Primary Quartz-rock in the South of Scotland, was read. The author concludes, from the occurrence of large quantities of water-worn Quartz-pebbles in certain localities, that, prior to the deposition of the Old Red Conglomerate, there existed in the Western parts of Berwickshire and Roxburghshire at least two or more patches or insulated portions of an older formation of Quartz-rock, of which there is not now seen a vestige *in situ*.

Mr. George Tate, secretary, laid before the meeting sketches, sent by Captain Oswald Carr, R.A., of sculptures on Rock-temples in Malta, of prehistoric age. They have some analogy to the peculiar sculptured rocks of Northumberland; but, as Mr. Tate explained, they resembled more the sculptures on cromlechs in Brittany, and on the sepulchral chamber at New Grange in Ireland. He would at an early day lay before the Club the result of his long researches among the sculptured stones of prehistoric age on the Borders.—G. T.

THE Third General Field-meeting of the BELFAST FIELD-NATURALISTS' CLUB was held on the 25th of June, at Greyabbey, Co. Down. Botanically, the district proved to be of high interest, but the principal point of attraction was the ruins of the Abbey, founded A.D. 1199. Greyabbey is situated upon the Lower Silurian clay-schists.* The quarries at Mount Stewart had been worked for

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* These are overlain by the upper members of the Old Red Sandstone. These latter beds have been bored at Mount Stewart to a depth of 567 feet in search of coal! The former at Tullygarvan, near Ballygowan, are somewhat bituminous, and contain one or two species of *Didymograpsus;* and they also, and that very recently, have been sunk into in search of coal!—R. T.

slate in this formation in old times, but were opened out some years ago by Mr. Montgomery, the proprietor, who brought skilled workmen over from Wales to quarry the slate and prepare it for use. A deep cutting, an embankment, and other works, have been made, but the quarries are not now worked. The slate is close-grained, and very good in colour.—R. T.

THE MALVERN NATURALISTS' FIELD-CLUB.—The Club met at Great Malvern on the 15th of June last, and started by rail for Ashchurch, where they arrived at noon, and were joined by the Rev. W. S. Symonds, the president, and a large party of friends. They then proceeded along the new line of railway to Evesham. Upon reaching Beckford, the whole party alighted to examine an excavation in the drift about ten feet deep. The marine origin of this deposit was proved by Miss Holland, who discovered in it a specimen of *Rissoa*. The president gave a description of this ancient sea-bed, which he considered to have been accumulated when the valley of the Severn was an arm of the sea and the Malvern and Bredon Hills only islands. In the cuttings along the line remains of *Elephas primigenius*, human bones, bone implements, Roman and later coins, have been turned up by the navvies. The members inspected other sections on the line, especially one beyond the Evesham terminus. The rest of the day was devoted to visiting the two churches and the old abbey at Evesham, dining at Beckford, and the reading of a paper contributed by John Jones, Esq., of Gloucester, upon some ancient deeds relating to property at Longdon, held by the corporation of Gloucester.

The next meeting will take place at Ross on July 21st.—W.S.S.

BRISTOL NATURALISTS' SOCIETY.—The first excursion of this Society for the season was held on the 17th June. The members of the Bath and West of England Agricultural Society had been invited to attend, and for the sake especially of these visitors the excursion of last September was repeated. The party, upwards of seventy in number, including several ladies, assembled at Hotwell-house, and proceeded along the course of the Port and Pier Railway as far as Shirehampton, in order to study the various geological sections laid bare by the cuttings, the interesting features of which were pointed out and descanted upon by the president, Mr. W. Sanders, F.R.S., and the hon. treasurer, Mr. W. W. Stoddart. From Hotwell House to the Black-rock the strata belong to the Carboniferous series—the fossils in the Mountain-limestone, as well as the shales, a thin bed of coal, and the Millstone-grit, attracting much attention. At the Black-rock, a great fault, or displacement of strata, occurs, and the whole series begins again. Near the old shooting-ground of the Rifle Corps, the first indications of the Devonian, or Old-red-sandstone group, are shown by flakes of mica in the shales. In this field, also, the botanists and entomologists of the party obtained several specimens; and here Mr. Stoddart pointed out a small bone-bed, about three inches thick, which he had accidentally discovered on a former occasion, as well as some strata containing many fossil Entomostraca.

The most curious section, however, was that near the powder-house, where the railway skirts the edge of Kingsweston-park; the beds are contorted, and thrust upwards in the middle, forming an anticlinal curve. These curved strata belong to the Old-red-sandstone series; and lying horizontally on the top of them is a bed of New-red-conglomerate. After passing beds of red clays and sands, the party left the line of the railway, and came down through Shirehampton into the marshes, where the botanists and zoologists found many opportunities of adding both to their collections and to their knowledge of the habitat of many minute organisms.

At a quarter past four the whole party re-assembled at Hooper's Hotel. Mr. Sanders then gave a brief geological sketch of the sections passed through that morning, and concluded by calling on Professor Buckman, who after referring to the fact of his having been secretary for seven years to the Cotteswold Field-club, said that he had met that day with a greater variety of plants than usual in a walk of the same extent, and especially was this the case with the grasses, which were his peculiar study.—*Bristol Daily Post,* June 20th.

The Dudley and Midland Geological Society and Field-club.—The first field-meeting was held at Cannock Chase, on 21st June. After leaving the Brownhills Station the party crossed the great Eastern Fault of the South Staffordshire Coalfield, and after traversing the more ancient collieries at Brownhills entered the extensive Cannock Chase Colliery, held by Messrs. McClean and Co. of the Marquis of Anglesea. Four seams of coal are here worked. The value of the 'Shallow' and 'Deep' coal-seams is well known. Gas is introduced into the pits as well as used on the surface, and the whole arrangements, both above and below ground, are unexceptional. The next point of geological interest was the section of coal-measures laid bare in cutting a branch line to the Hednesford Collieries. After visiting these latter works the members met for dinner and discussion, and a paper was read by Mr. Jones (the Secretary) on 'Organization in Field-club Work.'—J. J.

CORRESPONDENCE.

On the Occurrence of Cycloid Fish-scales, &c., in the Oolitic Formation.

To the Editors of the Geological Magazine.

It has hitherto been stated, that the remains of Cycloid and Ctenoid Fishes are not met with in strata older than those of the Chalk formation; an opinion, I believe, originating with that distinguished ichthyologist, M. Agassiz, when forming his arrangement of fishes by their scales into the four orders, namely, Placoid, Ganoid, Ctenoid, and Cycloid.

In a paper read before the Geological Society of London, Nov. 5, 1834, Prof. Agassiz says :—'If we estimate the number of fishes now known to amount to about 8,000 species, we may state that more than three-fourths of this number belong to two only of the above-mentioned orders, namely, the Cycloidians and Ctenoidians, whose presence has not yet been discovered in the formations inferior to the Chalk.'

Relying, no doubt, upon such high authority, eminent Palæontologists of our own country have perpetuated that statement to the present time. For example, the late Dr. Mantell says, in his 'Medals of Creation:'—'According to the data at present obtained, all the osseous fishes anterior to the Chalk belong to genera which have no representative among existing species, and they are characterized by rhomboidal scales, covered with enamel.' These are therefore the scales of *Ganoid* fishes.

Professor Owen, in his 'Palæontology,' published as late as 1861, writes, page 175:—'Seeing that the earth yields no indisputable evidence of Ctenoids or Cycloids anterior to the Cretaceous epoch . . .' From which I infer, that he has met with no information to remove from his mind the dictum of M. Agassiz.

In 1852, at the meeting of the British Association at Belfast, I communicated my discovery of parasitic borings in fossil fish-scales from the Chalk formation. Soon afterwards, when pursuing similar researches, on examining the laminated shale of the Kimmeridge Clay from Ely, and also in Norfolk, I found along with small vertebræ and ribs unmistakable *Cycloid* scales, and these scales had been attacked by boring parasites.* Herewith I send two enlarged outlines of scales from the specimen of Kimmeridge shale in my collection;

Fig. 1. Fig. 2.

Fish-scales from the Kimmeridge Clay (much enlarged).

one from a common scale (fig. 1), the other from a lateral tubular scale (fig. 2). The size of the common scale is $\frac{1}{6}$th inch in width, by $\frac{1}{8}$th in its antero-posterior diameter. When in London this spring, Mr. Davies, of the British Museum, showed me a small slab of Kimmeridge shale, containing fish-bones and fish scales strikingly resembling those in my specimen.

Prof. John Phillips, if my memory does not deceive me, informed me at the British Association meeting at Oxford, that he had seen Cycloid fish-scales in the Oxford Oolite. Accepting the above data,

* See Trans. Micros. Society, vol. iii. pl. 1, fig. 5.

I conceive it can no longer be affirmed that *Cycloid* fishes did not exist previously to the Cretaceous epoch.—Yours, &c.,

C. B. Rose, F.G.S.

Great Yarmouth, June 14th, 1864.

We append the following note in reply, obligingly furnished by Mr. W. Davis.
Edit.

Since Mr. Rose examined the slab in the British Museum (referred to in the above letter), another and a much better specimen has been acquired from the same locality, which, in addition to many scales in their natural position, exhibits portions of the jaws, with teeth having a *Sauroid* character.

As several species of true sauroid fishes, having similarly marked scales, occur in the Upper Oolite (Lithographic stone) of Solenhofen, it is probable that these imperfect specimens from our Kimmeridge Clay may prove to belong to a new genus of the same family.

Thrissops formosus and *Megalurus lepidotus* may be quoted as examples of *Ganoid* fishes having scales with *Cycloid* ornamentation. Agassiz describes the last-named species as having scales somewhat resembling those of the Carp, and gives an illustrative figure in pl. LI.[a] vol. ii. of his 'Poissons Fossiles.' W. Davies.

CAN THERE BE A RAINLESS DISTRICT?

To the Editors of the Geological Magazine.

In the first article of your first number I hail the words 'a wholesome scepticism.' Is the scepticism of the title of this letter 'wholesome?' I consider a 'rainless district' to be an impossibility. In Professor Desor's article on the Sahara, the 'rainless district' is not mentioned. But water is mentioned in rivers, in pools above ground, and in 'sheets' below ground, and 'moist beds' at a depth of eight or ten metres. A 'rain of several days' is mentioned, and the 'Desert of Erosion' is described as the result of 'rain and rivers.' As a matter of fact, I would ask through the medium of your Journal, does rain fall on the Sahara, or does it not? I ask the same question with regard to Egypt. According to the 'Star' of February 22, 1857, the passengers by the 'Indus' reported 'a fall of snow at Cairo.' In May 1860 part of the railroad between Cairo and Suez was washed down by heavy rains, and the travellers from India were stopped for two days. To the north of this district, in the desert of El Tyh, Mr. Lowth ('Western Footsteps in Eastern Climes') gets frequently soaked with rain. He describes the whole surface as scored with channels of torrents tributary to the Wady Legaba and El Arish. In one of these channels he found a river rushing, twenty yards wide, and three or four feet deep. And he was obliged to wait, like the rustic, *dum defluat amnis.* Now, this is no accidental affair, for the El Arish is the *Torrens Ægypti*, and has therefore carried torrents across Arabia Petræa *to the Mediterranean* for at least 2,000 years. Again, in descending the El Araba *to the Dead Sea*, Mr. Lowth mentions 'marks of the rush of waters, long, deep, sharp clifts in the ground, and water-worn stones and torn shrubs half uprooted in torrent-beds.' Now, Keith Johnston's 'western rainless district' includes all this region, and all Syria with the Jordan, and its 'former and latter rain,' and the greatest part of the Tigris and Euphrates. While his 'eastern rainless district' includes *the sources* of nearly all the largest rivers of the old world.—Your obedient servant,

GEORGE GREENWOOD, Colonel.

Brookwood Park, Alresford, Hampshire, July 13, 1864.

OUR Correspondent, F. F., Walgrave, is respectfully informed that 'Scriptural Geology' is not within the scope of the GEOLOGICAL MAGAZINE. We shall be glad, however, to receive notices of any geological facts he may have to communicate.

MR. R. SUGGATE, 15 Whitehall Place, favours us with a notice of the accidental finding of a piece of Teredo-bored wood in a rather large flint nodule from the Chalk of Hampshire. The flint filling the borings appeared to be slightly rayed from the centres. The specimen has been sent to the Oxford Museum.

MISCELLANEOUS.

THE FOSSIL ELEPHANT OF MALTA.—More remains of this animal have been discovered by Dr. Leith Adams, F.G.S., in extensive excavations lately made by him among the cavern-deposits and breccias near Crendi. One of the chief points with reference to the fossil Elephant found in Malta is the small size of its teeth, which, coupled with other characteristics, leaves no doubt that it was not only distinct from any living or extinct species, but was, as regards dimensions, a pigmy compared with them. It is supposed not to have been larger than a lion. Such relics, together with the bones and teeth of *Hippopotami*, &c., which of late years have been met with in great abundance in different parts of Malta and Gozo, tend to show that these islands are but fragments of what may at one time have been an extensive continent, in all probability connected with either Europe or Africa, or both. At all events, the physical geography of this portion of the Mediterranean must have changed very much since the above-mentioned animals wandered over our islands. Teeth and bones of the living Elephant of Africa, and another larger fossil species, together with the *Hippopotamus*, have been discovered by Baron Anca in the Palermo caves, thus showing that in all probability no less than three distinct descriptions of Elephants and two species of *Hippopotamus* frequented an area embraced within the southern point of Sicily and Malta, and during the Post-pliocene period, when we find the earliest traces of man's existence. None of the latter have yet been met with in Malta. But there is every probability that flint implements and such like will turn up, as they have in the Sicilian caves, more especially now that the attention of scientific inquirers has been earnestly directed to this important subject. Without the invaluable testimony afforded by the remains of the quadrupeds above mentioned, there are downcast fragments of the strata and faults along the shores of Malta, which testify to a submergence of the land. Besides, the subaqueous plateau, named Adventure Bank, uniting Sicily to Africa by a succession of ridges, not more than forty to fifty fathoms under water, points to the former contiguity of that island and the continent of Africa. So marked is the latter, that Sir C. Lyell has asserted that Sicily might be re-united to Africa by movements of upheaval not greater than those which are already known to have taken place within the human period in Sardinia, where the bed of the sea has been elevated 300 feet since man inhabited that island.—*Malta Times.*

Notes on Meteorites.—Prof. Kenngott, in arranging certain specimens in the Mineralogical Museum of Zurich, discovered a piece of iron, labelled 'Native Iron from Styria.' Supposing it to be meteoric, he sent it to the Director of the Imperial Museum of Vienna, who had it cut and polished. Its subsequent treatment with acids left no doubt of its cosmical origin. It contains crystals which appear to be olivine and pyroxene; and its general character seems to identify it with the meteorite which fell many years since at Steinbach in Saxony. It may be mentioned that no meteorite has yet been known to have fallen in Styria. It would be interesting if the directors of museums would submit any specimens of so-called 'native iron' that they may have in their possession to similar tests.

M. Haidinger, of Vienna, in a letter to M. A. Quetelet, of Brussels, gives some interesting particulars of the fall of an Aërolite at Inly, near Trebizond. It fell in an easterly direction, at about three o'clock in the morning, on December 10, 1863, with a terrific explosion, resembling the discharge of hundreds of cannon. Some pieces supposed to have belonged to it have been forwarded to Vienna; but, from the examination as yet made of them, their origin seems to be rather terrestrial than cosmical.—J. R. G.

Sir Charles Lyell.—Her Majesty has been pleased to confer the dignity of Baronet of the United Kingdom upon Sir Charles Lyell, by the title of Sir Charles Lyell, Baronet of Kinnordy, in the county of Forfar. All geologists will, we feel assured, rejoice at this well-merited mark of distinction bestowed by the Queen upon one of the ablest of our leading men, whose life has been devoted to the promotion of their science, and to whom we are indebted for so many valuable works. The honour just conferred upon him is the highest recognition of merit ever bestowed on a geologist in this country by the Sovereign, and among men of science he has long held the equally high and honourable title of 'the Historian of Geology.'

The family of Mr. Hugh Miller have resolved to put into complete repair the humble cottage in Cromarty in which he first saw the light. A neat railing is to be erected in front of the building, the inside of which is to be otherwise made neat and tidy. The cottage stands near the base of the handsome pillar, surmounted by a statue of Hugh Miller, which was erected to his memory by friends and admirers.—*Weekly Review*, June 25.

A bust of the late Dr. Buckland, obtained by subscription, has just been placed in the New Museum of Oxford, amongst the Buckland Collection of Fossils.—*Athenæum,* July 2nd.

THE

GEOLOGICAL MAGAZINE.

No. III.—SEPTEMBER 1864.

ORIGINAL ARTICLES.

I. On the Correlation of the Miocene Beds of the West Indian Islands; and on the Synchronism of the Chert-formation of Antigua with the Lowest Limestone of Malta.

By P. Martin Duncan, M.B. Lond., Sec. Geol. Soc., &c.

Corals of the Miocene Formations as means of Correlation.—Although a general correlation has been established between the European Mid-tertiary formations and the Nivajé Shale and Limestone of San Domingo,* the shale and part of the inclined limestones of Jamaica,† the three coralliferous beds of Antigua, and the Newer Parian beds of Trinidad,‡ still it has not hitherto been possible to determine a close parallelism between any particular European and West Indian Miocene stratum.

The coral-fauna of the Mid-tertiary period contained both many widely distributed species, and others restricted to small areas; there were forms whose existing allies and analogues live in reefs and banks, or in deep water; and a large number have ceased to be directly represented. Thus there are species common to the Vienna Basin, to the Miocene of Northern Italy, to the Miocene formations at Dax, Bordeaux, and Malaga, to the Nivajé Shale of San Domingo, and to its associated limestone, whilst others are common to the Faluns, the Turin Miocene, the Miocene of the Caucasus, and to that of the West Indies. On the other hand certain genera are only found in Antigua and Jamaica; and many species are restricted to a single European formation. The *Pocilloporæ* and the *Alveo-*

* Heneken, Carrick Moore, and Lonsdale, Quart. Journ. Geol. Soc., vol. ix. p. 115.

† Martin Duncan, Quart. Journ. Geol. Soc., vol. xix. p. 406; Moore and Jones, *op. cit.* p. 510.

‡ Wall and Sawkins, Report Geol. Trinidad, 1860.

poræ were doubtless then, as now, reef-corals, and the genus *Flabellum* inhabited deep water; moreover the large genera *Trochocyathus, Astrocœnia, Stylocœnia*, and others are extinct. The corals offer, then, advantages to the palæontologist both in estimating the relative age of distinct strata, and in considering the physical conditions under which they were deposited. Coral-growth had the same laws then, and the same physical conditions regulated the distribution and persistence of certain genera, as during the recent period: there were areas where corals flourished in greater abundance than in others, and localities where there was an extraordinary luxuriance of growth of some species, whose individuals were dwarfed in other and less favoured seas; and in the midst of the most prolific coral-seas there were spots where the polypes worked under disadvantages, and where a peculiar and adapted fauna existed.

By comparing the coral-faunæ of the various Miocene strata of Europe, America, and Continental Asia, and by paying attention to the present habits of the species and genera found represented in them, we can map out these areas of luxuriance, and also the localities where the coral-fauna has been influenced by external conditions unfavourable to the growth of certain species. Generally speaking, the European Miocene coral-fauna is less luxuriant than the West Indian; and it is remarkable that the formation in the Island of Antigua, which is characterized by a poverty of coral-growth, and by the predominance of genera and species that have small corallites, should resemble in this and many other particulars the lowest calcareous bed of Malta.

The unfavourable conditions which must have affected the coral-growth on the reef which afterwards became the 'Chert' of Antigua, can be estimated by the quantity of drifted wood and brackish-water molluscs which are found mingled with the silicified corals; and although these evidences of the former existence of more fresh water than was consistent with a luxuriant coral-growth are wanting at Malta, still the general inferiority of vigour in the European Miocene coral-fauna brings the dominant species of the lowest Maltese beds and of the Chert of Antigua into a very interesting relation.

Geological History and Relationships of the Coral-bearing Strata of Antigua.—The Chert in the Island of Antigua lies unconformably upon the oldest calcareous strata, which latter have a considerable inclination; and it is covered conformably by a vast marl.* The inclined strata dip towards the chert,

* Nugent, Trans. Geol. Soc., 1st series, vol. v. p. 459. 1821.

which is found in their line of strike, and in the position which a coral-reef would occupy in relation to its rocky basis. It is evident that the chert did not participate in the uptilting of the supporting strata, but that it was formed subsequently: it is equally clear that the chert and the inclined strata have suffered from oscillation of level and from great denudation. The marl, which was deposited during a period of subsidence, increased in thickness as the chert and the inclined strata sank slowly; and it is tolerably evident that, when the chert had passed considerably below the sea-level, the marl-forming reef was supported by the inclined strata. The marl is found above, beyond, and below the chert; it is in contact with the inclined strata; and it consists of the detritus of coral-reefs and of the remains of the Mollusca and Protozoa once living upon them. Its beds are imperfectly stratified, and are horizontal; its surface has been worn by denuding agencies, and its sea-margin supports recent coral-growths. It is of great depth; and its final upheaval was contemporaneous with that of the inclined strata and the chert.

The history of these coralliferous strata would appear to be as follows:—The trap and other igneous rocks, which now support the inclined calcareous strata, constituted the high land around which the first coral-atoll was formed; this, with its mud and detritus, gradually became, as the supporting rock subsided, a vast bed of calcareous marl and loam, coral-growth proceeding at the surface according to the usual laws. A period came when the subsidence ceased, and then one of elevation commenced. The coral-beds were tilted up, and the elevation which occurred in the restricted area of the original igneous rocks, did not affect the whole reef and mud equally: the part nearest the land was elevated, and the present dip of the inclined strata was determined. This elevation, which doubtlessly was gradual, was accompanied by volcanic outbursts, traces of which exist in and above the inclined strata. The inclined strata, together with the igneous rocks, then became surrounded by a coral-reef, of no very great luxuriance; and the whole gradually began to subside, until the future chert was developed from the coral-detritus, amongst which pieces of wood and brackish-water Testacea were mixed. The subsidence was over a larger area than the late upheaval, for the chert sank horizontally. The next change of level was an upheaval over as great an area as that of the subsidence; the chert was simply elevated with the mass of inclined strata and the old igneous rocks. It must have been lifted high above the sea, and doubtless fringed a hill-side, as the old reefs of

San Domingo, Owyhee, and Isle de Bourbon do now-a-days. The period of rest was a time of wear and tear for the future chert, and it was exposed to all the rapid destructive agencies of the tropics. A change in the general physical geography of a large area, of which Antigua formed a part, occurred before the next subsidence, for the coral-growth which then commenced was luxuriant in the extreme, and wood and land-shells more rarely drifted on to the reef. The new coral-reef grew at first from the supporting rock, lower down than the elevated chert, and the marl is now found below that older reef: as subsidence took place, the chert began to support the new coral-reef; as it progressed, the chert became covered, and growth commenced at the side of the inclined strata; and, finally, as the island sank hundreds of feet, the future marl collected.

The last changes were the gradual upheaval of the marl associated with all the older beds and the original trap-rocks,—its denudation to a great extent,—and a great alteration in the physical geography, fauna, and flora of the region.

It is hardly possible to connect these oscillations of level with those which have occurred in the other West Indian Islands; for, owing to the insular position and the local character of many of the disturbances of level, the ordinary rules of stratigraphy fail. There are inclined Tertiary strata in Jamaica and in Trinidad; but the strata which have excited attention in San Domingo are not inclined; but, like the Antiguan Chert and Marl, have been simply elevated *en masse* with the supporting mountain. The establishment of the West Indian equivalents of the Antiguan strata can, then, be but slightly assisted by stratigraphy alone.

Palæontological evidence, however, has been adduced which determines that general correlation between the limestones and shales which has been already noticed. They have all been decided to be of Mid-tertiary age; but as yet the equivalency or parallelism of the inclined strata of Antigua with the lowest of the Mid-tertiaries of Jamaica, and with the Nivajé Shale of San Domingo, can no more be asserted than that of the Antiguan Chert, the inclined Jamaican limestones, and the limestone (erroneously called 'tufaceous') of San Domingo. Further researches are required before these important matters can be determined. The immense distance between the West-Indian and European Mid-tertiary strata must leave serial relationship and palæontology alone to produce evidence concerning their approximate contemporaneity. In only one instance has an Eocene formation been asserted to exist in the Antilles;* and the Mid-tertiaries rest either on Lower Cretaceous strata or on mica-schist and intrusive rocks. But if the serial relation does not prove the correspondence of age, the numerical method and the community of characteristic fossils certainly do.

The general correlation, then, of the West Indian and European Mid-tertiary strata can be asserted; but from the presence of a dominant species of Coral in the Antiguan Chert, the same being dominant in the lowest of the Maltese limestones, the approximate contemporaneity of the distant formations is reasonably inferred. Professor Rupert Jones has come to this conclusion, irrespectively of any reference to the corals.†

Stylocœnia lobato-rotundata.—The commonest coral of the Antiguan Chert is *Stylocœnia lobato-rotundata,* described by Michelin as *Astræa lobato-rotundata*;‡ but its generic name was changed by MM. Milne-Edwards and Jules Haime.§ It grows in large masses, the corallites being agglomerated, so as to deserve the specific name; and it is often very curiously fossilized. It is of course unwise to rely upon negative evidence, but the species has not as yet been found in the Marl above the Chert; neither has it been found in any of the San Domingan Tertiaries.

In some recent investigations amongst the corals from the Maltese limestones, I found specimens of this very well marked species in nearly every piece of the lowest calcareous formation that Dr. Leith Adams sent me. It has not been found, as yet, in the strata above. Its growth and habit resemble those of the Antiguan form; and it certainly characterizes the bed 'No. 5' of Dr. Adams.‖

The species is not restricted in Europe to Malta, for it has been found in the Turin Miocene at Verona and at Dego.

In the Maltese limestone it is associated with *Dendrophyllia irregularis,* Blainville, sp., a well-known form of the Dax Miocene beds; and in the Antiguan Chert it is found with *Astrocœnia ornata,* Michelotti, sp., which is a species almost characteristic of the Mid-tertiaries of Turin. The relation between the Antiguan Marl and the calcareous beds above the lowest in Malta is not yet determined.

It is impossible to deny the enormous area of the Miocene coral-sea after the discovery of species common to such remote

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* Barrett, Quart. Journ. Geol. Soc., vol. xvi. p. 324.

† See Prof. Jones' communication on the *Orbitoides* of Antigua and Malta, p. 102.

‡ Michelin, Icon. Zooph., p. 62, pl. 13, fig. 2. 1842.

§ Milne-Edwards and Jules Haime, Ann. Scienc. Nat., 3rd series, vol. x. p. 295. 1849.

‖ Leith Adams, Quart. Journ. Geol. Soc., vol. xix. p. 277.

localities as Antigua and Malta, and after the Caucasus, Sinde, Travancore, San Domingo, Jamaica, and Guadeloupe have been proved to contain the same species of coral. It is clear that there must have been a freedom from those barriers against the diffusion of coral-species which now exist; for, if not, how has the West Indian Miocene coral-fauna a greater alliance with the recent Oceanic and East Indian coral-faunæ than with the recent Caribbean? At present the West Indian Miocene is separated from its correlative strata by great areas where no coral lives.

There is a point of some interest with regard to the anatomy of the *Stylocœnia lobato-rotundata.* Michelin's description and drawing, and the generic diagnosis of MM. Edwards and Haime, have determined the septa to be smooth and Eusmilian in their character. One of the specimens from the Maltese bed has its calices beautifully preserved; the septa are distinctly incised and faintly dentate. This fact removes the genus from the sub-family of *Eusmilinæ,* and associates it with the Astræans. It is worthy of notice that the closely allied genus *Astrocœnia* has recently been proved to have dentate septa, and has been classified with the last-named sub-family by M. de Froméntel.* The presumed connection between styloid columellæ and smooth septa has thus been rendered doubtful for the second time.

II. The Relationship of certain West-Indian and Maltese Strata, as shown by some Orbitoides and other Foraminifera.

By T. Rupert Jones, F.G.S., Professor of Geology, &c., Royal Military College, Sandhurst.

Dr. DUNCAN'S researches on the Palæontology of the West Indies have so much enhanced the value of any fossils found in those islands, that I do not hesitate to make a few remarks on some *Orbitoides* contained in a piece of Antiguan 'Chert,' given many years ago, by Dr. Nugent, to the Geological Society, and to which Mr. H. M. Jenkins, Assistant-Secretary G.S., some months since directed my attention; and also on some specimens of fossiliferous flint and limestone from Jamaica.

The Antiguan specimen† consists of flint with much carbonate of lime,‡ and is traversed in all directions by thin, flat,

* E. De Fromentel, Polyp. Foss., p. 232; and Reuss, Gosau Corals, Trans. Acad. Vienna, vol. vii. 1854.

† Labelled '"Flint out of Marl," Dr. Nugent, 15,526.'

‡ Like some from South Australia in this respect. These, like other siliceous bands and nodules, have the appearance of being so much calcareous matter more

discoidal *Foraminifera* belonging to the genus *Orbitoides.** Where weathering has affected the stone, it has become porous, its brown colour has changed to yellowish-grey, and the structure of the *Orbitoides* has become perfectly distinct; the walls of the numerous chamberlets remaining, as a skeleton, free from the infilling of subtranslucent, greyish-white carbonate of lime that obscures them in the stone. Dilute acid also removes the calcite, and clears the framework of the *Orbitoides,* showing even the canal-system of these shells.

Much of the weathered superficies, moreover, is roughened by the removal of exposed parts of the *Orbitoides,* furrows and hollows being left, which show the weathered edges of remaining parts of the organisms at the bottom of the holes. The weathered surface also is smooth and undulated in patches continuous with some of the now imperfect *Orbitoides,* and showing where these had formerly lain. One of these undulating *Orbitoides* is thus traceable over a space of at least $2\frac{1}{8}$ by $1\frac{3}{4}$ inches; and no indication exists of any part of its former circumference. It has an apparently uniform thickness (where it can be measured) of $\frac{1}{16}$th inch; and other fragments seen in section in the stone are of the same thickness (or less, with smaller width).

Besides the thin broad specimens, there are some small biconvex *Orbitoides* with expanded edges, about $\frac{1}{3}$ inch wide and $\frac{1}{12}$th inch thick at the centre; also a few *Nummulinæ,* small and biconvex, with sharpish edge, some measuring $\frac{1}{16}$th by $\frac{1}{24}$th inch, and some being rather larger. I have also detected the section of a *Globigerina*; and fragments of Echinoderms and Bryozoa† also appear in this flint.

Some, at least, of the small biconvex *Orbitoides* seem to belong to *O. dispansus,* Sowerby; some are probably the young of the larger flat form, or small individuals with relatively large primordial chambers.‡ This large thin *Orbitoides* is of considerable interest, especially for two reasons,—firstly, it belongs to that species of *Orbitoides* which is characterized by having vertical partitions to its central layer of chambers, and these more or less cylindrical — namely, *O. Mantelli,*

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or less perfectly converted into flint, which, at its outer limit, imperfectly replacing the particles of the chalk, marl, or shell-mass, ends with a rough surface.

* See Dr. Carpenter's 'Introd. Study Foram.' (Ray Soc.), 1862, p. 298.

† The network of the weathered *Orbitoides* first attracted attention as somewhat resembling Bryozoan structure.

‡ As in *Nummulina,* so also in *Orbitoides,* there may be seen individuals that, commencing with a relatively large central or first chamber, never attain a large discoidal growth, whereas others that begin with a small primordial chamber have a very much greater peripheral development.

Morton sp.; and, secondly, it is the exact counterpart of the *Orbitoides* that I have lately observed in some specimens of limestone brought by Captain Hutton from Malta (see 'Geologist,' vol. vii. p. 134; where by mistake I referred this Maltese *Orbitoides* to *O. dispansus*). The *Orbitoides* occurs (as Dr. A. Leith Adams and Captain Hutton have informed me) along the northern coast of Malta and Gozo, in the uppermost part of the hard white limestone (the lowest great stratum of the Maltese series), with *Scutella subrotunda* and *Heterosteginæ*.* In the next great stratum above this white limestone, namely, the 'Freestone,' occur numerous Foraminifera, exactly equivalent in every respect to many of those from the Vienna Basin (especially from the Baden beds), figured by D'Orbigny in his 'Foram. Foss. Bass. Tert. Vienne,' 1846.

The close likeness, as individuals, in the Maltese and Antiguan *Orbitoides*, and in the large *Foraminifera* of the Maltese Freestone and the Baden (Vienna) beds, is remarkable; and this is the more striking, as it is difficult to find any two sets (faunal groups) of *Foraminifera* agreeing in more than a similarity of *facies*.

In the nodular Orbitoidal Limestone of Jamaica,† at the base of the White Limestone, which, according to Mr. G. P. Wall, is probably unconformable to the shales containing these calcareous nodules, I find a few rather small specimens of the same variety of *O. Mantelli* as that so abundant in the Antiguan flint, mixed with numerous biconvex forms, referable probably to *O. dispansus* or *O. Fortisii.*

In a piece of grey flint‡ (less calcareous than that from Antigua), from the base of the White Limestone at St. Thomas, Jamaica, I find numerous *Orbitoides*, mostly *O. Mantelli*, though some may be *O. dispansus*, as in the Antiguan flint.

I may also notice here a piece of hard yellowish limestone from the base of the White Limestone at Clarendon, Jamaica,§

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* In the 'Geologist,' vol. vii. p. 134, I stated that *Operculinæ* occur in the Maltese limestone containing *Orbitoides*; but the majority of what I there referred to as two sub-varieties of *Operculina complanata*, Defrance sp., are certainly *Heterosteginæ*; and those in another hand-specimen, not now in my possession, may also prove to be *Heterosteginæ*. I have lately seen fine specimens of Heterostegina-limestone from Crete, in Capt. Spratt's collection.

† The subject of a Note communicated to the Geological Society last year; but at that time I had not recognized the presence of *O. Mantelli* in this limestone. See Quart. Journ. Geol. Soc., vol. xix. p. 514.

‡ Presented to the Geological Society by Mr. Thomas Bland, F.G.S.

§ Other Tertiary specimens from Jamaica, lately submitted to me by Mr. G. P. Wall, are:—Orbitoidal limestone, Hopewell, Metcalfe; Flint with *Orbitoides* and *Nummulinæ*, Orange River, Metcalfe; Limestone with *Operculinæ* and *Nummulinæ*, and the same semi-silicified, Brimmer Hall, St. Mary; Flint with *Operculinæ* and *Nummulinæ*, Preston, St. Mary; Orbitoidal limestone, Carron Hall, St. Mary;

confided to me by Mr. G. P. Wall, F.G.S. (late of the West Indian Geological Survey). This limestone is largely composed of *Heterosteginæ*, which, though rather stouter, represent the common Maltese species; and it corresponds to the same horizon (immediately beneath the White Limestone) as that of the Shells and Corals brought to England by Mr. L. Barrett, and lately described by Mr. J. Carrick Moore and Dr. Duncan.* The Orbitoidal limestone and flint above-mentioned belong to the same horizon, and altogether these fossiliferous rocks of the West Indies offer a striking analogy to the Miocene white limestone of Malta, rich in closely allied forms of *Orbitoides* and *Heterosteginæ*.

Orbitoides Mantelli, of stronger growth than the variety found in Jamaica, Antigua, and Malta, characterizes some of the Tertiary beds of Alabama,† Nummulites being absent, it is supposed. *O. Mantelli* occurs also in Sinde, associated with *Heterosteginæ* and small *Nummulinæ*; and there the other Indian form of *Orbitoides* (*O. dispansus*, near *O. Fortisii*) and well-developed *Nummulinæ* occur abundantly; but we still want exact information as to the stratal relationship of all the Tertiaries of that region. *O. Mantelli* is found also in the Tertiary beds of New Zealand.‡

The *Orbitoides* of Continental Europe are all, as far as I know, of the *O. Fortisii* type (as defined by Carpenter, Introd. Foram. 1862, p. 299); but I have seen (though I have not at hand) a large flexuose *Orbitoides* from Santander, of which I am reminded by the specimens under notice.

In Europe *Orbitoides* first appears in the Cretaceous rocks; and, though abundant in some Eocene beds, it is not (I believe) associated in the same stratum with Nummulites, except at Varna in Bulgaria.§ In Sinde (Dr. Carter, Ann. Nat. Hist., 1861), Jamaica (Quart. Journ. Geol. Soc., vol. xix. p. 514), Trinidad (Mr. Guppy, 'Geologist,' vol. vii. p. 159), and in Antigua, *Orbitoides* and *Nummulina* are directly associated; and it may be so in many other places. For Jamaica and Antigua, however, as in the Vienna Basin, the *Nummulinæ* are poor (see further on), and do not specially indicate any parti-

Alveolina-limestone, Crofts, Clarendon; and Orbitolina-rock, Vere; besides shelly and oolitic limestones from Thompson Town and Upper Clarendon.

* Quart. Journ. Geol. Soc., vol. xix. p. 510.

† See Lyell on the Orbitoidal Limestone of Alabama; Quart. Journ. Geol. Soc., vol. iv. p. 10, 1847.

‡ GEOLOGICAL MAGAZINE, No. 2, p. 75.

§ I have some polished pieces of limestone in which largish *Nummulinæ* accompany *Orbitoides*; but I do not know whether they are from Europe or India; probably, I think, from the latter.

cular geological horizon, as far as my observations serve me; and the same may be said of some, at least, of the small *Nummulinæ* associated with *Orbitoides* in Sinde. Much requires to be learned as to the exact mode of occurrence and distribution of these little fossils. *Orbitoides* have long been, and still sometimes are, mistaken for *Nummulinæ*, *Orbitolites*, and *Orbitolinæ*—all very different one from another; and even when they are recognized, it is often difficult to get at their *specific* characters. The species of *Orbitoides* can be discriminated more easily than those of *Nummulina* in some cases; for the vertical cross-section is important in the former, and of comparatively little value in the latter; and in rock-specimens it is often difficult to get at the pattern followed by the alar flaps of *Nummulina*, the character whereby its different species and varieties can be best distinguished.

The *Nummulinæ* in the Antiguan flint clearly belong to the simple 'radiate' group, composed both of young individuals and small varieties of the large Eocene Nummulites, and also of the existing representatives of the Nummuline genus. In fact we have, in this case, a small and feeble form, such as *N. Ramondi*, Defr. (Carter, Ann. N. Hist., Ser. 3rd, 1861, vol. viii. p. 374, pl. 15, fig. 5); and its analogue (*N. radiata*, D'Orbigny) is not wanting in the Vienna Basin, in strata contemporaneous with but poorer than those of Baden abovementioned; it is present also in the Jamaican flint and limestone, as well as in Sinde.

The full development of *Nummulinæ* certainly took place in and characterized the early Tertiary (Nummulitic or Eocene) period, but they neither began nor ended at that time; in fact, they still exist in great numbers, but are degenerate: and scattered individuals, neither well-developed nor of a specialized form, may occur in many different deposits, but be of little or no use in 'homotaxis,' or the comparison of fossiliferous strata possibly equivalent as to time and geographical area.

At all events, we see some definite points of agreement between certain deposits in the East and the West, as to their faunal characters, by means of gregarious, well-developed, and conspicuous *Foraminifera*; and thereby a strong relationship is recognized for the fauna of the Viennese and Maltese areas, in the Eastern part of the Mid-tertiary Ocean, and that of the probably contemporaneous Coral-islands, in the West, which have their geological history elucidated by Dr. Duncan's foregoing communication.

III. On a Nearly Perfect Specimen of *Eurypterus lanceolatus* (Salter) from the Upper Ludlow Rock at Lesmahagow, Lanarkshire. [Plate V. figs. 7–9.]

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

THIS species (under the generic name of *Himantopterus*) was first noticed by Mr. J. W. Salter in the Quarterly Journal of the Geological Society for 1856 (vol. xii. p. 28, fig. 5); but only the penultimate segment and telson* were then known.

In vol. xv. of the same Journal (1859), Mr. Salter described eight species of *Eurypterus*, from the Upper Ludlow Rocks and the Old Red Sandstone; but he did not refer to *E. lanceolatus* in that paper. Of these eight species of *Eurypterus*, *E. pygmæus*, from its smaller size, is the best preserved species. It occurs in the Downton Sandstone of Kington, in the Basement-beds of the Old Red Sandstone at the Ludlow Railway, and in the Upper Ludlow Rock of Ludford; and I have lately seen an entire specimen (in the cabinet of Mr. Jas. Powrie, F.G.S.), only one inch in length, from the Old Red Sandstone of Petterden in the Sidlaw Hills, Forfarshire.

EE. acuminatus, *linearis*, and *abbreviatus* are still only known to us by their telsons or tail-joints. *E. chartarius* Mr. Salter is now inclined to consider only an obscure specimen of *E. lanceolatus*; but the original specimen I have never seen. *E. Symondsii* is now known to belong to a distinct genus (*Stylonurus*, Page), upon the evidence of more perfect specimens discovered by Messrs. J. Powrie and R. Slimon.† Probably *E. megalops* may also be shown to be distinct from *Eurypterus*. These two last-named species are only known by their carapaces; but they are well-marked forms.

In the 'Memoirs of the Geological Survey' (1859), Monograph I., 'On the Genus *Pterygotus*,' by Prof. Huxley and Mr. J. W. Salter, the entire body, with the swimming-feet, of a specimen of *Eurypterus lanceolatus* is described and figured (p. 65, pl. 1, fig. 17); but, owing to the imperfect state in which the fossil is preserved, it was impossible to give a very detailed description of the separate parts, or even to be quite certain (except from the spine-like form of the caudal joint) that it was a true *Eurypterus*, as it was the only specimen then known.

Mr. Slimon, of Lesmahagow, from whom all the Lanarkshire

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* Terminal joint, or tail-plate.

† To be described and figured in a future Number.

specimens of *Eurypteridæ* have been obtained, has laboured on incessantly, since the first discovery of these beds in 1851,* and has increased our knowledge of these remarkable Crustaceans by more perfect specimens from year to year. The British Museum has lately acquired, among other specimens, the impression and counterpart of a very beautiful and nearly perfect example of *Eurypterus lanceolatus* from this locality, and an outline-figure (restored to the natural position) is given herewith (Pl. V.), showing the upper and under surfaces of the body. The specimen measures only 4 inches in length, and barely 1 inch across the fourth (or widest) thoracic segment. The absent organs are correctly represented from other specimens. The position of the eyes, not clearly seen in this specimen, and also the antennules, are given upon the authority of, and from careful drawings sent me by, Mr. Slimon, whose accuracy may be safely relied upon. The details of the antennæ and swimming-feet, the form of the carapace, the thoracic appendage, body-segments, and telson are all copied from actual specimens.†

In the form of the joints of the swimming-feet, in the number of the body-segments, the shape of the telson and thoracic plate, it closely agrees with the American, and, so far as known, with the Russian, species of *Eurypterus*; but the carapace is more oblong-ovate vertically, whilst that of the American species is much broader and shorter in proportion. The eyes in *E. lanceolatus* are placed much nearer to the margin of the carapace than in other species; the swimming-feet are longer and narrower, and the thoracic plate seems deeper in proportion to its width, as compared with James Hall's figures of the American *Eurypterus remipes*, &c. This is *not absolutely* the case, however; but is, I believe, due in a great degree to an error in Professor Hall's restoration, in which the broad basal joints of the swimming-feet, and part of the post-oral plate are placed considerably beyond the posterior margin of the carapace, so that they overlap nearly one half of the thoracic plate,‡ a position which it would seem impossible

* See Report of the Meeting of the British Association at Glasgow for 1855, and Sir R. I. Murchison's paper on the Geology of Lesmahagow, Quart. Journ. Geol. Soc., vol. xii. 1856.

† Another nearly entire, but much distorted, example has been obligingly lent me by Mr. Bryce M. Wright, from which I have been enabled to make out the form of the post-oral plate and some other parts more distinctly than before; but I am especially indebted to Mr. Slimon for his drawings, which have been of the greatest assistance.

‡ In Hall's figure they overlap the body to the extent of the first thoracic segment; the thoracic segment being equal in depth to the first two thoracic joints which it covers.

for them to have occupied during life, and in which they never occur in any examples that I have seen of the closely allied *Pterygoti* from Lesmahagow, many of which have these parts well preserved *in sitû*.

A single antennule discovered by Mr. Slimon shows these appendages to have eight articulations: the broad basal joint is serrated along its inner margin, and evidently served the purpose of a manducatory organ. The three succeeding pairs are serrated along their articulations; but are not so spinose * as in the American species, or in those discovered by Dr. Scouler in the Burdie-house Limestone, and described and figured under the name of *Eurypterus Scouleri* by Dr. Hibbert in the 'Transactions of the Royal Society of Edinburgh' (1836, vol. xiii. p. 281, pl. 12). The *metastoma*, or post-oral plate, is cordiform and quite destitute of any median ridge or ornamentation. Its lateral margin slightly overlaps the interior margins of the broad basal joints of the swimming-feet, whose serrated palpi fulfil without doubt, in this as in all the other species of *Eurypteridæ*, the chief duty of mandibles.

A slight groove or furrow surrounds the anterior and antero-lateral margins of the carapace, gradually thinning off and disappearing at the latero-posterior margins. In his 'Palæontology of New York' (1859, vol. iii. p. 397), Professor Hall gives the number of articulations in the swimming-feet of *Eurypterus* as 'eight, with a terminal palette.' He evidently considers the intercalated plate (seen in the figure) to form a part of the seventh segment; for he says, *op. cit.* p. 397, 'At the line S there is a soldered suture, connecting the fixed ramus of the chela with the penultimate joint. In some specimens the parts have been separated along this line.' In the specimen from Lesmahagow I have been unable to discern more than seven articulations and a terminal palette. The third appears to be the absent joint; and Professor Hall says (p. 397): 'In indicating the number of joints, I have been governed by no theoretical views, but simply by the appearances of separation in the parts; and though the two extremities of the *third joint*, as marked, show no articulating processes, the limitation of the parts is distinct, and they may have been separated only by a thin extension of the chitine, and may not be properly articulating surfaces.' Supposing then this third joint of Professor Hall to be absent, we shall agree exactly in the number of

* A single antenna is seen in Mr. Wright's specimen; it is more robust than the antennule, and the number of joints appears to be eight, but they cannot be clearly made out. A specimen in Mr. Slimon's cabinet shows two of these simple palpi *in sitû*; but does not help us as to the number of the joints.

articulations in the swimming-feet as well as in their general form. The intercalated plate and minute terminal palette, well seen in *E. lanceolatus*, are peculiar to this genus. There are certainly eight articulations in the antennules; but I cannot positively discern a ninth.

The lateral lobes of the thoracic plate in this species are much deeper, in proportion to the central double appendage, and the two intercalated plates are larger, than in the American *Eurypteri*. The line of division between the pair of central organs is continued much higher up; and they are divided near their terminations into three joints, as seen in the figure (Pl. V. fig. 8 *t*).

The entire surface of the thoracic plate is closely covered with the minute scale-like markings, or wrinkles, peculiar to this group, which are also observable upon the anterior half of each thoracic segment, the abdominal segments being smooth and free from all ornamentation.

There seems no reason to doubt the homology of this (*thoracic*) plate with the leaf-like appendage of *Limulus*, as pointed out by Professors Hall and Agassiz (*op. cit.*), and still more strongly confirmed by Professor Huxley, in his lectures on the anatomy of *Limulus* (part of his course of 'Lectures on General Natural History,' published in the 'Medical Times and Gazette' for 1857), in which he has demonstrated it to be a *thoracic* and *not an abdominal* appendage, as it might at first sight be considered. This thoracic plate in *Limulus*, which bears the reproductive organs upon its inner surface, overlaps in great measure the five corresponding and succeeding *abdominal* lamellæ, which cover and sustain the branchiæ. We have no indication of branchiæ in the *Eurypteridæ*, although it is quite certain that these must have existed. Peculiar and delicate striated markings have been observed upon and near the thoracic plate in *Slimonia acuminata*;* and it is highly probable that this plate covered both the branchiæ and the reproductive organs.

I have been unable to detect the larval eye-spots which are seen so clearly in the American *Eurypteri* and in some of the *Pterygoti* also.

There is without doubt an affinity between the genera *Eurypterus* and *Slimonia*. The latter approaches the former and recedes from *Pterygotus* proper, not only in the absence of chelate appendages, but also in the more narrow and elongated

* I shall have occasion to refer to this species again in a future paper; but I may state that more than one plate is now known to have been attached to the thorax of *Slimonia*.

form of the abdominal segments, and the more lanceolate form of the telson, which in *Pterygotus* proper is broader, less acute, or even bilobed. The chelate antennules in *Pterygotus* are not adapted for *palpi*; but in both *Eurypterus* and *Slimonia* the basal joints of the simple antennæ perform that office.

Eurypterus differs, however, from both *Pterygotus* and *Slimonia* in the position of the eyes, the form of the carapace and the telson, the form and number of the articulations of the swimming-feet, and lastly, in the structure of the thoracic plate.

Dimensions of E. lanceolatus.—The largest and smallest specimens known are in Mr. Robert Slimon's collection: the former measuring $7\frac{1}{8}$ inches in length, and nearly 2 inches across its fourth and widest thoracic segment; the latter measuring only $1\frac{5}{8}$ inch in length by $\frac{3}{8}$ across its widest segment. Mr. Wright's specimen measures $6\frac{3}{4}$ inches in length; but is much distorted and compressed laterally. The length of the specimen in the British Museum is $4\frac{1}{8}$ inches, of which the head forms $\frac{3}{4}$ of an inch, the six thoracic segments 1 inch, the six abdominal segments $1\frac{1}{2}$ inch, and the telson $\frac{7}{8}$ of an inch. The fourth thoracic segment is the widest, and measures 1 inch across; the succeeding segments taper gradually to the ninth, which is scarcely $\frac{5}{8}$ of an inch in width; and at the twelfth segment the abdomen is only $\frac{3}{8}$ of an inch wide. The first eight segments are of nearly equal depth, or about $\frac{1}{8}$ of an inch; the ninth, tenth, and eleventh segments are about $\frac{2}{8}$ of an inch in depth; and the twelfth more than $\frac{3}{8}$ of an inch deep. The swimming-feet reach down to the fifth thoracic segment.

The geological and geographical range have been already given by Mr. Salter, in the Geological Society's Quarterly Journal;* and Professor Hall's monograph † contains a most beautiful series of illustrations of all the American species of this singular group, with careful descriptions.

EXPLANATION OF PART OF PLATE V.

Fig. 7. Upper side of *Eurypterus lanceolatus* (restored).
" 8. Under side of same, showing the mouth, with the organs of mastication, prehension, and locomotion; also the thoracic plate (*t t*) covering the branchial and reproductive organs.
" 9. A single antennule enlarged, showing its broad serrated basal joint, which served as a foot-jaw, as did also the three succeeding pairs of palpi and the basal joints of the broad swimming-feet (*e e*).

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* 1859, vol. xv. p. 229. † Palæontology, New York, 1859, vol. iii. p. 397.

IV. Note on *Plicatula sigillina*, an undescribed Fossil of the Upper Chalk and Cambridge Phosphate-bed. [Plate V. figs. 1–6.]

By S. P. Woodward, F.G.S., A.L.S., &c.

Everyone who has collected the fossils of the Upper Chalk will have noticed how the Echinoderms and Belemnites are overgrown by small oyster-like shells with a striated disk, commonly passed by as the fry of *Ostrea vesiculosa.* There is a beautiful example of *Micraster cor-anguinum* in the Museum of the Geological Society (given by Mr. Bayfield, of Norwich, to the late Daniel Sharpe), on which a dozen of these little shells, each about half an inch across, have left their lower valves; and above twenty are congregated on a fragment of Ananchytes (occupying a space of about three square inches) in the British Museum.

More than a year ago my attention was particularly called to these shells by the Rev. Norman Glass, F.G.S., who insisted on their distinctness from the young Oysters occasionally parasitic on the same fossils, and the disk of which is only marked by the muscular impression on the left or hinder side. Mr. Glass also pointed out that in the smaller examples, measuring less than one-quarter-inch across, the border is radiated, as in the small attached *Spondyli* ('*Dianchoræ*') found under the same circumstances. At this early stage there is no inner ridge dividing the striated disk from the smooth pallial region; but in examples like that figured (Pl. V. fig. 2), the two ridges are already distinguishable, and in a set of specimens the subsequent rapid growth of the border may be observed. The plicated margin, wanting in the larger specimens, may also be traced to its extinction in the same series. The *Spondyli* of the Chalk have always lost their inner shell-layer, and exhibit a uniformly striated interior. It is evident that the *Plicatulæ* also have lost their sub-nacreous lining; these genera are very closely allied; but in the recent *Plicatula* the foot is obsolete, the shell having a broad attachment, while some of the *Spondyli* (like *Sp. spinosus* of the Chalk) are free.

In the Oysters the shell is minutely vesicular between the laminæ; and traces of this structure may be seen, without the help of a glass, in all the specimens of *Ostrea vesiculosa* I have examined, from the smallest to the largest, amounting to several hundreds. Owing to this difference in the constitution of the shell, the hinge is preserved, with its ligamental area and pit; and the smooth interior with its adductor-scar. In some of the Chalk *Plicatulæ* a trace remains of the hinge-line, with its narrow ligamental fissure, as represented in Pl. V. fig. 3.

The largest specimen I have seen of this *Plicatula* measures 8 lines by 10, the 'breadth' being usually greater than the 'height,' and the elevation of the free margin never exceeds 2 or 3 lines. A magnified representation of this shell is given in Pl. V. fig. 3; and a young *Ostrea vesiculosa* of similar size is added for the sake of comparison (Pl. V. fig. 6). It will be seen that their principal growth is in opposite directions, the Oyster fixing itself by its *left* valve, while *Plicatula,* like the rest of the *Pectinidæ,* is attached by the *right* shell. Fig. 1 represents a group of *Plicatulæ,* with *Thecidium Wetherelli* and other small shells, attached to a Helmet-urchin from the Upper Chalk of Kent. This beautiful and instructive fossil was presented to the National Collection by the Rev. Norman Glass, who at the same time expressed a wish that it should be described and figured. On another Helmet-urchin Mr. Glass detected a minute *Plicatula* with the upper valve preserved *in sitû,* which, from its extreme tenuity, has taken an exact impression of the miliary granules on the surface of the *Ananchytes* below. In Dr. Bowerbank's collection there is a similar example, but in the example figured (Pl. V. fig. 5) the upper valve is imbricated with projecting laminæ.

The only known *Plicatula* with which this shell can be compared is the *P. inflata* of James De C. Sowerby (Min. Con. pl. 409, fig. 2), a smooth, inflated species, not uncommonly found in the hard cream-coloured Chalk of Cambridge and Sussex, and the Grey Chalk of Dover. It is also met with in the Upper Greensand of Petersfield, the Isle of Wight, and Warminster. From these localities it has always been obtained in pairs, unattached; but it seems to have been fixed to extraneous objects, at least when young, by a small portion of the umbo of the convex valve; the upper valve is deeply concave, as in *Ostrea vesiculosa.* Dr. Mantell described a young or dwarf condition of this shell, with slightly spinulose valves, by the name of *Plicatulas pinosa* (Geol. Sussex, pl. 26, figs. 16, 17). This variety approaches the *P. pectinoides,* J. Sby., found in the Gault of Folkestone, and in the phosphate-bed of Greensand at Cambridge, which is not deeper than a 'native' Oyster, and the young individuals sometimes grow on the upper valve of the adult, notwithstanding its prominent spines.

I am disposed to consider the *Plicatula* of the *Upper* Chalk as a distinct species from *P. inflata,* and to distinguish it by the name of *sigillina,* on account of its broad attachment and diminutive size. It is probably identical with the small *Plicatulæ* which abound on the concretions, shells, and bones of the 'Coprolite-beds' at Cambridge, and serve in a remarkable manner to identify their source. In Owen's 'British Fossil Mammalia' (p. 520) the neck of a fossil Whale is figured and attributed to the *Phocæna crassidens*, although stated by Professor Sedgwick to have been obtained in a Kimmeridge Clay-pit near Ely. The improbability of so great antiquity attaching to any *Cetacean* fossil, induced Professor Morris to substitute 'Pleistocene' for Oolite, in his Catalogue of British Fossils (p. 361). But the bone in question, which is preserved at Cambridge, has no connection with the Fen Grampus in the Stamford Museum. Mr. Seeley has discovered on its surface a *Plicatula sigillina*, proving that it was derived from the *Upper Greensand*, of which a small mass has been detected on the surface, in the very pit from whence the fossil was derived.

EXPLANATION OF THE FIGURES (PART OF PLATE V.).

1. Group of *Plicatulæ* on *Ananchytes*; nat. size. Kent.
2. Very young *Plicatula*; magnified 4 diameters. Kent.
3. Largest specimen; magnified 2 diameters. Norwich.
4. Profile of section across the same, from side to side.
5. Small *Plicatula*, $\frac{4}{1}$, with upper valve broken in the centre. Norwich.
6. Young *Ostrea vesiculosa*, magnified 2 diameters. Norwich.

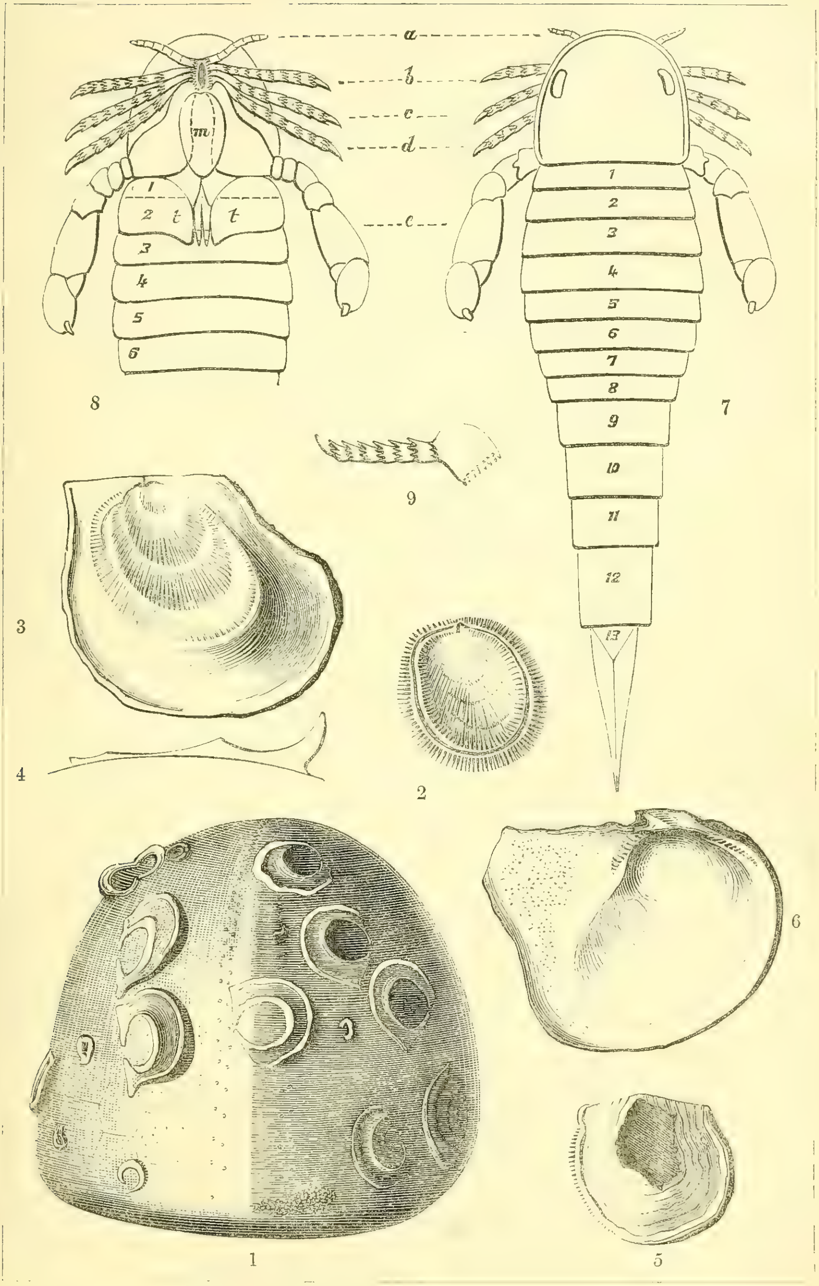
V. Description of a New Fossil Fish from the Lower Chalk.

By Albert Günther, M.A., M.D., Ph.D.

[Plate VI.]

THE British Museum has lately received a fossil Fish from the Lower Chalk at Folkestone, which appears to be undescribed, and is probably the type of a distinct genus. The fossil is twenty inches long, with the vertebral column and the fins tolerably well preserved, whilst the head unfortunately has suffered so much that scarcely any part of it can be distinguished.

What first arrests our attention in examining the specimen, are bony plates disposed in longitudinal series, which are extremely similar to those of *Dercetis* and *Rhinellus*, as figured by Agassiz (Recherch. Poiss. foss., vol. ii. pl. 66a, figs. 6 and 7). Although the fishes named are also from the Chalk, they belong evidently to different genera. *Dercetis scutatus* is the type of the genus *Dercetis*, and described as having the ventral fins very close to the pectorals, short, and composed of five rays only, the dorsal and anal fins long, the former occupying nearly the whole of the back, the latter the lower part of the tail. In our Fish, on the contrary, *the ventral is remote from the pectoral, and the dorsal and anal are short.* The typical specimens on which Agassiz has founded the second species, *D. elongatus*, and which I have



FIGS. 1–5. PLICATULA SIGILLINA, NOV. SP.
FIG. 6. OSTREA VESICULOSA (YOUNG).
FIGS. 7–9. EURYPTERUS LANCEOLATUS, SALTER.

examined in the British Museum, do not show sufficient traces of the fins, by which their form or position could be ascertained; but there is a fragment of another large example in the British Museum, in which some of the dorsal rays are well preserved, and which confirms the generic character derived by Agassiz from the dorsal fin. The rays are short, slender, wide apart, and simply bifid at the extremity. The vertebræ of *D. elongatus* also are very different from those of this specimen, their central part being perfectly smooth and polished, whilst it is very rough and longitudinally grooved in the specimen before us. Pictet (Poiss. foss. Mont Liban., pp. 46, 47) describes three other species of *Dercetis*; and there can be scarcely any doubt that he is correct in referring them to that genus, and consequently that they are different from our Fish.

As regards the second genus *Rhinellus*, the characters originally given by Agassiz (*l. c.* p. 260) have been rectified by Pictet (*l. c.* p. 43). It agrees, then, with our Fish in having a short dorsal fin, nearly in the middle of the total length, above the nine- or ten-rayed ventral fin. Whether both ought to be referred to the same genus is impossible to decide, partly on account of the imperfect state of the specimens of *Rhinellus furcatus*, partly on account of the total want of evidence as to the form of the head and jaws in our specimen. The probability is that they belong to different genera; for, whilst *Rhinellus* is described as having three series of bony plates on each side, this has only two; the dorsal fin of the former is placed more backwards; and the specimens known have only a length of three or four inches, and are from the Lebanon. Finally, as regards the *Rhinellus nasalis* of Agassiz, or *Pegasus lesiniformis*, our knowledge of it rests, at present, solely with the rude figure of the 'Ittiolitologia Veronese' (pl. 39, fig. 1), from which we do not obtain any further information than that it is a fish similar to *Rhinellus furcatus*.

We proceed to characterize the genus which we propose for our fossil, and to add a detailed description.

PLINTHOPHORUS,* gen. nov.

Body oblong, apparently scaleless, but with a dorsal and ventral series of imbricate, arrow-shaped, osseous scutes on each side. Dorsal fin rather short, placed in the middle of the total length, above the ventrals; anal short, at some distance behind the dorsal; caudal fin forked. Pectorals and ventrals well developed, without osseous spine, the latter nine- or ten-rayed.

Plinthophorus robustus, spec. nov.

The *vertebral column* is nearly entirely preserved, only the verte-

* Derived from πλινθοφόρος, bearing tiles.

bræ nearest to the head, perhaps six or seven in number, having been lost; the remaining portion is composed of fifty well ossified and solid vertebræ; in comparison with their circumference, they are of moderate length, with the articular portion considerably swollen, and with the central part much contracted; their surface is rough, deeply furrowed by longitudinal grooves. The following are the measurements of some of the vertebræ. As regards the number with which the several vertebræ are marked, I must remark that the first seven are supposed to have been lost, so that the entire column would be formed by 57 vertebræ:—

Length of the entire vertebral column .	$16\frac{2}{3}$	inches.
,, ,, ninth vertebra . .	$3\frac{2}{3}$	lines
Width of its articular surface . .	$2\frac{2}{3}$	,,
Length of the twenty-eighth vertebra .	4	,,
Width of its articular surface . .	3	,,
,, ,, centre	2	,,
Length of the forty-fourth vertebra .	$3\frac{1}{4}$	,,
Width of its articular surface . .	2	,,

The neural and hæmal spines are of moderate length and strength, and those of the last six vertebræ, which are much shortened, are close together, imbricate, forming the base for the caudal fin. The ribs are simple and slender, not stronger than the neural spines, and appear to be continued to the thirty-fourth vertebra.

The *dorsal fin* is composed of sixteen rays, of which the anterior are rather strong and long, the posterior gradually decreasing in strength and length. The first ray is the strongest: a portion of it, more than two inches long, is preserved, but it must have been at least three and a half inches long when intact; its interneural spine corresponds to the neural of the nineteenth vertebra. The rays of the *anal fin* are in an imperfect state; their number appears to have been eleven. This fin resembles the dorsal in general form, the anterior rays being much longer than the posterior; its interhæmals correspond to the hæmals of from the thirty-eighth to the forty-fifth vertebra. The *caudal fin* is forked, the lobes being of moderate length.

The *pectoral* is inserted quite below on the side of the trunk, and composed of twelve rays, the first of which is very short, rudimentary; the second the longest, twenty-nine lines long. The distance between the root of this fin and that of the ventral is $6\frac{1}{2}$ inches. The *ventral fin* is composed of ten or eleven rays, and has a broad base, which lies below the twenty-seventh vertebra, or immediately behind the last dorsal rays; its longest rays were at least nineteen lines long. The *pubic bones* are flat, elongate-triangular, as long as the ventral fin, leaving a narrow, free space between their symphysis and anterior extremity.

No traces of scales are visible, but there are the remains of series of imbricate *osseous scutes*, a great part of which still occupy their natural position. One series runs along each side of the uppermost part of the back, from the nuchal region, along the base of the dorsal fin, towards the caudal fin; the anterior portion of this series, to the middle of the dorsal fin, is well preserved, whilst only single scutes of the caudal portion are preserved. Both ventral series, that of the right side as well as of the left, are visible, and in their natural connection; that of the left side, however, has been somewhat displaced, and the *inner* surface of its scutes became exposed to view. This series runs from behind the root of the pectoral fin to the outer ventral ray; it is continued behind the ventrals, but only a few of the scutes of this sub-caudal portion are preserved, two presenting their outer surface, and three their inner. All these are before the anal fin, and it is doubtful whether the series was continued beyond it.

The general form of these scutes is arrow-head-shaped, with a longitudinal keel running from one end to the other; the uncovered broader posterior part is corrugated; the anterior portion, which is covered by the preceding scute, is more slender, tapering, and smooth. All these scutes were so connected that they could easily slide one above the other, allowing the lateral motions and the temporary extension of the body after feeding or during the season of propagation; and the whole arrangement reminds us of a similar chain of scutes in *Doras* and *Hypostomus.* Their inner surface is smooth, with a longitudinal groove on the posterior half, to receive the keel of the scute next following. Those of the anterior part of the dorsal series are the largest, and comparatively short, being only six lines long and five lines broad; only a small part of them is covered by the preceding shield, as no great mobility was required in this part of the fish. Posteriorly they become rather smaller and narrower. The scutes of the abdominal series are much narrower, and from six to seven lines long; their corrugated posterior portion is much shorter than the anterior smooth part, and there is a very distinct flat prominence on each side where the corrugated part passes into the smooth surface. The scute at the base of the ventral fin is especially large, differing in shape from the others; the upper half of its posterior portion, which is on the side of the trunk, is produced backwards, whilst the lower half is, as it were, cut off, to allow the insertion of the ventral fin; the entire length of this scute is one inch. The scutes behind the ventral fin are the smallest of the series, subrhombic, $4\frac{1}{2}$ lines long and 3 lines broad.

Although it is probable that *Plinthophorus* must be placed near to *Rhinellus,* the degree of their affinity cannot be ascertained before the structure of its head, and especially of its jaws, is known. The difference in the series of osseous scutes appears to justify, at present, its generic distinction. As regards the position of these genera in the system, no ichthyologist of the present day will maintain their affinity to the *Sclerodermata,* to which they have been referred by Agassiz. They belong even to a different family than *Dercetis,* as is clearly shown by the form of the vertical fins. Whether these fishes be *Ganoidei* or *Teleostei* cannot be decided in the present state of our knowledge; but if they should belong to the latter subclass, they are the remains of an extinct family, not represented in the present creation. Pictet compares *Rhinellus* with *Belone*, and refers it to the family of *Esocidæ* as defined by Cuvier, who associated *Belone* with *Esox*. But the position of the dorsal fin in the middle of the body is too important a difference to admit such a union, either with the *Esocidæ* proper, or with the *Scomberesocidæ*.

EXPLANATION OF PLATE VI.

The principal figure is reduced in size, in the proportion of the two lines drawn below it. One of the scutes, from the right abdominal series, is drawn twice the natural size.

ABSTRACTS OF FOREIGN MEMOIRS.

Discovery of *Paloplotherium* in the 'Calcaire grossier supérieur.'

IN the 'Comptes Rendus,' vol. lviii., No. 21, May 23, 1864, M. A. Gaudry states that the Museum of Natural History, Paris, has from time to time received from M. Geurin, of Coucy-le-Château (Aisne), many portions of *Paloplotherium*, which have been found in the 'Calcaire Grossier,' of Jumencourt. The remains consist of an almost perfect skull, the two rami of a lower jaw, several other jaws, the upper portion of a radius, an astragalus, some fragments of the pelvic arch, and of the scapula.

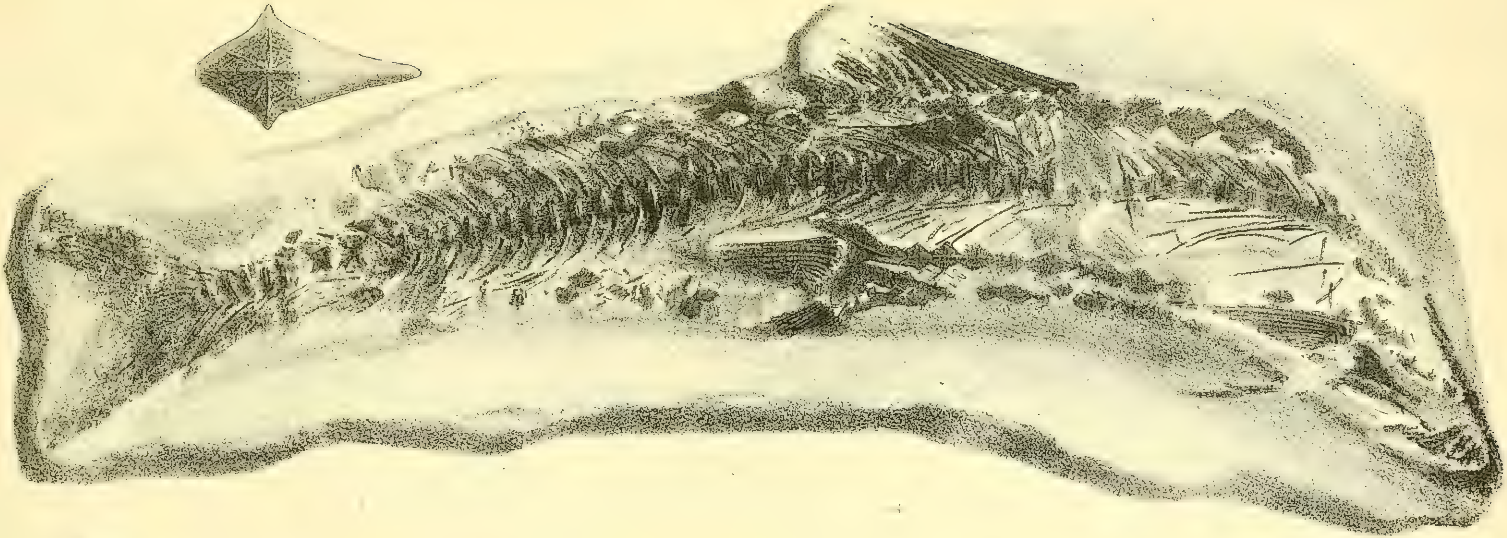
Paloplotherium has hitherto been unknown in the 'Calcaire Grossier.' The type of the genus is *P. annectens* (Owen), from the lacustrine beds of Hordwell, Hampshire, to which species that from Coucy bears a great resemblance. It has, however, four upper premolars, whilst the Hordwell species has three; the last upper premolar is a little narrower forwards, its external surface is not divided in the same way into two by a vertical ridge; the crown has no indication of a division into two parts; and the last lower molar has three lobes, whilst in *P. annectens* there are only two: still in a specimen from the Débruge, near Apt, referred by M. Gervais to that species, there are three lobes.

Palæotherium minus, Cuvier, has been placed in the genus *Paloplotherium*; it is much smaller than the Coucy fossil, and has only three upper premolars, the last of which is divided into two lobes and bears a vertical ridge across the middle of its outer surface.

The remarks of M. Aymard on the fossil of Puy, called by him *Palæotherium ovinum*, show that it ought to be placed in the genus *Paloplotherium*; but they are not sufficient for the determination of the species. If the *Paloplotherium* of Coucy differs from *P. ovinum*, M. Gaudry proposes to name it *Paloplotherium Codiciense*.

The principal differences in the species of *Paloplotherium* are as follows:—

There are three upper premolars in *P. annectens* and *P. minus*, four in *P. Codiciense*. The last upper premolar has four fangs in *P. annectens*, whilst there are three in *P. minus* and *P. Codiciense*. The hind molar in the lower jaw has two lobes in *P. annectens*; but



J. Dinkel lith.

PLINTHOPHORUS ROBUSTUS. *Gthr*

in the *Paloplotheria* of the Débruge and of the Paris Basin there are three. The absence of a slight prominence on the inner surface of the lower molars is not very constant; it is hardly visible in *P. annectens* and *P. Codiciense*, but is very well shown in *P. minus*. The ridges of enamel which have been pointed out as occurring on the posterior portion of many of the molars constitute a peculiarity of equally slight importance.

Besides these unstable characters, there is one which is sufficiently persistent to warrant the generic separation of *Paloplotherium* and *Palæotherium*; in the former the back molars are markedly distinct from the premolars, whereas in the latter, all the molars and premolars, except the first premolar, are similar. This difference, however, is not even strictly defined in the three species of *Paloplotherium*; in *P. minus* the last premolar resembles more the hind molars than in *P. annectens*, and still more than in *P. Codiciense*.

It is interesting to note these modifications in relation to time. *P. Codiciense* is the oldest known form of the Palæotherian type, and is the farthest removed from the true *Palæotheria*. After it comes *P. annectens*, which is less distinct. Afterwards, in the 'époque du gypse,' there appears *P. minus*, so much resembling some species of *Palæotherium* that Cuvier considered it referable to that genus. The range in time of *Paloplotherium* is very limited; since the Miocene age it has been replaced by *Acerotherium*.—R. T.

Observations sur les principaux Eléments du Terrain Quaternaire; sur les Théories proposées pour en expliquer la Formation; et sur l'Age de l'Argile à Silex. Par M. E. Hébert. (Bullet. Soc. Géol. France, 2me Sér. vol. xxi. p. 58, &c.)

In this memoir (read 16th November, 1863) the author compares the opinions of M. de Mercey and himself with regard to the Quaternary deposits of Picardy, in which of late years so many real, as well as some suspicious, remains of pre-historic man have been discovered. 1. He agrees that the clay of the plateaux in Picardy, regarded by M. Buteux as contemporaneous with that of the valleys, may be the most ancient of the Quaternary series; but he is not yet satisfied with the evidence. But he points out that, if so, this plateau-clay must be different from the *Limon Hesbayen* of Dumont, which has been identified by Lyell ('Antiq. Man') with the *Loess*; and different also from the clays worked at St. Acheul above the red gravel, which M. Buteux has regarded as the continuation of the plateau-clay. He points out also the close resemblance of the brick-clay of St. Acheul with that of Menchecourt as presenting a difficulty yet unexplained.

2. M. Hébert then alludes to the red gravel, pointing out its great importance and the small attention that he considers it has hitherto received. It is traceable over a large part of northern France. Under the name of 'old alluvium,' M. d'Archiac has connected it with the Loess of the Rhine; but with this view M. Hébert does not agree. It is in the red gravel that the original discoveries of M. Boucher de Perthes was made. Its uniform presence over a wide

tract renders it important as a land-mark, and as proving the greater antiquity of underlying 'diluvial' beds.

3. The gravel of Moulin Quignon is considered to be derived from débris washed down the slope of the hill, and to be a mixture of rolled flints with red gravel, whose date is not determined. It follows, of course, that, according to this view, the Moulin Quignon beds are newer than the red gravel.

4. The loess, or marly loam of Picardy, overlying the grey gravel, is regarded as older than the red gravel, and older than the loess of Paris.

5. In considering the various explanations of the deposits of the Quaternary period, M. Hébert does not adopt the theory that the Loess was the mud of the glaciers once covering Europe. He shows a section in which the red gravel covers and penetrates the Loess and upper beds of grey gravel, filling large and irregular swallow-holes, and affecting the upper beds of the Calcaire Grossier, at a height of 180 feet (55 mètres) above the sea, in precisely the same manner as it affects the grey gravel. He points to the agency of acid thermal waters as worthy of consideration; but thinks that for the present the sea and marine currents afford the best explanation, pointing out the terraces and parallel roads of Picardy as analogous to those of Glen Roy and others in the British Islands.

6. The age of the 'clay with flints' (*argile à silex*) of Picardy M. Hébert believes to be still doubtful. He had formerly regarded it as contemporaneous with the plastic clays of Picardy; but more recently has come to the conclusion that it is more ancient, as he finds sections in the Forest of Dreux in which the superposition of the plastic clay on this *clay with chalk-flints* is clear, and there is an intermediate bed of white and yellow sand. He remarks the similarity in the circumstances of deposit, when this clay is compared with the red gravel.—D. T. A.

NOTES ON FOREIGN GEOLOGY AND MINERALOGY.

By Dr. T. L. Phipson, F.C.S., &c.

The Mineral Riches of Roumania.—The Lake of Balta-Alba.—On the Colouring-matter of the Emerald.—Fossil Musk-ox at Précy.—Great Quantity of Human Remains from Moulin Quignon.

M. P. POENAR has written in the Belgian journal 'Le Progrès par la Science,' an interesting account of the *Mineral Resources of Roumania*, one of the Danubian Provinces. I will endeavour to condense the results of M. Poenar's observations:—

Several streams and rivers of Roumania are *auriferous*, especially the Olto, the Argis, the Dîmbovitza, and the Talomitza. The gold-washers find now and then grains of a considerable size adhering to a quartz-gangue.—Carbonate of *copper* is met with in the district of Mehedintzi, on the River Bîrza; copper-mines were worked when the Austrians occupied Little Wallachia, at Baja-de-Rama, the name of which hamlet signifies in English 'Mines of Copper.'—Carbonate and oxide of *iron* are met with in the district of Vilcea, also in those of Prahova, Comarnik, and Focsani, at the source of the River Rîmnik, where iron-ore is very abundant, and in the neighbourhood of the immense virgin forests which cover the sides of the Carpathians.—Traces of native *mercury* were met with at Pitesti, in the district of Argis, in a thin bed of clay, whilst the foundations of a house were being laid; but the metal has not been sought for since.—*Rock-salt* is the most abundant mineral substance of Roumania. The Government Mines are worked in Vilcca, Prahova, and Bouzéo. About 36,000 tons are raised annually. Beds of salt appear in many places even at the surface, principally on the mountain-sides, but they generally plunge about 100 yards under the surface; they are upon an average about 160 yards thick.—There is indication of *coal* at several places, on the borders of the River Bahna, in Mehedintzi district, near the town of Tourna Severino, and in the district of Vilcca, near the village of Tamasesti. The seams do not appear very considerable, but they have never been properly explored.—Roumania abounds in *lignite*, especially in the districts of Vilcca, Mehedintzi, &c. It has given rise, from time to time, to some curious geological phenomena. Thus, during the earthquake of 1838, crevasses were suddenly formed, out of which rolled torrents of bituminous and mineral waters. M. Poenar was directed by Prince Alexandre Ghica to study these phenomena. In certain localities he found the lignite had taken fire during the earthquake; and it has continued to burn ever since. In the neighbourhood of Malavetza, in the district of Mehedintzi, he witnessed an extraordinary fact. Underneath a layer of clay, about six yards thick, was a bed of lignite; the earthquake detached the clay, which slipped during the night down the side of a hill, carrying with it the peasants' houses and the trees, which remained standing almost perpendicular as before: the bed of lignite took fire immediately on being thus laid bare in contact with the atmosphere. Neither coal nor lignite is worked in Roumania, although the latter is so abundant, and often close to the surface.—*Bitumen* is met with in several localities, sometimes in the solid state, sometimes liquid; it is worked at Prahova and at Bouzéo, where the mines yield about 170 lbs. per day. Liquid bitumen, or petroleum-oil, is abundant, and would doubtless have been extensively worked before this, if the means of communication were better.—*Sulphur* is found native in the district of Dîmbovitza, near the village of Chotinga. It is found in a layer of green clay, in the form of globules. It is also met with at the mineral springs of Baboci.—At Sibicia, Coltziu, and Valea Boouluï, in the district of Bouzéo, *amber* is found. It is generally of a greenish tint, and more esteemed on that account.—In the district of Argis, on Mount Ciocan, and at the mineral springs of Olanesti in Vilcca, *garnets* are met with in micaceous sandstone, and in the gravel and sand on the borders of the rivers.—M. Poenar terminates his two papers by an account of the *mineral waters* of Roumania. There are three kinds, ferruginous, sulphurous, and alkaline. These mineral springs appear to be abundantly dispersed over the whole district. At Prédial, and Cornu in the district of Prahova, both iodine and bromine are found in these mineral waters. All the springs are cold except that of Cozia, the water of which has a temperature of 75° Centigrade. At the Olanesti springs there exists a medical establishment.

The following is the description given by M. Pierre Pocnar (*loc. cit.*) of the Salt Lake Balta-Alba, at the end of his account of the mineral riches of Roumania. This lake is situated at 12 kilomètres (about $7\frac{1}{2}$ miles) from the town of Rimnik-Sarat, in the middle of a vast plain; it is 7 kilomètres (about $4\frac{1}{2}$ miles) long, and varies in breadth from two to three hundred mètres; its depth is from one to two mètres only. The water of this lake is very salt, and forms saline deposits on the borders, where it is of a reddish-brown colour, and nauseous to the taste, on account of the multitudes of its aquatic birds, whose excrement (guano) is constantly driven upon the shores. At a few yards from the side the water is very clear, colourless, and odourless; but has a strong saline taste, rather bitter. Its specific gravity is 1·112; and its mean temperature 19° Centigrade (15° Reaumur). The bottom of the lake near the centre is level, very firm, and sandy; whilst the shores present a bottom of black greasy mud, exhaling constantly an odour of sulphuretted hydrogen. This mud contains the remains of the numerous aquatic plants which cover nearly the whole surface of the water in the shallower parts. It is much used in cutaneous diseases, rheumatisms, scrofula, &c.* The mud is applied to the affected part, and allowed to dry in the sun. This treatment is repeated several times in the day; and a bath is taken in the lake at night and morning. The Lake Balta-Alba appears to owe its origin to subterranean springs passing through some of the layers of salt spoken of above. Its water has been incompletely analysed: it contains chloride of sodium and sulphate of soda, with a little carbonate of lime and sulphate of magnesia.

In 1858 I gave an account, in 'The Geologist,' of the researches of Dr. Lewy, of Paris, upon the colouring matter of the emerald, in which it was stated that the emeralds of the Muso mine, in Mexico, contained a certain amount of organic matter to which they owe their colour. This interesting question has been lately examined again by Professors Wöhler and Gustav Rose, and the result communicated to the Paris Academy of Sciences. They do not deny the existence of about $1\frac{1}{2}$ per cent. of organic matter in the emerald; but they find that the emerald does not lose its colour by calcination, as stated by M. Lewy, but becomes opaque; moreover, that the emeralds of Muso contain 1·186 per cent. of chromic oxide, a quantity which the last-named author considers too little to account for the colour. To prove this point, MM. Wöhler and G. Rose melted together 7 grammes of colourless glass with 13 milligrammes of oxide of chromium, and obtained a transparent, homogeneous, green glass, the colour of which was found to be identical with that of the emeralds of Muso. Vauquelin, when he discovered chromic oxide in the emerald, at once

* I have lately had forwarded to my laboratory for analysis, two specimens of volcanic mud from the Island of Ischia, which is applied likewise with considerable success in various diseases of the skin. I shall be able to make known its composition in the course of a short time.—T. L. P.

attributed to it the beautiful green colour, and his opinion appears after all to be the true one.

M. Lartet has published an account (Comptes Rendus, lviii. 26) of the fossil cranium of the Musk-ox (*Ovibos moschatus*) found by Dr. Eugène Robert in the Diluvium of Précy on the right bank of the Oise. It was found at a depth of about 2 mètres in a gravel-deposit belonging to the Diluvium or Drift, which is there covered with 3 or 4 mètres of loam, analogous to the *loess*. Among some other remains of large animals found there was the tusk of an Elephant. In the French and English remains of the Musk-ox we have an example of an animal restricted at the present day to the northern parts of America, above 60° of latitude, which at one time lived in our 'quaternary' Europe under the 47th degree, and we know also that the arctic Reindeer ranged in ancient times to the Pyrenees. M. Lartet supports the relationship of the Musk-ox to the *Ovidæ,* rather than to the *Bovidæ* as advanced by Owen in his paper on the English fossil remains of Musk-ox, in the Geological Society's Journal, 1856.

M. Boucher de Perthes (Comptes Rendus, lix. 3) has discovered recently some more human remains at Moulin Quignon—a locality that became celebrated by the finding of the jaw-bone which gave rise to so much discussion. M. de Quatrefages publishes (*loc. cit.*) a long note upon this discovery. The box forwarded to Paris by M. Boucher de Perthes contains 16 or 17 teeth, several fragments of cranium, a portion of the occiput of an adult, a piece of the temporal bone of a young subject, some vertebræ, a portion of a sacrum, &c. These were forwarded on the 8th June, 1864; since then an entire jaw-bone and a cranium have been discovered, together with a quantity of other bones, about 200 in number. M. de Quatrefages terminates his paper with the following remark: 'To day, as last year, I leave to geologists the task of determining the age of the *terrains de transport* of Moulin Quignon, and consequently that of the human race the remains of which they have preserved. At any rate, the existence of this antehistoric human race, quite distinct from the Celtic races, can be no longer contested.' M. Elie de Beaumont reiterates the expression of his desire to see these bones placed in the hands of an expert analytical chemist; but he does not state his reasons for wishing these analyses to be made.

REVIEWS.

Geological Essays, and Sketch of the Geology of Manchester and the Neighbourhood. By John Taylor. London: Simpkin, Marshall, & Co., 1864; pp. 282, 8vo.

EVERY physical science, like almost every field of research and subject for thought, has its two classes of writers—the scientific and the popular; but we very much doubt whether the writers on any science exhibit so wide a difference in education and ability as do those on Geology. Doubtless this peculiarity may be partly explained when the peculiar nature of geological research is taken into account; for, while in every other physical science the investigator must be either a good mathematician or a skilful operator, both of which qualities imply education, in Geology, as we all know, a quarryman, a coastguardman, and a blacksmith have become good observers, and even, in the first-mentioned case, a polished writer and a bold and ingenious theorist.

Notwithstanding this isolated case of success in geological literature, it would be far better if Geology could limit the actions of her humbler votaries to original work ; but the fatal notoriety attached to 'writing a book' is to them a stumbling-block and to us foolishness.

The work now before us well illustrates our meaning ; it is one of the most absurd books on a geological subject that we ever remember to have read, for the author (who is *not* the late Mr. John Taylor, of mining celebrity) knows just enough of geological phenomena usually to misrepresent them ; and, although he writes of 'Tales told in Athens,' he has such remarkable opinions as to the right spelling of the names of fossils, that we feel assured that in a knowledge of Latin and Greek and of the subject of which he treats he is equally wanting.

As an example of the author's knowledge of palæontology and comparative anatomy, we give the following paragraph from p. 113 :—

> But what is most characteristic of these palæozoic corals is this: whilst those of the present day have their septa, or radiations, either in fours, or a multiple of four, the former have always a multiple of six. . . . . . . The septa were formed by the animals as furrows, along which to thrust their tentacles, so that beautiful as the fossils themselves are, when they served as dwelling-places to their jelly-like inhabitants, they must have been more beautiful still, for then the summit of each was adorned by a coronal of brilliantly coloured tentacles, like those of the common sea-anemone. In fact, the only distinction betwixt the anemone and these fossils is this, that the former have a leathery envelope only—whereas the latter are encased in a calcareous defence.

It is bad enough to be told that the palæozoic corals have their septa in sixes, and that the recent *Zoantharia* have them in fours ; but here we may charitably suppose that the author has been looking at facts through a bad glass, which inverted nearly everything and distorted the rest; but when he writes of septa being formed as furrows, along which tentacles were thrust, and of corals having a calcareous defence, we perceive that he is completely ignorant of his subject.

We have already mentioned his bad spelling; when treating of fossil reptiles, he remarks of one of them, 'This goes by the *classic* name of *rhyncosaurus*, which "being interpreted," means the "beaked lizard."' The italics being his own, the sentence contains a satire on itself. We also read of *Caryophylla sexdecimale*, and of many other species spelt on the same plan ; of *Syringipora*, *Rhynconella*, *Cellipora*, *Producto*, *Buccinium*, and so forth.

Mr. Taylor's notions of physical causes are as remarkable as his comparative anatomy; and his account (p. 59) of a 'brecciated limestone' having been formed from shingle, is particularly absurd. He is very fond of a simile now and then: and, although we occasionally get a good one, we are frequently at a loss to imagine how he has satisfied himself of their applicability; for instance, we are told of 'the sea, like a huge mortar, pounding its coast-lines into muddy sediments, to be again reconsolidated.' The best we have met with in the book is that in which the geological record is compared to the old Woodstock Palace, as described by Sir Walter Scott, the different fronts of which were said to contain specimens of every style of architecture, just as the different rock-formations contain examples of every fauna. If the ideas, many of which, we are told, 'were sketched during a few minutes' rest in some solitary quarry,' were more frequently of this stamp, we should be inclined to forgive the author for many inaccuracies, in the hope that such similitudes, by impressing the reader with a sense of the beautiful, would draw off his attention from errors in facts and principles, or, at any rate, loosen their hold on his mind.

It becomes, indeed, a serious matter when men who, though having probably a very tolerable knowledge of local facts, undertake to write a work of this kind for the public at large, having no better knowledge of palæontology than what induces them to believe that a *Turbinolia* differs from a *Cyathophyllum* only in being 'smaller, and more even in its outline,'—an opinion which he immediately illustrates by figuring a *Cyathophyllum* as a '*Turbinolia.*' A man must be a very accomplished geologist to write a good general or elementary work; and the more popular the book, the more care and knowledge does it require. For this reason, such men as Phillips, Huxley, Ramsay, and Jukes, spend a portion of their time very advantageously in providing intellectual food for the rising generation of amateur geologists; but men of Mr. Taylor's stamp can employ themselves much more profitably in working out a special subject, than in composing a bad imitation of Hugh Miller's writings, as full of errors as it well can be.

Notes of a Trip to Iceland in 1862. By Alexander Bryson, F.R.S.E., F.G.S. Edinburgh, Grant, 1864. 8vo. pp. 56.

THIS little pamphlet, reprinted from the 'Scottish Guardian,' is more genial than scientific, and the author evidently did his best to deserve the name of 'Bacchus,' given to him by one of his fellow-travellers. There is, however, some geology; and what there is is good and useful, for Mr. Bryson belongs to the modern school, and does not take things too much for granted.

The lava of Iceland would seem to represent, in modern times, the eruptions on a great volcanic line, skirting the extreme west of the old world. This line has existed since the Cretaceous period, and the points of eruption have been gradually travelling northwards. Unlike the great volcanos of America, which erupt through tens of thousands of feet of upheaved mountain, most of the eruptions of the European series were either submarine or only at moderate elevations above the sea. The basalt of the north-east of Antrim and the Western Islands of Scotland are examples of some of the earlier outbursts. The Faroe Islands are more modern, and Iceland is still among the localities from which molten rock is poured out. It is impossible, therefore, to pass by without notice any really honest account of Icelandic phenomena by a competent observer.

The Geysers and the Strokr, those singular examples of intermittent fountains of boiling water and steam, were, however, the only objects that the shortness of the author's visit allowed him to study. He found the Great Geyser basin to measure 74 feet by 68, the temperature of the water in it varying from 176° to 179° F. The depth of the tube was 70 feet on one side, and 64 on the other. With thermometers specially contrived so as to lose part of the mercury when exposed to a temperature above 212°, he and his companions determined the temperature of the bottom of the tube, not long before an eruption, to be 240°, while the temperature half-way down was in one case as high as 270°. Not only this, but every important fact known concerning the district proves that the causes of disturbance are purely local, and that they are probably produced by chemical action. The explanation given by Bunsen is supported by Mr. Bryson's observations. The absence of organic matter in the Geyser water was proved by the use of permanganate of potass, and is a fact not without importance.

The Strokr erupts when turf and stones are thrown into its funnel, and very rarely without such provocation. Mr. Bryson suggests, as a reason, the floating of mechanical particles on the surface of the water already boiling, and the consequent incapacity of the steam to escape into the air without bubbles, which in this case are represented by an eruption. He illustrates the case by the behaviour of water boiling in a vessel where a broken egg supplies a film of albumen.

It is suggested that the phenomena of the Geysers are probably modern. The measurement of the siliceous sinter of the Great Geyser by Capt. Forbes would give an age of about a thousand years; and this estimate is somewhat strengthened by the fact that there is no notice of this spring in the earlier days of the colonization of Iceland, 986 years ago.

Address at the Anniversary Meeting of the Royal Geographical Society, 23rd May, 1864. By Sir Roderick I. Murchison, K.C.B., G.C.St.A. & St.S., D.C.L., LL.D., F.R.S., Director-General Geological Survey, President. London, 1864. 8vo. pp. 89.

The presentation of the royal awards to Baron Charles von Decken and Captain Grant, the Obituary Notices, and the report of progress in British and Foreign Geography constitute, of course, the bulk of this interesting Address; but there is one section in it of especial interest to Geologists, namely, a notice of the Glaciers of the Himalayan Mountains and New Zealand, as compared with those of Europe, and a review of what is known about the powers of Glaciers in modifying the surface of the earth, and the agency of floating icebergs (pp. 57–77).

Following up a subject referred to in his Address to the Royal Geographical Society in 1863, namely, the former glacial condition of Northern Europe, Sir R. Murchison reminds those of his readers 'who have not attended to the connection between existing geography and the ancient conditions of the globe, that Scotland and large portions of Northern Europe must, at a period anterior to the creation of man, have been in the same condition as that in which Greenland and its adjacent seas are now;'—that at the Glacial Epoch those lands were covered by snow-fields and glaciers, and bordered by coast-ice, from whence ice-bergs and ice-floes floated off to discharge their loads of mud, sand, and stones in the neighbouring waters. The conditions and the results of such great continuous or continental ice-fields, were sketched out for Scotland and Sweden by R. Chambers in 1853 (who thought that great thicknesses and wide areas of hard rock-masses had been removed, probably along lines of fracture, by the action of an extensive glacier-sheet), and illustrated about the same time by Rink's account of the ice-clad mountains of Greenland, and previously by Ross's great Antarctic land-ice. We all know that multitudinous observation and hypotheses, both before that time and since, have been made for the elucidation of the manifold phenomena of 'Glacialization,' both local and general, and both as to the agents and the results; and 'the new theory of the power of moving ice,' namely, 'that the excavation of deep hollows in solid rocks is due to a weight of superincumbent ice pressing and grinding *downwards and outwards*, over high, flat, and sometimes broad watersheds and table-lands, during that period of intense cold which produced the old glaciers,'—excavating, for instance, such lake-basins as those in Switzerland and North Italy, is the point which Sir Roderick takes specially into consideration in the Address before us, prefaced with a notice of the discoveries made in the glacier-world by Captain Godwin-Austen, Dr. Haast, and Dr. Hector. A review of the progress recently made by Martins, Gastaldi, Mortillet, Paglia, Studer, Escher, and others, in pointing out the extent to which ancient glaciers and their moraines have ranged within or on the flanks of the Alps, seems to prove that old water-worn alluvium in many places underlies the oldest moraines of glaciers, which therefore have not necessarily been excavating bodies, though in some instances they have pushed before them the débris lodged in old rock-basins; that glaciers exercise comparatively little erosive power; that the direction and depth of some of the lake-basins said to have been hollowed out by ice-action, as well as the slopes of their floors, offer insuperable objections to the application of this theory of excavation; and that the old glacier of the Rhone has carried its load of stony débris across the area of the Geneva Lake, then probably choked with ice.

As a geologist, with wide experience, the President of the Geographers clearly states his conviction (mentioning, too, his facts and his supporters), that, in spite of general statements to the contrary, there are cracks, rents, and gorges of fissure in the rock-masses, 'orographic depressions and deep cavities,' in some of which glaciers and rivers flow, often with but little wear and tear, whilst others have been unwrought by ice; and that these fissures, giving the main features to the ground, have been caused by upheaval, by ruptures, and denudations.

The formation of real glacier-lakes by moraines,—the burstings of such lakes,—Nördenskiold's map and memoir illustrating the glacialization of Finland,—the striations and roundings of surface by the action of ice-bergs, as suggested by Peter Dobson, more than twenty years ago,—these are the other points discussed by Sir Roderick in his concise and well-handled review of the subject of Ice-action.

We also find geological information scattered through this Address, as indeed it must be in all good geographical reports; and we extract the following:—

'From the researches of M. Schmidt, the geologist, aided by the botanist Glehn and the topographer Schebunin, we learn that the region beyond the Sea of Baikal is distinguished by a great variety of geological formations. Crystalline rocks, however, abound; and the unaltered sedimentary fossiliferous formations are much less extended. Among the latter, the Devonian and the Jurassic deposits have been best recognized. The latter has the petrographical characters of the Jurassic rocks of the Caucasus, and contains certain beds of coal, which in one spot is said to pass into graphite. Further eastward, and along the Saigon or chief mountains, and on the Amur below the juncture of the Zeia, there are spread out great freshwater formations of Tertiary age; whilst in the great Island of Sakhalin very recent marine Tertiaries repose on true Chalk and Cretaceous deposits. Having discovered what he believes to be many transitions between crystalline rocks and unaltered sediments with fossils, M. Schmidt is of opinion that all such changes have been brought about in an aqueous manner, and not by any plutonic or igneous action. The ingenious author is obliged, however, to admit the existence of obsidian in one place, and has not yet developed his proofs in favour of his novel system, in which, if I have not been misinformed, he seems to carry the chemical and Neptunic ideas of Bischoff to what I cannot but consider an extravagant length' (p. 40).

Proceedings of the Berwickshire Naturalists' Club. Vol. v. No. 1, 1864. 8vo. pp. 92. Three lithographic plates, and four woodcuts.

Transactions of the Tyneside Naturalists' Field-club (With List of Members and Index to the Volume). Vol. vi. part 2, 1864. Newcastle-on-Tyne. 8vo. pp. 197, with several woodcuts and 5 plates.

Proceedings of the Warwickshire Naturalists' and Archæologists' Field-club, 1863. Warwick, 1864. 8vo. pp. 41, with one plate.

Report of the Proceedings of the Teign Naturalists' Field-club for the Year 1863, and List of Members. Exeter, 1864. 8vo. pp. 11, with a photograph.

Transactions (No. 4), List of Members, and Rules of the Woolhope Naturalists' Field-club, 1863 (pp. 49); Transactions (No. 5), 1864 (pp. 77). 8vo. Hereford.

Bristol Naturalists' Society. Established 1862. Report of the Council read and adopted at the Second Annual Meeting of the Society, held May 5th, 1864. With the Rules, and Lists of Officers and Members. Clifton, 1864. 8vo. pp. 19.

List, Rules, and Notes of Field-meetings of the Caradoc Field-club, Shropshire. Established 1863. Ludlow, 1864. 8vo. pp. 15.

Transactions of the Dudley and Midland Geological and Scientific Society and Field-club. No. 1, December 1862. With List of Members. Dudley. 8vo. pp. 23.

Proceedings of the Dudley and Midland Geological and Scientific Society and Field-club. No. 2, June 1863. Including Appendix to List of Members. Dudley. 8vo. pp. 39.

Transactions of the Manchester Geological Society. Vol. iv. No. 12. Session 1863–64. Manchester, 1864. 8vo. pp. 19.

THE titles above given of serials now before us serve to indicate the wide-spread and well-managed operations of naturalists and geologists in Britain, and some of the useful results of their research. We leave it for others to work out the statistics and history of the Societies and Field-clubs themselves, however interesting the subject may be; we shall take our casual collection of their Proceedings as a sample of the work they do, and proceed to point out some of the chief geological matters in which they have interested themselves. The veteran Naturalists' Club of Berwickshire publishes an account and figure of a new fossil Sea-star (*Cribellites carbonarius*) from the Mountain-limestone of Northumberland, with a notice of its association with Carboniferous Plants, from the pen of Mr. George Tate, F.G.S., who points out that, by careful observation, the difference of the fossils in successive layers of Carboniferous strata, in more than one instance, is found to show that marine conditions gradually gave way, 'probably from a gradual alteration of level, and an influx of fresh water,' the water becoming estuarine, and afterwards entirely fresh; and the remains of plants becoming more and more abundant. Messrs. Rupert Jones and G. Tate supply also a paper on some small Bivalve Crustaceans (*Estheria striata, Candona* (?) *Tateana*, and *Beyrichia Tatei*), from the Carboniferous rocks of Berwickshire and Northumberland, illustrated by woodcuts. Mr. Turnbull's Address to this Club contains an interesting account of the tastes and progress of the Club, as shown by their published Transactions: Geology and Mineralogy have had 16 papers out of 215 since the Society began.

The Tyneside Naturalists' Field-club, near neighbours to the foregoing, work as enthusiastically, and publish even fuller Proceedings, the completion of a series of local catalogues of animals and plants being kept prominently in view. This year Tyneside geology is elucidated by a note on some fossil teeth of Horse from Stockton, by Mr. J. Hogg, and by two papers by Mr. J. W. Kirkby, and one by Messrs. Kirkby and Atthey.

Fossils are rare in the lower portion of the Magnesian or Permian limestone in the neighbourhood of Sunderland; but Mr. Kirkby obtained some in a new quarry at Bishopwearmouth, where 68 feet of the 'Lower Limestone,' the 'Marlslate' (3 feet 7 inches thick), and some of the Red Sandstone at its base, were exposed. The fossils are:—

Nautilus Freislebeni, *Geinitz.*
Straparollus planorbites, *Münster.*
Chiton Loftusianus (?), *King.*
Leda speluncaria, *Geinitz.*
Spirifera Urii, *Fleming.*
Camarophoria crumena, *Martin.*
Chonetes, *sp.*
Fenestella retiformis, *Schlotheim.*
Ichthyorachis anceps, *Schlot.*
Cyathocrinus ramosus, *Schlot.*
Serpulites anastomosis, *sp. nov.*

Mr. Kirkby remarks that these represent a local fauna, differing from all other Permian groups that he knows of; the prevailing species being 'either wholly new to Britain, or such as are comparatively rare in other localities where they occur.'

The highest beds of the Durham Coal-measures have yielded some little fossils to Mr. Kirkby's careful search—namely a band of minute shells in ironstone, a specimen of which, however, had been found years since, and preserved in Mr. Vint's collection at Sunderland, though the exact locality was forgotten. Professor Phillips had long ago seen that specimen, provisionally and doubtfully referring the fossils to *Ancylus*; Mr. Kirkby thinks it probable that *Estheria* ought to claim them; Mr. Rupert Jones sees no evidence of that relationship, but agrees with Mr. Davidson that the little fossils belong to *Discina*. *Beyrichia arcuata*, *Anthracomya acuta*, *Neuropteris*, *Asterophyllites*, and Fish-scales accompany *Ancylus* (?) *Vinti* (Kirkby) in the ironstone.

Messrs. Kirkby and Atthey treat of numerous fish-remains from the Coal-measures of Northumberland and Durham, chiefly found in a carbonaceous shale or 'black stone' at Newsham Colliery; and they enumerate the following genera as being indicated by these fossils:—*Rhizodus*, *Megalichthys*, *Holoptychius*, *Acrolepis* (?), *Pleuracanthus*, *Orthacanthus*, *Gyracanthus*, *Ctenoptychius*, *Diplodus*, *Ceratodus*, *Platysomus*, *Cœlacanthus*, and *Palæoniscus*, besides others, as well as some *Mollusca*, *Insecta*, *Entomostraca*, and *Annulata*. We recollect to have seen in Mr. Atthey's collection of fossils from Newsham a little jaw closely resembling that of one of the Reptilia from the Nova-Scotian coal. *Rhizodus lanciformis*, Newberry, *Holoptychius sauroides*, Agassiz, and *Holoptychius*, sp. indet., have been worked out by the authors, aided by Sir P. Egerton, and are illustrated in a lithograph of rare delicacy by T. Brady of York.

Lastly, a short paper, by Mr. G. S. Brady, on the fauna and flora of some pools, of different degrees of brackishness, in Hylton Dene, near Sunderland, is of considerable importance to geologists.

'Estuarine swamps,' says this careful observer, 'such as this, seem to be the nearest analogues we now possess of those extensive lagoons which, during the Carboniferous Period, supported the rank vegetable growth now fossilized in our Coal-measures. To the Palæontologist it must be matter of considerable interest to note the association of species in such localities; and I think enough has been said to show that considerable caution should be used in pronouncing upon the saline or freshwater nature of any deposits merely from the nature of the animal forms which they enclose. Judging from analogy, however (if our own island may be taken as a type), we should suppose that any great luxuriance of vegetable growth must be indicative of freshwater conditions. We uniformly find in the saline portions of these marshes a peculiarly dwarfed and stunted vegetation, while as we recede from the salt-water influence it often assumes a rank luxuriance, putting on a character quite as much in accordance with vegetation of the Coal-period as can be expected in these degenerate days.'

The Warwickshire Field-club publishes a lecture on the Hyæna-den at Wookey Hole in Somerset, by Mr. Parker, the fellow-workman with Mr. Dawkins in exploring this cave, and in the careful collection, sorting, and preservation of the numerous bones from the different layers of cave-earth and breccia, and from different parts of the cave, as well as of the more rare and valuable stone implements of human manufacture, found there. A Presidential Address well adapted for Naturalists, Geologists, and Archæologists, and interesting notes of the doings and sayings at the several indoor and outdoor meetings of the Club, form the rest of this part of the Proceedings, which, though neither printed nor edited so well as those already mentioned, is an honest and useful witness of scientific life in Warwickshire.

The Teign Naturalists chronicle six excursionary meetings, at which old churches, quarries, mines, fossils, botany, and social dinners were, as usual, important features, advancing knowledge and tending to good fellowship.

The Presidential Addresses for 1861 and 1862 to the Woolhope Naturalists, by Messrs. Banks and Lightbody, treat *con amore* of the geological work done and to be done in those parts of the country visited by the Club; and Mr. Hoskyn's Address in 1864 (there seems to have been none in 1863) indicates clearly and pleasantly the comprehensive character of the scientific and social purposes of Field-clubs. Mr. E. J. Isbell contributes a short paper on the Earthquake of October 6th, 1863, illustrated by a lithograph sketch-map, representing the varying intensity of the shock along a line from Lancashire to Somerset, and transversely east and west.

The Bristol Naturalists, counting 214 ordinary and 16 corresponding members, announce that they make steady scientific progress and enjoy continued financial prosperity; they look back with pleasure, and forward with hope. Enjoying the use of the Museum of the British Institution, they have presented a valuable specimen of *Apteryx* as a contribution in acknowledgment, as well as money-grants. They enjoyed and profited by four excursions, and had several interesting papers read at their indoor meetings. Geology has a fair share of their attention.

The Caradoc Field-club, youngest of all, show by their first report that they know how to avail themselves of the manifold advantages that Shropshire affords for the zoologist, botanist, geologist, and archæologist. They enhance, too, the pleasures and advantages of their excursions by meeting the Woolhope Club, the Oswestry and Welshpool Club, and the Severn Valley Club.

Like other kindred associations, the Dudley and Midland Field-club has been established for the development of the scientific resources of a special district; and, being in a mineral district *par excellence*, geology is foremost on its list of objects, geologists are strong on its staff, and its inaugural address was eminently geological. The field-meetings work over the many interesting outcrops of well-known strata, and are rewarded with rare plants and antiquities, as well as fossils, much information being obtained and disseminated; and, in fulfilment of a judicious determination to cooperate with other societies, the Woolhope, Oswestry, Warwickshire, Cotteswold, and Severn Valley Field-clubs have been sharers in the work. The Dudley Geological Society (as it is sometimes termed) holds also field-meetings in the winter with good result. Some good papers on local geology are published in No. 2 of the Proceedings, especially Mr. H. Johnson's, on the practical application of Geology to the industrial pursuits of the South Staffordshire Mineral District, and Mr. E. Hull's, on the New Red Sandstone of Central England, and its usefulness as a source of water-supply.

We have now to refer to the Geological Society of Manchester, last, but not least—as venerable among its class as the Berwickshire Field-club is with naturalists. As a representative of the chief provincial societies for the cultivation of geology, we allude to this scientific association of Manchester men. No. 12 of vol. iv. of their Transactions contains much information in a paper by Mr. E. Hull, on the occurrence of Glacial Striations on the surface of Bidston Hill, near Birkenhead, which he saw with Messrs. Morton and Cunningham, and a paper by Mr. J. Plant, on the discovery of Coal in Brazil, where, it seems, from his brother's notes on the subject, 65 feet of coal occurs in 114 feet of strata, extending over 150 square miles! *Stigmaria*, we are otherwise informed by Mr. Plant, underlies some at least of the coal; and we learn too that *Sphenopteris* and *Lepidendron* are present, as well as a minute fossil crustacean, *Beyrichia*, characteristic of the Palæozoic period.

We need not enlarge our list of Scientific Societies to show the good resulting from the steady activity of British geologists; cooperating with each other, with the Irish societies, and with their geological brethren abroad, they seize and utilize much that is of value: as eyes are opened, facts are seen; as natural history is cultivated, facts must be grouped; we have seeding-time and harvest in science as in farming; we must watch the outgrowth of facts and their concentration in theory; truth and judgment, supported by industry and enthusiasm, work in this; and where are better evidences of this good work than in the Proceedings of our Field-clubs and Scientific Societies?

REPORTS AND PROCEEDINGS.

Dumfries and Galloway Natural History and Antiquarian Society.—This Society had its first excursion for this season on 7th June last, the district selected being that around Drumlanrig Castle. Shortly after nine in the morning members and their friends, to the number of about thirty-five, met at Dr. Grierson's Museum at Thornhill. Having been conducted by Dr. Grierson over his well-arranged collection, which comprises very numerous specimens of the natural history, antiquities, and geology of Nithsdale, the party set out from Thornhill about ten o'clock. At Boatford the party turned aside to inspect the remarkable upright stones in the field there, the rude ornamentation on which, as Dr. Grierson pointed out, was of precisely the same character with that on the ancient cross of Durrisdeer, a portion of which is in his own collection, and which probably belonged to the 11th century. The next object of interest, indeed the chief for the day, was Tibbers Castle, the ruins of which are at present being excavated under the inspection of Mr. Howitt, master of works to His Grace the Duke of Buccleuch. After the several points of interest had been inspected, Dr. Grierson read an interesting paper upon Tibbers Castle. In the introduction the Doctor said, 'I will go back to the beginning—back to the time when these mountains were formed. They are Silurian, and form a basin which is the Vale of the Nith. Lying upon the Silurian (I think not the Devonian) is the Lower Carboniferous of Closeburn and Keir, a marine formation, in which are the remains of the characteristic testacea. Of vertebrate animals, all that has ever been met with are the flat teeth of the *Psammodus*, a family of fish having a cartilaginous skeleton. Succeeding the Lower Carboniferous, are sandstones. In these, excepting when in immediate connection with limestone, there has rarely a trace of organization been found. In the dark red sandstone such has never been met with; but in the lighter sandstone there are a few vestiges of vegetable remains. No indications of animals had been met with until within the last eight months. Those were footprints, which were recognized to be those of the Cheirotherium, a gigantic Labyrinthodont animal, whose race has long been extinct. During the formation of the red sandstone, and immediately preceding it, the earth was convulsed, and then issued from rents in the Silurian rocks molten lava. The place on which we stand was once that lava, now amygdaloidal trap. After the formation of the sandstones, be they Carboniferous, Permian, or Triassic, no other formation of solid rock was formed, or, if formed, it has disappeared without leaving a trace behind. Afterwards this valley became filled with glaciers. How many ages of frost there were, and what changes in subsidence and elevation the earth underwent, is not to be determined; but the ice melted, and there were formed glacial lakes, which at times broke their barriers, sweeping along the débris of the rocks, and depositing heaps, in part forming the undulated surface which characterizes this district. Ages passed on, and the glaciers had melted away, but onward flowed the clear streams of the Nith to the Solway. I will not attempt to argue when it was that men first occupied this valley. The first have left a few stone celts, and by these we know that there were men ere history had began.' Dr. Grierson then took up the archæological history of Tibbers Castle, tracing it down from the time of the Roman occupation to its destruction by Robert Bruce in 1311. The company then proceeded to Drumlanrig Castle, and thence to Durrisdeer. Here, some went to examine the King's Quarry, others held on up the hills, by what was formerly the only road—properly the bridlepath—to Edinburgh, till they struck into the ancient Roman road which leads to the Roman Camp.—*Dumfries Herald*, 10th June.

Exeter Naturalists' Club.—On Saturday, 18th June, this Club made an excursion to Strete Raleigh, by invitation of Wentworth Buller, Esq., who awaited their arrival, and threw open his hothouses and conservatories, containing a very fine collection of orchids, palms, and ferns, to their inspection.

The party next proceeded to the interesting gravel-pit at Straightway Head, where beds of pebbles identical in character with those seen on the beach at Budleigh Salterton are inter-stratified with bands of white sand and red marly clay. Having made a minute examination of these, the members continued their walk for some distance up the hill, and on their return to Strete Raleigh were shown two living Badgers, captured by Mr. Buller on the borders of Dartmoor, near Becky Falls. The Badger is a peculiarly interesting animal to the naturalist and geologist, being the last representative of the Bear-tribe existing in the British Isles, of which it is, geologically speaking, one of the oldest existing quadrupeds, its bones being mixed with those of extinct animals in the bone-caverns around Torbay, &c. Unfortunately it bids fair to disappear before long, though a few still exist about Poltimore and on Haldon, as well as on Dartmoor.

Mr. Buller read a highly interesting paper on the distribution of plants in the south-western parts of England. The general conclusion Mr. Buller arrived at, was that the last climatic change was not from a colder, but from a warmer period to the comparatively cold climate of the present time.

Mr. Vicary then read a paper 'On the Pebble-bed of Budleigh Salterton.' (This has since been published in the Quarterly Journal of the Geological Society, No. 79.) Engravings of the fossils, and a geological map showing the continuity of the various formations on the opposite sides of the English Channel,* were exhibited in illustration of Mr. Vicary's paper, which excited great interest amongst the members.—*Exeter and Plymouth Gazette*, 24th June.

The Dudley and Midland Geological Society held their second Field-meeting at Llangollen on the 14th and 15th July, in con-

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* See Geological Magazine, No. 1.

nection with the MANCHESTER and LIVERPOOL GEOLOGICAL SOCIETIES. Shortly after twelve o'clock the party commenced their examination of the geological features of the northern side of the valley. The route lay along the banks of the Dee for upwards of a mile, and the first halt was made at the slate-works, near Llantysilio, where the huge slabs brought down from the quarries near the summit of the adjoining hills are prepared for industrial purposes. As roofing material these slabs appear somewhat coarse, though they are said to be durable. They are not in such demand as the thicker slabs, which are used for cisterns, chimney-pieces, &c. The next point of interest was the venerable pile of ruins, all that now remains of Valle Crucis Abbey, which was at one period a famous monastic establishment in the Valley of the Cross, one of the most secluded and picturesque dells which could have been selected for a religious community. The Abbey appears to have been built A.D. 1200. From this point the party divided, one portion, including several well-known botanists of Llangollen, taking the road for the World's End, a division of the Mountain-limestone ridge of Eglewseg, while the remainder took a pathway across the hills, and came upon the remarkable exposure of limestone further south. This bold and terraced escarpment extends from near Trevor in a north-western line for many miles, and affords to the geologist many characteristic fossils of the Carboniferous formation. The lower measures consist of light-coloured beds, which are extensively quarried for use in the ironworks of Staffordshire and Lancashire. The upper layers are of a darker colour, and of less industrial value. The organic remains are principally *Productus* (*P. Llangollensis* being the most characteristic), *Syringopora*, *Euomphalus*, *Pleurotomaria*, *Spirifera*, *Rhynchonella*, &c. At the base of these rocks a small exposure of the Old Red Sandstone gives its peculiar colour to the slope, and in several places has been penetrated, apparently in search of mineral veins, of which the range contains many examples, though they are not productive in this locality. After spending some time in skirting the Eglewseg Rocks, and with many a halt to admire the ever-changing scenery, the summit of Dinas Bran was at length attained. From this point the sea of hills piled up in tumultuous succession towards the west, the blue outlines of the more distant mountains, and the varied features of the adjoining vale, almost entirely diverted attention from the ruined fortress which crowns the eminence, and dates its origin from the early times when the Britons were retreating before the invading and conquering Saxon race. At five o'clock the various sections assembled at the Hand Hotel, where a cold collation was provided.

In the evening Mr. Edward Wood presided, and Mr. Plant (Salford Museum) gave an account of the geological features of the district inspected during the day. He described the Upper Silurian rocks, which are supposed to be the equivalents of the Wenlock Shale and Limestone. These measures form the hills in the immediate neighbourhood of Llangollen, and also those from which the slates are obtained. These vast layers of rock, he said, must have been formed in a deep sea, and hence they are not rich in fossil remains ; but the few that have been found undoubtedly connect this formation with the Limestones and Shale of Dudley and Wenlock. The sandy character of the beds would also, he thought, account for the scarcity of fossils. Passing upwards, another member of the Palæozoic series was faintly represented in the district. He had until that day entertained some doubt of the correctness of the Geological Survey in putting in a patch of Old Red Sandstone at the base of the Eglewseg Rocks, but what he had seen on the excursion fully convinced him that the published maps were correct. Above this formation came the Mountain-limestone, remarkably rich in fossils, and which he claimed as belonging to the geology of Manchester, for the range of hills near Llangollen formed their horizon-line.—Mr. Jones (Dudley) expressed on behalf of the Midland Society his pleasure in meeting so many distinguished representatives of the Manchester and Liverpool Geological Societies, and hoped that such meetings might be of frequent occurrence. He raised one or two points for discussion in connection with Mr. Plant's paper, particularly with reference to the conditions under which the Wenlock beds were deposited in North Wales and in the neighbourhood of Dudley respectively. The President and several gentlemen took part in the discussion, after which a vote of thanks was given to Mr. Plant for his valuable address. In acknowledging the same, he enlarged on the important questions which were occupying the attention of the geological world at present, particularly with reference to the presumed antiquity of the human family. The customary vote of thanks to the Chairman closed the official business of the day, after which, in the cool of the evening, many points of interest in the locality were visited.

Early on Friday morning the party set out for a day's excursion on the south side of Llangollen, under the guidance of Mr. D. C. Davies (Oswestry), who has done much valuable work by his long continued investigation of the geology of this locality. A short halt was made at Plas Newydd, famed as the residence of the 'Ladies of Llangollen' for many years. The front of the cottage is ornamented with richly carved oak, some portions of which appear of great antiquity. The road to Glyn Ceiriog, the place of destination, leads over a portion of the Berwyn Hills, and for a considerable distance is extremely steep and fatiguing, but at almost every point fresh combinations of rugged scenery opened up. The village of Llansaintfraid was reached about eleven o'clock, and after refreshment, the geological features of the valley were examined. The principal point of interest was a quarry of Bala Limestone, where a few characteristic fossils of the formation were obtained. The stone fences and the loose material lying on the hill-side afforded, however, by far the best organic remains, which are very similar to the fossils found in the neighbourhood of Church Stretton, in the eastern equivalents of the Bala rocks. The botanists were rewarded by several rare plants; but time did not allow of a very careful search. A portion of the party made a long *détour*, in order to reach the lower beds of limestone, and the curious interstratified layers of igneous rock. They spent considerable time in examining the first bed of Bala Limestone, which affords numerous and varied organizations. They also passed the several bands of felspathic ash, and joined the straggling remains of the general party at the New Inn, Glyn Ceiriog. The majority of the members, after partaking of luncheon at Llangollen, returned home; but not a few made this the starting point for a tour in North Wales.—J. J.

THE second meeting of the members of the COTTESWOLD NATURALISTS' FIELD-CLUB took place at the Speech-House, in the Forest of Dean, on Friday, the 24th of June. After breakfasting at Mitcheldean, and looking at the fine old church there, the members proceeded to Drybrook, to examine the section of the transition-beds of the Old Red Sandstone and Carboniferous Limestone, which was worked at some time since by Messrs. John Jones and W. C. Lucy. The section was found accurate; indeed, so carefully has the work been done that no less than 150 divisions were made; and a strong desire was expressed that it should be published in the Transactions of the Club, as the bank on either side will soon be covered with grass. During the walk to the Speech-House, the Rev. W. S. Symonds explained in a very lucid manner the position of the various beds of the Mountain-limestone and Coal-measures which were seen or passed over during the excursion. After dinner, Dr. Bird, of Cheltenham, who had resided in the forest for some years, read an interesting paper on the local History, Geology, and Botany of the district.—W. C. L.

ROYAL SOCIETY, *Thursday, 9th June,* 1864.—The reading and discussion of Professor Owen's first paper 'On the Cave of Bruniquel' occupied the entire evening. This cave is situated on the estate of the Vicomte de Lastic, in a limestone cliff, on the north side of the valley of the Aveyron, Dep. Tarne et Garonne, in the south-west of France. A collection of the remains found in this cavern having been offered to the Trustees of the British Museum by the Vicomte, Professor Owen visited the spot and reported on the contents already exhumed. The Trustees immediately decided upon the purchase of the collection offered, which was at once secured and brought away, and now forms a part of the National Museum. The collection comprises pieces of bones with rude carvings of heads of the horse and reindeer upon their surface, numberless weapons of bone and horn, flint flakes (of the pattern which occurs in nearly all the caverns of this period in Central and Southern France) thousands of remains of reindeer and other animals—extinct or partially extinct—(the bones indicating by their fractured condition that they had all been broken to obtain the marrow, and the horns cut to form weapons), and lastly, portions of ten human* skulls, the jaw of a child about five years of age, and the remains of an infant. These human remains, Professor Owen considers, were interred in the breccia of the cavern, before its consolidation by the stalagmite, when it consisted of dry loose earth mixed with bones, &c. From the absence of pottery, and from the nature of the animals found associated with the works

* Of the Præceltic type; one dolichocephalic.

of art and human remains, Professor Owen is of opinion that the latter will prove to be, perhaps, the oldest yet discovered.—Dr. Falconer spoke at great length on the various classes of cave-remains, but principally to point out the inaccuracy of Dr. Schmerling's descriptions of animals from the Liége caverns.—As the enumeration and description of the animals met with in the cavern at Bruniquel will form the subject of a future paper, Mr. John Evans, who had visited the cave, thought it would be unwise to discuss the question of the antiquity of the remains without such data.—Professor Busk described a cavern lately opened at Gibraltar from which parts of as many as thirty-five separate human remains had been found associated with works of art of all ages from the historic to the stone age, and with remains of Rhinoceros, Hyæna, and other animals extinct in Europe. Some of the human remains were very remarkable indeed, and would be shortly described.—Professor Huxley defended the Engis skull, upon which a doubt had been thrown by Dr. Falconer. He (Prof. H.) looked with distrust on the contemporaneity of bones buried in breccia—he considered there was *primâ facie* evidence that the human remains were newer.—Professor Owen defended the contemporaneity of the human and animal remains, and reasserted their antiquity; he believed the cavern had been inhabited for ages.—General Sabine (the Chairman) then summed up and returned thanks, and the meeting ended.

In a Report by M. Milne-Edwards, recently made to the French Academy, the following notices refer to Geology, and indicate so much important progress in the provinces and principal cities in France, that the record cannot fail to be interesting. It will also be useful to many readers of the Geological Magazine:—*Marseilles*: A medal to M. Coquand for researches on the Geology and Palæontology of the Province of Constantine (Algeria). Notice of a memoir by M. Matheron on the Tertiaries of Provence, and by M. Reynès on the boundaries of the Cretaceous rocks of the same province.—*Montpelier*: Gold medal to M. Gervais for his Palæontological researches.—*Dijon*: Notice of researches by M. Perrey on certain relations between earthquakes and the position of the moon, indicating tides in the interior of the earth.—*Toulouse*: Notes by M. Leymerie on the Geological Constitution of the Valley of the Ariége; and by M. Filhol on the Mineral Waters of the Pyrenees.—*Bordeaux*: Examination of the Biarritz Tertiaries by M. Gosselet.—*St. Etienne*: Memoir of the Sulphur-mines of Sicily by M. de la Bretoigne; on the granular Iron-ore of Audricourt, by M. Maussier; and on the Anthracite- and Coal-mines of the Sarthe and the Mayenne, by M. Dorlhac.—*Lyons*: Memoir on the Jura, by M. Fournet; and remarks on the influence of the miner on civilization, by the same author.—*Grenoble*: Researches by M. Lory on the Geology of the Alps.—*Metz*: Researches by M. Terquem on the Foraminifera of the Lias.—D. T. A.

The following Medals recently voted by the French Academy relate to Geological work:—Gold medal to M. Eudes-Deslongchamps for his Palæontological researches, and chiefly his work on *Teleosaurus*. Silver medal to M. Coquand for his work on the Geology of Algeria; to M. Bonissent for his work on the Geology of the Département de la Manche; and to M. Boucher de Perthes for his researches on the natural history of man in prehistoric times. A gold medal has also been voted by the Society for the Encouragement of National Industry to M. Alibert, for his discovery of Graphite in Siberia, magnificent specimens of which were shown in the Great International Exhibition of 1862.*—D. T. A.

CORRESPONDENCE.

To the Editors of the GEOLOGICAL MAGAZINE.

YOUR correspondent Col. Greenwood suggests an enquiry concerning rainless districts. I believe it is quite certain that the North of Africa and the whole of Asia Minor are subject to occasional rains, in a certain sense seasonal, though for the most part, and sometimes for more than one year at a time, in the greater portion of these wide tracks no rains fall. At any rate, there are no periodical rains; and it is rather in contradistinction to such districts, and to distinguish areas where there is no constant precipitation, than as an absolute proposition, that the expression is made use of. Col. Greenwood is no doubt aware that there are other tracts, especially that on the west side of the Andes, where rain is so excessively rare that the inhabitants would regard it as almost a miracle. I remember being told some years ago by a resident at Alicante, on the east coast of Spain, that there had been no rain in that district for more than twenty years. Since then there have been rainy seasons, and it is probable that small showers may have been forgotten; but there are local conditions in that neighbourhood very unfavourable to rain. Perhaps this explanation will satisfy your readers that it may be convenient, and in some sense correct, to call certain large areas 'rainless,' though rain occasionally falls on parts of them, and include others among provinces of autumn- or winter-rains, which are as dry as the former. Certainly Canada and Ireland would not be incorrectly regarded as excluded from earthquake-districts, though a shock now and then may be felt in either country.

D. T. ANSTED.

Impington Hall, Cambridge, August 6, 1864.

VISIT TO SELSEY. From Letter, Aug. 8, 1864.

'LAST week I spent a couple of days (or rather tides) at Selsey in examining some of the Quaternary deposits. They are very curious, but not easy of interpretation, though I had read Godwin-Austen's paper† before going there. I saw the Pholas holes in the Eocene beds, a privilege which fortune has seldom if ever granted, I believe,

* One of the finest specimens of Siberian Graphite brought over by M. Alibert is now placed in the British Museum.

† Geol. Soc. Journ., vol. xiii. p. 48.

to a geologist, they being usually covered up by sand. I also saw, in the Chichester Museum, a rolled elephant's tooth, found somewhere near Selsey, which I take to belong to *E. meridionalis.* I believe the common Elephant of these deposits to be *E. antiquus.* This association of species agrees with that in the Forest-bed at Cromer. I dare say you know that there is a great part of a very fine individual of *E. antiquus* in the Chichester Museum.—Yours, &c.,

O. FISHER.

MALTESE BONE-CAVES. Extract from Letter, dated August 4, 1864, from Dr. A. LEITH ADAMS, Surg. H.M.S. 22nd Reg., F.G.S., &c.

'NEXT winter I mean to work especially at the *Elephas Melitensis,* and draw up a concise account of the deposits in which the remains have been found, together with a complete summary of all the specimens of the animal yet discovered. I have in my own possession a goodly collection already, mostly brought together by dint of very hard work, comprising some eight or nine specimens of teeth of different individuals; an upper jaw with teeth in place; portion of a tusk, 8 inches long by $6\frac{1}{4}$ in greatest circumference, composed of beautiful ivory; vertebræ; a scapula; fragments of long bones, &c. No doubt these islands (Malta and Gozo) have been re-elevated. We find all their large Mammalia, such as the *Hippopotamus,* &c., either in breccias, in fissures, or in stony soils at low levels in hollows and depressions, where, from the subangular fragments (many scored deeply, and a few well-rounded and even polished, are distributed throughout the red earth in gaps and hollows, the bigger stones being at the bottom), it is clear that in all probability they had been washed by the sea downwards as the land was rising or sinking. I look to the situations of the alluvial gravels as significant; more especially as the denudation of the soil is complete everywhere on slopes; and, excepting in hollows and sheltered nooks, there is certainly no alluvial deposit in the island (I mean *in sitû*: man has carried it to any height).

'No doubt our Elephant is distinct; my collection shows that; as I have teeth of all ages almost. They are much fractured, however, and have evidently been knocked about a good deal. One skeleton was found *in sitû*; that is, so far so that I collected parts from the

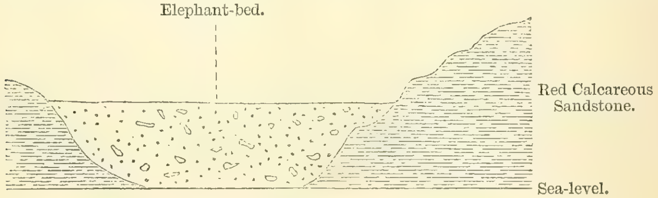


Fig. 1.

tail-bones to the skull on a cutting along the face of a bank about three yards in length. The abundant remains of the animal in one hollow, of the above shape (fig. 1), in the "Calcareous Sandstone" are quite extraordinary. Remains of as many as seven individuals were found at divers levels on the face of the bank, which is about 30 feet in perpendicular height, and about 100 feet in its greatest breadth. Several shells (all, I think, belong to *Helix*) were also found. I have sent them to Mr. Woodward. From the manner in which this gap is filled up with red earth and rounded stones, there is every likelihood that all had been washed from higher lands; the bones are very fragmentary. There was no trace of man here; but a stone implement was discovered forty years ago in a fissure filled with clay, and a very clear description of the discovery has been preserved.

'I think I mentioned in a former letter that I had discovered a cave on the coast of Malta containing abundant remains of the fossil *Myoxus* I had formerly described from another cavern in the neighbourhood, containing also *Hippopotamus* and Land-shells. The vein-cavern is situated on the same terrace-cliff with the last-named, and is firmly packed with red earth and stalactite, so that it requires a great amount of labour to clear it out. I have penetrated only about 6 feet inwards, making a section 14 feet high and about 8 feet square. I give a rough sketch of the deposits (fig. 2). I wish very much

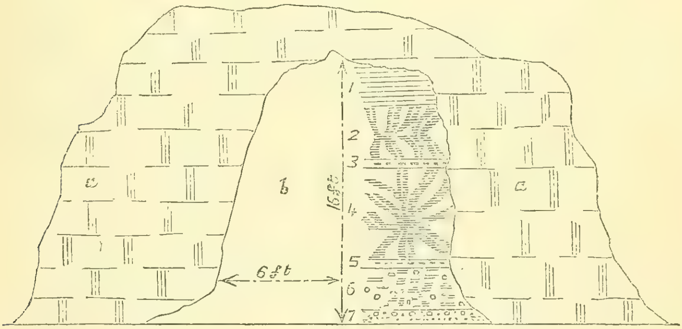


Fig. 2.

1. Stalactite. 2. Red loam and stalactite.
3. Remains of *Myoxus Melitensis*, Birds' Bones; with *Helix*, *Clausilia*, and *Bulimus* (all existing shells).
4. Red loam and stalactite. 5. Yellow loam.
6. Red loam, with a few nodules of stalactite, and abundant remains of a Rodent (undetermined).
7. White stalagmite, containing a tooth of *Carcharias megalodon* and Fish-bones.
a a. Lower Limestone of Malta. *b*. Undisturbed portion of the cave.

to clear the whole out, as I feel confident that there will be found some interesting remains; but the expense is more than I can afford. Possibly the cavern runs many yards inwards; and nothing could be more suitable for the preservation of organic remains; and the fact of finding Fish-bones and the serrated tooth of the great Shark (common in the Calcareous Sandstone) on the floor would point to something like human occupation. If I could obtain a grant from any of the Museums or Societies, the cavern might be cleared out, also the other mentioned gap, where I have found so many remains of the little Elephant; I believe that £30 would do for the two; of course the fossils would be sent home, and a full description of the proceedings.'

THE PRESENT STATE OF THE BRIDLINGTON CRAG.

To the Editors of THE GEOLOGICAL MAGAZINE.

MR. S. P. WOODWARD has stated, in his paper on the Bridlington Crag, upon the authority of Mr. William Bean, of Scarborough, that 'the whole mass has been entirely removed or built over,' and that 'the only remaining chance of obtaining the fossils consists of dredging in the harbour.' I beg to state that, during the prevalence of south-east winds, large tracts of the Bridlington Crag are exposed by the removal of the sand and gravel which generally lie over it from low to high water-mark, leaving it bare sometimes for weeks together. At other times, however, it remains covered up beneath thousands of tons of sand and gravel; and I have waited for years, hoping the sea would remove the surface, but it did not do so. At length, in January last the tide laid bare about 150 yards of the Crag for nearly a fortnight, and I collected a good series of fossil shells, &c. Only the upper portion of the deposit immediately under the cliff has been walled up; all the rest can be seen at intervals when exposed by the sea between tide-marks. I send you a Bear's tooth which was obtained from the Bridlington Crag.*—Yours, &c. EDWARD TINDALL.

Old Guildhall, Bridlington, 24th July, 1864.

NOTE FROM MR. S. P. WOODWARD, F.G.S., &c. &c., ON THE BRIDLINGTON CRAG.

IN my paper last month, *Montacuta bidentata* is mentioned as a Bridlington Fossil in Dr. Bowerbank's collection, on the authority of Professor Edward Forbes. I have just obtained the very specimen, and it is labelled on the *back* of the tablet 'Nar Valley' (Norfolk), where it was found by Mr. C. B. Rose.—S. P. W.

MISCELLANEOUS.

DISCOVERY OF AN AËROLITE, AND VISIT TO A PETRIFIED FOREST IN NORTHERN QUEENSLAND. — At the monthly meeting of the Queensland Philosophical Society, on the 2nd of February last, Mr. Le Gould read a paper entitled 'Geographical and Geological Observations in Northern Queensland.' We extract the following:—

Mr. Le Gould says, 'When two days' march beyond the Isaacs, a beautiful stream, and the first branch of the Mackenzie River, passing along a rocky valley, covered with large ferns and some good-sized trees growing about, I came upon a large gum-tree,

* The tooth referred to is a canine tooth of the Brown Bear (*Ursus arctos*), hitherto only obtained from the fens of Cambridgeshire, &c.—EDIT.

divested of all its bark and leaves, which lay across my track. It had been sharply broken about five or six feet from the ground, through its base, which was three or four feet in diameter. I wondered what could have broken so huge a tree in so sharp a manner, as it had not the appearance of having been struck by lightning. I dismounted to examine it, and found a great bruise in the trunk. I proceeded to search the locality, and about fifty or sixty yards away saw something which appeared like a large cannon-ball. My surprise was great, believing that no artillery of such a calibre had ever been so far inland. On inspection it proved to be an Aërolite. It was of a dark metallic colour, extremely hard, and about ten inches in diameter; in fact, it very closely resembled a ten-inch shot, and was about the same weight. It was perfectly round, except that one side was slightly flattened; its surface was extremely smooth, and very slightly perforated. The extraordinary appearance of the tree was now clearly accounted for in my mind; it must have been struck by the Aërolite on its downward passage to the earth. I regret that my limited means of transit did not permit me to bring this extraordinary phenomenon to Brisbane for this society; but my next visit may enable me to do so, as I have planted it for that purpose.

'The following day I came upon a complete petrified forest, which I found, by the time I got through it, to be nearly sixty miles in extent. I have traced whole trees fifty or sixty feet in length through this forest, with their limbs and branches perfectly visible, and their trunks varying from twelve to twenty inches in diameter, imbedded in the shale and sandstone formation peculiar to this district. Although these fossil trees are completely silicified, they still preserve their original appearance, except that many of them are somewhat flattened, the result of the pressure which they have sustained. The living trees of this part are chiefly bricklow, myall, sandalwood, ironbark, and a variety of other hard woods.'—*Queensland Daily Guardian*, 16th February.

The Nephrite of New Zealand.—Professor Hochstetter communicated the following to the Vienna Imperial Academy of Sciences on May 12th:—This mineral, held in high esteem among the natives as a material for weapons, tools, and various ornamental objects, occurs exclusively on the west coast of the South Island, which is called 'Te Wahi Pooramoo,' signifying 'the place of the green stone.' It appears generally in the form of pebbles in river-beds and on the sea-shore; it is, however, said to occur also in masses in the vicinity of considerable veins of serpentine. The natives distinguish by name a great number of varieties, different in hardness, colour, and translucence, which may be distributed in two groups:—A. Of intense green (generally leek-green), more or less translucent, with a hardness between that of felspar and quartz; compact, not schistose. B. Of less value than the former; this is analogous in physical properties and chemical composition to M. Damour's 'Jade blanc,' from the East, represented by the formula $\dot{R}\ddot{S}$ (proportion of oxygen $=1:2$), and probably belonging to the family of the Amphiboles.

The group A offers no analogy with the same mineralogist's 'Jade vert,' or 'Jadéite,' from China, the chemical formula of which is $3(\dot{N}a\ \dot{C}a\ \dot{M}g\ \dot{F}e) + 2\dddot{A}l^2 + 9\ddot{S}i$. The examination of two conspicuous varieties, examined in Dr. Fehling's laboratory at Stuttgart, has given the following results :—*a* ('Tangiwaii'), translucent ; structure, scaly laminated ; hardness between calc-spar and felspar ; specific gravity 2·61 ; infusible before the blowpipe ; chemical formula $\dddot{A}l^2\ddot{S}i^3 + 11(\dot{M}g\ \dot{C}a\ \dot{F}e\ \dot{K})\ddot{S}i + \dot{H}$. *b* ('Kawa-Kawa'), translucent at edges ; scaly laminated ; between fluor-spar and quartz in hardness ; specific gravity, 3·02 ; fused with difficulty before blowpipe ; chemical formula $\dddot{A}l^2\ddot{S}i^2 + 5(\dot{M}g\ \dot{F}e\ \dot{K})\ddot{S}i + \dot{H}$. By calculating these analytical results according to the theory of polymeric isomorphism, the general formula $\dot{R}^2\ddot{S}i^3$, with the proportion of oxygen = 1 : 3 (as in steatite and meerschaum) is obtained. COUNT M.

GEOLOGICAL EXAMINATION UNDER THE SCIENCE AND ART DEPARTMENT.—The Science and Art Department of the Committee of Council on Education, as a part of their scheme for aiding the Working Classes in scientific instruction, held examinations in the Applied, Physical, and Natural Sciences, in May last, at the several localities where classes had been preparing in compliance with the requisite conditions. The chief centres of examination in Geology were Stroud, Netherton, Holywood and Belfast, Bristol, Waterford, Liverpool, Glasgow, Cheltenham, Salford, Wigan, and Banbridge. The examiner was Prof. Ramsay, F.R.S., G.S. The character of the examination may be judged of from the following selected questions from the examination-paper of May 23rd :—

Name the *substances* of *economic value* extracted from the Carboniferous series. (12.)

Explain the reason of the occurrence of different *qualities* of *spring-waters* or of *river-waters*, with or without examples. (12.)

In what British formation do the remains of *terrestrial quadrupeds* first occur? (10.)

Name some of the chief *building stones* of Britain, state their general mineralogical composition, and the *formations* to which they belong. (22.)

Explain the theory of *slaty cleavage*. (24.)

Name the chief British *formations* from which ores of iron are obtained for economic purposes. (18.)

Name the *genera of Crustacea* (*exclusive of Trilobites*) found in the formations that range between the base of the *Lingula-flags* and the top of the *Upper Silurian strata*. (20.)

Explain the connection of three or four *geological formations* with the *agricultural* or *pastoral* state of the country in which they lie. (20.)

Name some of the chief leading points in the *grouping of fossils* that distinguish the *Palæozoic* rocks from those of *Mesozoic* (Secondary) age. (20.)

What is the reason that the strata of *coal-fields* frequently lie in *basin-shaped* curves? (18.)

What *stratified formations* in the British islands are associated with *true volcanic rocks*? and name the districts in which these volcanic rocks are found. (20.)

The results have now been published. There were 164 candidates: of these, 15 gained 1st class prizes; 21 2nd class, 34 3rd class, 35 were honourably mentioned, 32 merely passed the examination, 27 failed.—R. T.

THE

GEOLOGICAL MAGAZINE.

No. IV.—OCTOBER 1864.

ORIGINAL ARTICLES.

I. On the Nature and Origin of Banded Flints.

By S. P. Woodward, F.G.S.

[Plates VII. and VIII.]

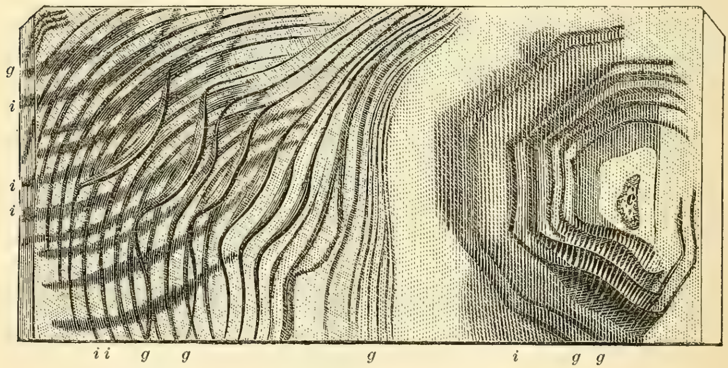
THE idler picking up pebbles on the sea-shore, and the geologist breaking stones in a gravel-pit, frequently meet with banded flints, which display their markings like a painting on the smoothly fractured internal surface, or, in other cases, in the form of lines more or less deeply engraved on the exterior by the action of the weather. The bands seen in section are often accompanied by discolorations of fanciful shape, in which imaginative people find pictures of their friends and others.

In the British Museum there are about fifty of these flints, chiefly Sussex specimens, from the collections of Dr. Mantell and Mr. Dixon; there are also examples from Germany and Poland; and they are most likely to be found wherever chalk-flint gravel occurs. Large numbers of curious gravel-flints have been collected by Mr. John King, of Norwich, Mr. J. W. Flower, of Croydon, and Dr. Bowerbank. But the most extensive and instructive collection is that of Mr. Wetherell, of Highgate, to whom we are indebted for the use of most of the flints now figured.

The origin of these flints has been a puzzle to stone-breakers for the last fifty years. Those with the furrowed surface were considered by Parkinson to be the wrinkled and petrified remains of the peduncle of the *Anatifa*, or Duck-barnacle. In the third volume of the 'Organic Remains,' (p. 241, pl. 16, fig. 18) he figures and describes such a flint as that represented in our Pl. VII., fig. 7, but quite irregular in its form. In the first Mantellian collection are two flints labelled in accordance with this view; but there is no reason to suppose their learned owner latterly entertained such a belief. It is, however, well-known that Dr. Bowerbank considers them fossilized sponges,—an opinion which few will share with him. When slit and polished, the banded portions shew no microscopic peculiarity to distinguish them from the adjacent unbanded flint, and no organic structure save where they invade the texture of a Sponge, or envelope Foraminifera, so-called Xanthidia, and other minute organisms with their hazy shroud. I believe that I can now offer conclusive evidence that the coloured bands in flints are *produced by infiltration*, as taught by the late Professor Henslow; a view in which Mr. Wetherell coincides on the proof afforded by his own specimens.

All kinds of siliceous pebbles derived from gravel-beds are more or less affected by agencies to which those beds have been subjected, and especially they are liable to be stained by the penetration of water charged with iron or manganese, which has produced coloured zones and dendritic infiltrations in the most compact jaspers and agates as well as in the more permeable flints derived from the waste of the Chalk-formation.

The well-known pebbles of Egyptian jasper, when cut and polished, have a dark border of ochre and umber; the centre creamy, with one or many sets of parallel brown lines, encroaching upon and obliterating their precursors like successive waves. In the 'Crystallography and Mineralogy' of MM. Mitchell and Tennant (p. 509) there is a representation of one of the Egyptian jaspers in the British Museum, which has been considered to resemble the portraits of Chaucer! We here represent one of the mocha-stones in the same collection. These were probably formed, like other agates, in the vesicular cavities



Mocha-stone, in the British Museum; polished section, nat. size.

of trap-rocks; but, having been set free by the breaking up and decomposition of their matrix, they contributed to form the beds of gravel from which they are now obtained. The stone is pellucid and stained with at least three sets of ferruginous lines and zones. Of these one set (*g*) evidently marks the successive stages of *endogenous* formation, as proved by the small drusy cavity remaining in the centre (*c*). They have been rendered visible by the infiltration of iron-oxide in waves, not coinciding with the layers of structure, but crossing them in various directions (*i*).

That some important change in the physical condition of the alternate layers has been produced by these infiltrations cannot be doubted, for in the case of our own banded flints the laminæ are acted upon unequally by the weather. By those, however, who are familiar with the molecular changes produceable in mineral bodies this peculiarity is considered of less account.

Sometimes the pebbles of banded flint are small, and evidently formed by the breaking up and bouldering of larger flints, as in the example represented by fig. 2, Pl. VII.; and it is a rare thing to find a flint of any considerable size banded throughout with concentric laminæ of colour, like the agates and Egyptian pebbles. The bands are for the most part local, and their form and direction bear no relation to the outline of the entire flint.

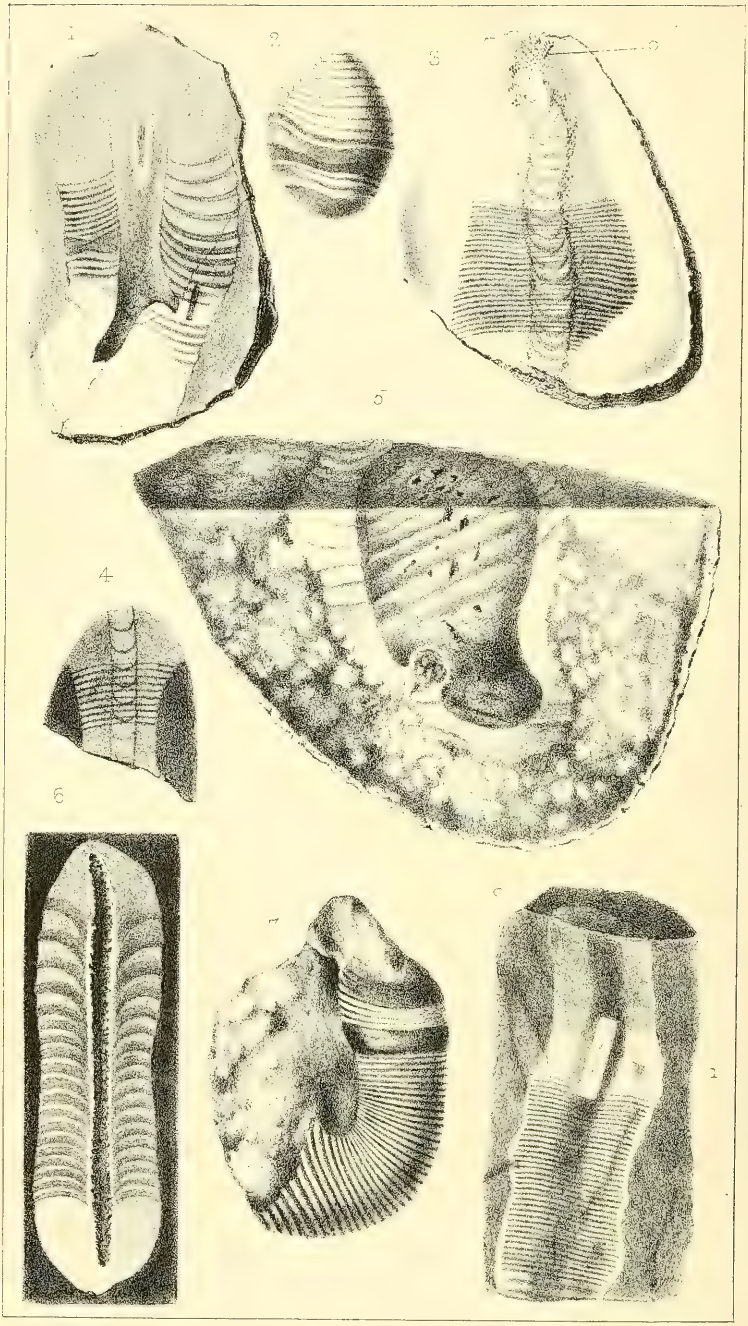
The newly broken black flints from the Chalk-pits near Gravesend are remarkable for the frequency of discoloured spots and markings before referred to, especially where a Sponge or other imbedded substance has afforded easier access to the bleaching agency. These light clouds are often zoned with dark lines which become fewer and further apart at each end of the discoloured tract, and when there is an axis running through it the bands are curved and sometimes crescentic as in fig. 6, Pl. VII. The bands appear to be *convex* in the direction from which the infiltration has proceeded. The axis of the banded tract is often merely a dark line, as in fig. 8, Pl. VII., where it incloses an angular fragment of the fibrous shell of *Inoceramus*; or it may be an open tube, drused with minute crystals, as in fig. 6; or a tube filled up by a succession of siliceous deposits traversed by the bands of infiltration, like the surrounding flint, as in figs. 4 and 3. In fig. 3 the upper part of the tube is filled with strings of oviform bodies (*o*) like those figured and described by Mr. Wetherell in the Mag. Nat. Hist.

Mr. Wetherell's cabinet contains several banded flints with a spongeous axis, besides the four examples now figured. One of them is a funnel-shaped Ventriculite (Pl. VIII., fig. 1). Another, more slender, had two roots which have left cavities passing to the outside of the flint (Pl. VII., fig. 1). The small pebble, before-mentioned (Pl. VII., fig. 2), contains a segment of a third form of Sponge, through which the bands pass unconcerned; and the critical example (Pl. VII., fig. 5) exhibits both in long and cross section a well-defined sponge, permeated by canals like the stem of a *Siphonia*, which appears to be equally unaffected by the passage of the coloured zones.

Equally conclusive of the inorganic origin of the banded tracts in flints are the specimens in which they are connected with ancient fractures formed while yet *in sitû* in the Chalk. Flints thus broken, and subsequently re-cemented together, have been frequently noticed. In the one represented by Pl. VIII., fig. 2, there is a minute displacement, visible externally at either end (x). The flint is broken along the line of fissure, and shews the side of the vein of white flint filling it, while a second fracture at right angles shews the relation of the banded infiltration. Fig. 3 is a similar flint, broken so as to shew on each side, the banded tract bordering the plate of cementing flint, and also along the plane of this old fracture. Waterworn pebbles formed from flints of this description have been found by Mr. Wetherell in the gravel-pits of Muswell Hill.

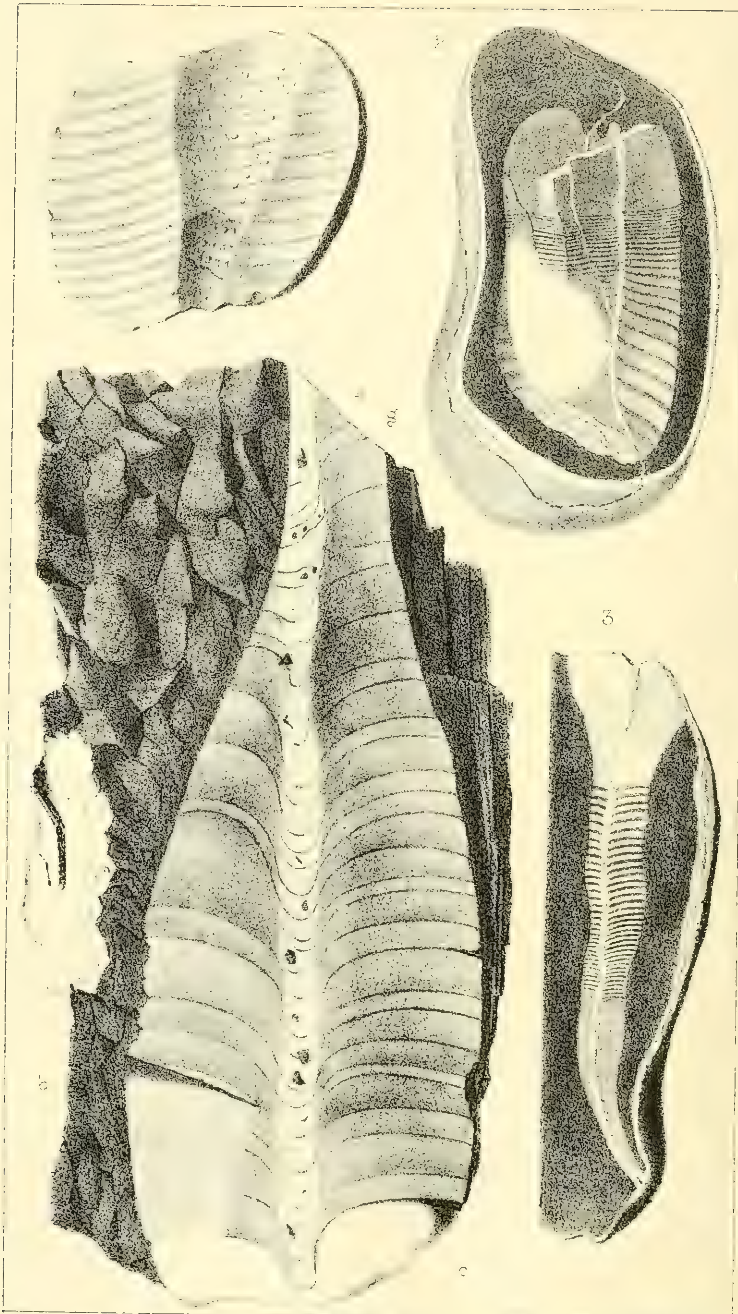
I take this opportunity to give some account of another banded flint, which, though outwardly resembling some of those already mentioned, has had a very different origin. The specimen represented by Pl. VIII., fig. 4, is part of a vein from a fissure in the Chalk at Dover, and was presented to the British Museum in March 1862, by Mr. John D. Richardson, one of the contractors for the extensive works then in progress for increasing the fortifications on the west face of Dover Citadel. The Chalk-pits in some parts of England, as in Hampshire, exhibit more than elsewhere the phenomenon of inclined and vertical fissures filled with flint, which consists of two or more laminæ separated partially by a central layer of chalky or ferruginous earth. These veins establish the fact of the deposition of flint by water flowing through it, like mineral springs, after the consolidation and movement of the Chalk. The fissure at Dover appears to be filled up chiefly with Chalk, and only in one horizon by a grey siliceous deposit, which has re-united a broken course of flints. It contains minute angular fragments of the black flint that seem to have occasionally fallen in and become imbedded. The current flowing through the fissure gave to its contents a laminated arrangement, and formed a deep central groove which appears to have been continuous in all the deposited layers, chalk and flint alike.

Mr. Richardson states in his letter that the vein of banded flint was met with in cutting through the Chalk-ridge that runs parallel with the coast, and about opposite the Shakespear



S. P. W. del. M & N Hanhart imp De Wilde lith

BANDED FLINTS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Cliff. The surface was much varied with 'pot-holes,' ranging from 5 feet wide and 20 feet deep to one of 30 feet across and 40 feet deep. The Chalk, where not disturbed, was very solid, with layers of flints about 5 feet apart. The vein with banded flint was slightly inclined with a drop, on the down-cast side, of about 2 feet. Eight to ten feet lower than the banded flint, and about 25 feet from the surface, there was a course of very compact yellowish chalk, about 3 feet thick and as hard as Portland stone; it was perforated with holes, as if by the *Pholas*, 1–1½ inches wide, through which water seems to have percolated; and 10 feet below this was a layer of flint not more than ¼ to ½ inch thick, as evenly laid and horizontal as a flag-paving, extending for more than a hundred feet through the cutting.

EXPLANATION OF PLATES VII. AND VIII.

Plate VII.

Fig. 1. Broken section of flint containing a Ventriculite; the upper part solid, but the branched root forming cavities in the stone. (Mr. Wetherell.)

2. Small flint pebble containing a segment of a fossil sponge (*Cephalites*), still showing the labyrinthic wall and angular meshes of sponge-fibre. (Muswell Hill, Mr. Wetherell.)

3. Thin slice of a translucent yellow flint, containing a flexuous tube, filled up with curved deposits of similar flint, and containing strings of 'oviform bodies' (*o*) in its upper part. (Finchley, Mr. Wetherell.)

4. Small fragment of black flint, with similar tube and bands. (Finchley, Mr. Wetherell.)

5. Section of pebble, containing a Sponge enveloped by an irregular discoloured space, through which and the Sponge itself the bands of subsequent infiltration have passed. (Kent, Mr. Wetherell.)

6. Fractured surface of a small black flint, with a tubular drusy cavity. bordered by coloured bands. (British Museum.)

7. Flint pebble, much waterworn, and corroded by the weather; one portion showing ordinary flint; the other corrugated and resembling a Hamite. (Muswell Hill, Mr. Wetherell.)

8. Polished section of a black Chalk-flint, from Gravesend, presented to the British Museum by the Rev. Norman Glass. The axis of the banded portion is stained with dark streaks, and contains an angular fragment of *Inoceramus* (*i*).

Plate VIII.

Fig. 1. Broken section of a flint-pebble, containing a Ventriculite, the whole zoned with coloured bands. (Finchley, Mr. Wetherell.)

2. Black flint, with thin plate or vein of white flint running through it, bordered on each side by a discoloured and banded space. (Finchley, Mr. Wetherell.)

3. Similar flint, with more simple fracture. (Finchley, Mr. Wetherell.)

4. Fragment of black flint from Dover, containing vein of banded flint and Chalk. *b*. Black flint. *g*. Grey flint. *c*. Chalk.

II. On a Section of the Lower Chalk near Ely.*

By Harry Seeley, F.G.S., of the Woodwardian Museum, Cambridge.

ELY stands on a hill extending somewhat beyond the city as a ridge to the north; and a mile north-east of the Cathedral, at a spot variously named Roslyn or Roswell Hole, its flank is reached at a well-known pit, where the Kimmeridge Clay is dug for mending the river-banks; and the excavation shows some Boulder-clay and Chalk. What the relative positions and relations of these latter deposits may be has been long disputed; some holding that the Chalk is there *in sitû*, let down by a fault; others maintaining that it is merely such a drifted mass, included in the Boulder-clay, as those which form so strange a feature in the Drift of the Norfolk Coast.† Professor Sedgwick has long been convinced that this latter view is a groundless hypothesis; for when the railway was made from Ely to Lynn, it exposed at about 100 yards off a section showing Kimmeridge Clay and Chalk side by side, and Boulder-clay between them; so the conclusion inevitably followed that there had been a great fault, letting down the Chalk for at least two or three hundred feet. This section was still to be seen in the spring of 1860, when I examined it. The faulted faces of both stratified formations were perfectly erect, parted by a column of Boulder-clay, some twelve feet wide, which from a distance looked like a basaltic dyke.

Such were the known stratigraphical phenomena and inferences up to August, 1862, when, visiting the Roswell Hole, I discovered a section which, as exhibiting structures and relations not otherwise seen in this part of England, is here described.

The pit is in form a long horse-shoe, the whole north side and curve of which offer an admirable exhibition of Kimmeridge Clay. The south side shows at its terminal end Chalk, and at the part where it joins the curve characteristic Boulder-clay; and this is the side of the pit which claims special description. Though Ely stands on a slight rise, the country around is wonderfully flat; and though there is no difficulty in detecting the Shanklin Sands, an absence of escarpments renders it difficult in a country much covered with peat to detect even a rock so

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* This paper was read, February 16, 1863, before the Cambridge Philosophical Society.

† The figures given in Sir C. Lyell's 'Elements,' p. 129, are not included pinnacles of Chalk, but only reconstructed chalky drift, full of all sorts of rocks. Last summer I found a grand boulder SE. of Cromer, 180 feet long, and in shape like half a pear, fairly in the Boulder-clay. It was of soft Chalk; and the flints were cracked, but less than those of Freshwater.

marked as Chalk. Hence it was that well-practised eyes long overlooked the following succession, which indeed was probably only recently exposed. The east end of the south side of the pit is lower in level than the other parts; and here comes on the Chalk, pale-yellowish and sandy, showing, in its thickness of about 12 feet, numberless little joints, as though it had been shaken until there was not a whole block in it. I do not think, however, that it has been shaken. The upper foot or two is rubbly, and has a reconstructed aspect, due, I think, to the action of receding waters; but in the lower part the bed is undisturbed; and here lines of colour run in various courses, which are planes of division in the Chalk. Some are quite horizontal; some highly inclined, and dipping at every angle west and east. The hammer discovers the innumerable *Pernæ* (usually called *Inocerami*), with which the bed abounds, not always resting flat, as in other Chalk, but often inclined on end at an angle of 50 degrees; and specimens of these, as well as many other fossils, often occur between the very planes dividing the rock. This is so extremely characteristic, that I regard it as an instance of false-bedding in the Chalk. A small piece of this, as seen on February 10, 1863, I have drawn in fig. 1, which represents the lower 6 feet of the section, and shows such

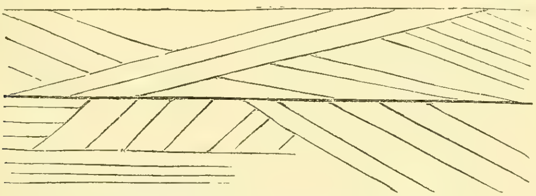

Fig. 1. Section (about 18 feet long) of the lower 6 feet of the Chalk (12 feet exposed) at Roswell Hole, near Ely; shewing false-bedding.

a complexity of false-bedding as would indicate frequent changes of powerful currents, and probably near proximity to land and

Fig. 2. Diagram-section shewing opposite dips in the Chalk, due to cross-stratification, at Roswell Hole.

a shallow sea. In another part of the cutting there was a section (fig. 2) at right angles to fig. 1, which showed still further evidence of false-bedding, in that the planes below the line at the top of fig. 1 dip south, while those above it dip north. These strata are low down in the Lower Chalk, and hold *Avicula gryphæoides* and *Pecten Beaveri*.

Since discovering this section, I have met with another instance of false-bedding on a larger scale, and not so complicated, in the Lower Chalk of Cherry-Hinton, near Cambridge. This is shown in fig. 3. Perhaps such sections are to be looked for

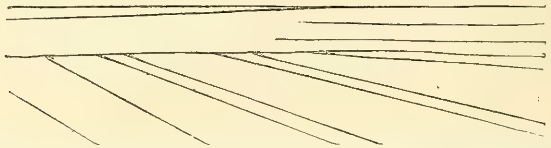

Fig. 3. Section (60 feet long and 10 feet high) in the Lower Chalk of Cherry-Hinton, shewing false-bedding. (In another part of the pit, one seam at twelve yards from its commencement is one foot thick, and four feet at six yards further.)

in all sandy and argillaceous Chalk; for the presence of such impurities must always lend a probability to its having been accumulated near to land.

In this part of England the Lower Chalk is thin, and at Cherry-Hinton not more than 80 feet thick. There, at 30 feet from the base, it is as hard when wet as an Oolite limestone, splitting into massive blocks. I have seen from that place halves of Sea-urchins separated by slips; sometimes in *Holaster* the anus and mouth slipped together. Whether such shiftings are due to earthquakes I think doubtful, and regard them as the result of contraction.

Here the Chalk is porous, and water soaks through it; but Professor Kingsley tells me that chalk becomes impervious when 'puddled'; so that clear ponds of water, full all the year round, are formed on the chalk-hills by merely digging and well puddling a hole. Now it appears to me that at the time of deposition, the sea, washing the fine chalky mud about in this cross-stratification, or even enough to embed fishes, must have effectually performed on a large scale this operation that the farmer calls puddling. And if so, it would appear highly probable that the Chalk when deposited was a rock nearly as impervious as clay. A very simple test applied to water which has soaked through chalk shows that it has dissolved part of the carbonate of lime: that is, it has rendered it more porous than it was before. Of course the next water that passes through will make it more porous still; and to the water which soaked through before either it must have been even less pervious. Therefore I would suggest that the open absorbent character of

Chalk is probably to a great extent due to the interstitial atoms having been dissolved and removed by the solvent action of water passing through its mass.

If it be granted that this Chalk has been formed in a comparatively shallow sea, it must be a matter of some interest to compare its fauna with that of Chalk in other localities, presumed to have had deeper water. Subjoined is such a list, from materials in the Woodwardian Museum:—

Ventriculites radiatus; Swaffham.
V. quincuncialis (?); Cherry-Hinton.
Cephalites; Swaffham.
Micrabacia coronula; Burwell.
Pentacrinus Fittoni; Burwell.
Cidaris Bowerbankii; Cherry-Hinton.
C. sulcata; Cherry-Hinton.
Discoidea cylindrica; Cherry-Hinton, Hunstanton.
D. subuculus; Hunstanton.
Hemiaster; Burwell.
Holaster subglobosus; Cherry-Hinton.
H. Trecensis; Cherry-Hinton.
Serpula rustica; Burwell.
Enoploclytia Imagei; Burwell, Cherry-Hinton.
E. brevimana; Isleham, Burwell.
Glyphæa cretacea; Cherry-Hinton.
Two unnamed Brachyura; Burwell, Cherry-Hinton.
Rhynchonella Mantelliana; Cherry-Hinton, Burwell.
Terebratulina striata; Reach, Cherry-Hinton.
Terebratula squamosa; Burwell, Isleham.
T. biplicata; Cherry-Hinton, Burwell, Hunstanton.
Ostrea curvirostris; Burwell.
O. frons; Burwell.
Pecten orbicularis; Burwell.
P. Marrotianus (?); Burwell.
P. Beaveri; Burwell, Cherry-Hinton.
Lima globosa; Burwell, Cherry-Hinton.
L. parallela; Burwell.
L. aspera; Burwell.
Plicatula inflata; Burwell.
Avicula gryphæoides; Burwell, Reach, Fen-Ditton.
Perna Crispii, var.; Ely.
Pholadomya decussata; Burwell.
Teredo amphisbæna; Burwell.
Cerithium ornatissimum; Burwell.
C. Gallicum, var.; Burwell.
Scalaria striato-costata; Burwell.
Scaphites æqualis; Burwell.
Turrilites Scheuchzerianus; Burwell, Cherry-Hinton.
T. tuberculatus; Reach.
Ammonites Sussexiensis; Reach.
A. Rothomagensis; Reach, Isleham.
A. varians; Reach.
A. Icenicus; Burwell.
A. planulatus; Burwell.
A. Mantelli; Reach.
A. navicularis; Burwell.
Nautilus elegans; Isleham.
Belemnitella plena; Burwell.
Ichthyosaurus campylodon; Burwell.
Rhaphiosaurus; Cherry-Hinton.
Pterodactylus; Cherry-Hinton.

Besides these, there are a few new species, especially some Gasteropods. Perhaps the most striking feature in the list is the number of *Encephala* and *Crustacea*; and I notice nothing that would suggest conclusions as to the depth they lived in, contrary to the physical consideration; but to say they supported the hypothesis of a shallow sea would assert too much. As a group, they differ but little from other Lower Chalk collections, and offer little or no ground for assuming theories as to relative depth in the Lower-Chalk Ocean.

At Cherry-Hinton the Chalk-pit is about 30 feet above the Greensand. At Madingley there is a chalk-pit much lower in the Chalk; and in this locality the lower beds are less compact, have a slightly marly character, and contain *Rhynchonella lineolata.* In this pit there are lines of bedding which dip south; and here the Chalk forms a hill overlooking the whole Fen-country; the Greensand cropping out a few yards below, and a great plane of Gault extending beyond to the north. The hills of the Lower Chalk are all low; Cherry-Hinton Gog-Magog, which is the highest, being only some 200 feet; and all the higher part of this is of Upper Chalk, which formerly, full of flints, was also seen in the Cherry-Hinton pit, but has been quarried away. The Lower Chalk contains some small fragments of vegetable remains, but no plant more definite than the dubious *Chondrites.* I have never seen any extraneous specimens excepting a phosphatic nodule from Reach, derived from the Upper Greensand; and it fortunately is a phosphatized *Cucullæa,* of a different species to any yet detected in the Cambridge district. The Gasteropods have come chiefly from Burwell. Crustacea occur indifferently at Burwell and Cherry-Hinton; as do Cephalopods, though these are much more abundant at Burwell than anywhere else.

III. On the Laurentian Formation: its Mineral Constitution, its Geographical Distribution, and its Residuary Elements of Life. By J. J. Bigsby, M.D., F.G.S., formerly British Secretary to the Canadian Boundary-Commission.

PART I.

It is intended in this paper to present a general outline of the Laurentian Formation under the heads mentioned in the above title; dwelling principally on the latter clause, its residuary elements of life, or, in other words, on those mineral substances, contained within it, which at some earlier period have been the constituents of organic bodies. This formation, or system of rocks, which have been called 'fundamental,' has of late years very generally received the name of 'Laurentian,' a geographical denomination, taken from the country (Laurentide or Laurentian Mountains) in which it has been well studied, and where it exists in vast force. An assemblage of metamorphosed rocks may usually be considered 'Laurentian,' when over great spaces (with or without the intervention of the

Huronian and Cambrian rocks*) it underlies discordantly beds more or less fossiliferous, named 'Primordial' in Bohemia, 'Lingula-flags' in Wales, 'Potsdam Sandstone' in North America. Such is its position in the crust of the earth. To Sir William Edmond Logan belongs the honour of having distinctly announced the peculiar significance of the 'Laurentian :' geologists not having recognized the fact, that it consists of altered sediments, once possibly rich with organisms, and still leaving us far from the beginning of life. For the purpose of study it will be well to consider the Canadas as possessing the type of this formation ; for it there occupies a space of 200,000 square miles, in ample development (40,000 feet thick); and it has there been subjected for many years to the systematic examination of observers of the highest qualifications; mainly at the expense of the Canadian people.†

Sir W. E. Logan says of these Laurentian or oldest sedimentary rocks : 'They are altered to a highly crystalline condition, and are composed of felspathic rocks, interstratified with important masses of limestone and quartzite. Great vertical thicknesses of the series are composed of gneiss containing chiefly orthoclase or potash-felspar ; while other great portions are destitute of quartz and composed chiefly of a lime-soda-felspar, varying in composition from andesine to anorthite,‡ and associated with pyroxene or hypersthene. This rock,' he adds, 'we shall distinguish by the name of anorthosite.' The chief divisions then, without reference to any order of superposition, are—

1. Orthoclase-gneiss, sometimes granitoid ; with quartzite, hornblendic and micaceous schists, pyroxene, and garnet-rock.

2. White crystalline limestone, and dolomites, in numerous thick beds, containing serpentine, pyroxene, hornblende, mica, graphite, iron-ores, apatite, fluor, &c., and interstratified with bands of gneiss.

3. Lime-felspar-rock, or anorthosite, containing hypersthene, ilmenite, pyroxene, hornblende, graphite, &c. These three groups are traversed by granitic and metalliferous veins.

1. *Gneiss.*§—The Laurentian Gneiss of Canada is grey or light-red, and is composed of quartz and felspar, in minute combination, and many thin layers of black mica (often mixed with or replaced by little plates of hornblende) running along the foliation. This rock is greatly contorted, and for miles together, as in north-east Lake Huron, is ribboned with pretty festoonings : the laminæ are regarded as sedimentary layers. The strike is mostly NE.–SW., or NNE.–SSW. For practical purposes, Logan divides this gneiss into two principal kinds—(1) the granitic or micaceous, and (2)

* See Geol. Report Canada, 1863, p. 50; and Quart. Journ. Geol. Soc., vol. xix. p. 36.

† See the successive Reports on the Geology of Canada, by Sir W. E. Logan and his colleagues, especially the large comprehensive Report for 1863, as well as the Descriptive Catalogue of Canadian Minerals and Rock, Internat. Exhib. 1862.

‡ Report, 1863, p. 22. These varying triclinic felspars being anorthic in crystalization and approaching anorthite in composition, Delesse proposed to give them the name 'anorthose,' and 'anorthosite' to the rock-masses formed of them.

§ By 'gneiss' is meant a rock consisting of the same materials as granite (with or without hornblende), but with a lamellar structure.

the syenitic or hornblendic; thereby simply expressing what is continually taking place, the preponderance of one or other. The second form is very prevalent. The beds accompanying Laurentian gneiss in the Canadas are crystalline limestone, anorthosite, quartzite, hornblende-rock, granite, and micaceous, hornblendic, and chloritic slates, relatively abundant in the order they are here set down; the hornblendic slate is more abundant near marble, and the chloritic slate is in much smaller masses than in the succeeding Huronian formation. The quartzite occasionally interleaved with this gneiss may vary; but it is usually white, translucent, granular, and seldom conglomeratic.

2. *The Crystalline Limestone.*—This is either pure white or grey, and often has broad grey bars owing to finely diffused graphite. The phosphates which it holds in great abundance will be spoken of in the sequel. Its crystallization is always coarse, and sometimes extremely so; single crystals being sometimes two or three inches wide. It is seldom saccharoid, and almost everywhere alternates with gneiss, in bands from 50 to 1,500 feet thick, as I have seen it near Gananoque, on the Lake of the Thousand Isles, and on the Mattawa, an affluent of the Upper Ottawa River, and elsewhere. The Norwegian representative of this marble is in much less quantity. The bands of this Canadian marble are tortuous, and often, by bending round sharply, they return by a parallel course to within a short distance from their visible point of departure. Corrugated seams of gneiss are sometimes inclosed in the limestone.

In the township of Bastard, on the River Ottawa, and of Madoc, on Lake Ontario, the Geological Commission met with two forms of conglomerates and grits, which are decisive of the sedimentary origin of the Laurentian beds of Canada, and therefore of the highest interest.* As an instance, in Bastard township there lies between two beds of white marble a fine-grained quartzose sandstone, with pebbles of grey calcareous sandstone, phosphatic, with others of vitreous and opalescent quartz; the mass of sandstone being at the same time interspersed with mica and graphite; the dip is ENE. $\angle$ 30°. We have another example of this near Madoc Village, where, resting on marble bands, are two other conglomerates, totally different. One is a bluish micaceous schist, holding numerous fragments of greenstone and syenite: the other is a dolomite with large pebbles of quartz, felspar, and a few of calcspar.

3. *The Lime-felspars, or Anorthosite.*—In the latter part of the 'Report for 1863' it is intimated that the anorthosite constitutes a separate, newer, and unconformable formation. The discovery in many parts of Canada of lime-felspar-rocks in large tracts is wholly due to the Government-Survey of the Colony. It is of much importance, both geologically and economically, as it explains the unexpected fertility of an extensive district to the north of Montreal, which had been previously supposed to be gneissic and comparatively barren. On the Lower Ottawa this lime-felspar-rock is 10,000 feet thick,

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* In 1846 Elie de Beaumont announced the sedimentary nature of the Swedish gneiss; Bullet. Soc. Géol. France, n. s. vol. iv. p. 501.

in prolonged hill-ranges, twelve miles broad; it occurs at Château Richer, below Quebec, and from thence extends at intervals NE. into the Straits of Belleisle, and so northwardly along the eastern shores of Labrador, according to the investigations of Professor Hind, of Toronto, and as shewn by the specimens of labradorite, hypersthene, &c., brought from thence by Admiral Bayfield, and now in the Museum of the Geological Society of London. In the Georgian Bay of Lake Huron I found it in exclusive possession of a group of islets, five miles long. A careful analysis of anorthosite by Sterry Hunt shows* that it is a felspar with a lime-base and a small per-centage of potash or soda. He finds from 7 to 15 per cent. of lime in most of these rocks. Being of variable composition, they have received several names—andesine, labradorite, hypersthene, vosgite, &c.; the difference being chiefly in the proportions of the ingredients. The anorthosite, as found in rock-masses north of Montreal, is composed chiefly of felspar, with a little black mica, green pyroxene, some epidote, garnet, ilmenite (titanitic iron), iron-pyrites, and calcspar as accidental minerals. Its texture is not always the same: sometimes the mass is a confusedly crystalline aggregate, exhibiting cleavage-surfaces three or four lines in diameter; with a fine-grained paste, somewhat calcareous, in the interstices. Occasionally the whole rock is uniformly granular, with cleavable masses of felspar at intervals; and its colour may be greyish and bluish white, lavender- and violet- blue (opalescent), flesh-red, greenish, and brownish. The crystallization is triclinic, which, taken with the density 2·66—2·73, shews this rock to belong to the same group as albite and anorthite,—in fact, a mixture of the two (S. Hunt). The anorthosite has been seen to pass into orthoclase-gneiss (that is, gneiss containing potash-felspar). There is no doubt of the presence of these lime-felspars in Norway and Scotland; and the rose-coloured crystals of the red antique porphyry of Egypt, according to the analysis of M. Delesse, have the same composition (S. Hunt).

The other associated rocks of the Laurentian Gneiss of Canada, possessing no features of novelty, will be passed over here in silence; but still it seems necessary even in this very brief description to state that on the Lower Ottawa syenite forms a large boss, with a porphyritic core, in this gneiss; and that there are dykes and veins belonging to four epochs in that district,—of dolerite (going east and west), and of syenite, cutting the doleritic dykes; felsite-porphyry, cutting the syenite; and augitic trap, traversing the Laurentian in all directions;† the last, it is important to remark, invading the Lower Silurian rocks. Iron-ores, metallic sulphurets, graphite, fluates, and phosphates occur abundantly in the Laurentian here and in other countries.

Distribution.—Laurentian rocks occur in many widely scattered localities in the United States, as in Pennsylvania,‡ Missouri, the

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* Geol. Report, 1854, pp. 374, 383. † Report, 1863, p. 37.

‡ Compare Rogers's Final Rep. Geol. Pennsylvania, vol. i. p. 62; ii. pp. 744, 747, &c.

Kansas, Texas, &c., also in South America (Brazil).* The Laurentian or fundamental gneiss of Scandinavia,† with its companion beds, so singularly resembles that of Canada that, although in another hemisphere, it may be said to be idertical in every particular of any moment; and, to avoid useless repetition, we shall be content only to announce the fact, on the authority of Durocher, Keilhau, Scheerer, Naumann, and Macfarlane.‡

Nearly the same may be said of the fundamental gneiss of North-west Scotland and the Hebrides. It, too, has its marble bands, talcose and micaceous schists, its quartzites, hornblendes, &c. The gneiss which predominates and characterizes the group is usually massive and intensely crystallized. It is both micaceous and hornblendic, as in Canada; the younger and very different palæozoic gneiss of the same part of the Scottish mainland is unconformable to it; and here are eruptive masses similar to those America, in the same attitudes.§

France contains much Laurentian, although hitherto that horizon has not been claimed for any of its crystalline deposits. It may turn out that one of the two granites of Brittany, the fine-grained and the porphyritic, is of this age, from its position and behaviour. The relations of the granite of La Vendée I cannot as yet master; but the hill-ranges of Forèz and Tarare in Central France seem to be Laurentian very distinctly,‖ according to the descriptions of Elie de Beaumont and Grüner. Palæozoic fossiliferous beds (the Carboniferous, for instance) rest upon it unconformably, and are never penetrated by it; and this, while waiting for further information, entitles me to treat of the underlying rock as Laurentian. Similar conditions take place in the mountains of the Vosges, where we have again the fine and coarse granites of different ages. The first form is contemporaneous with gneiss, leptinite, and some schists, which support unconformably Coal-measures, Trias, &c.; while the newer and coarser rock breaks through every bed here named, and has engulfed masses of the gneiss.¶

TRANSLATIONS AND NOTICES OF MEMOIRS.

The Fossiliferous Nodules in the Post-tertiary Clay of Norway. By Dr. M. Sars, Professor of Zoology, Christiania.

[Translated by the Rev. Robert Boog Watson, B.A., F.R.S.E.]

THE following is a summary of part of a paper by the celebrated Norwegian naturalist, Dr. M. Sars. It was published in the Nyt Magazin for Naturvidenskaberne (Christiania) for 1863, under

* D'Orbigny's Amér. Mérid. vol. iii. p. 222.

† Norway, Sweden, Lapland, and Finland.

‡ See also D. Forbes and Dahll, Quart. Journ. Geol. Soc., vol. xi. p. 166, & Misc. p. 9.

§ Murchison, Quart. Journ. Geol. Soc., vol. xiii. p. 30; vol. xvi. p. 216; and Murchison and Geikie, *op. cit.*, vol. xvii. p. 176–187.

‖ Explic. Carte Géol. France, vol. i. p. 130; Grüner, Géol. Loire, *passim.*

¶ De Beaumont, Explic. Carte Géol. Fr., vol. i. p. 327.

the title, A GEOLOGICAL AND ZOOLOGICAL JOURNEY IN THE SUMMER OF 1862.—R. B. W.

A characteristic of the marly clay which overlies the Boulder-clay of Norway is the presence of balls of hard marl, which, from their extraordinary rounded form, almost seem artificial, and in Sweden have obtained the name of 'Marlekor' (Marl-cows), 'Näckebröd' (Nick's bread), 'Imatrastene' (Imatra's stones). They are round, oval, kidney-shaped, biscuit-like, long and straight, or bent, sometimes oblique, and always more or less flattened. The edge is often irregular and jagged; but is sometimes smoothly rounded, and often shows distinct stratification, the laminæ being always parallel with the flat sides. The nodules are very hard, strongly calcareous, internally blackish, bluish, or ash-grey, and contain numerous very small particles of mica. The exterior is always lighter in colour than the interior, and chiefly yellowish-grey.

The origin of these lumps had been variously attributed to hardened nodules derived directly from the Silurian limestones, or to concretionary action in the marl.

No trace of organic remains had been found in them, but Dr. Sars has at last obtained from them fossils which determine at once the time and mode of their formation. At the mouth of the Rauma River, which flows through the famous Romsdal, and falls in at Veblungsnœs at the head of the Romsdal Fjord, immense quantities of these nodules are to be found, both in the marl itself, and washed out of it by the river. Of these many contain no visible organic remains; not a few, however, enclose a fossil. Dr. Sars gathered over a hundred such. The enclosed organisms are in a markedly different condition from such as are found in the Glacial formation. These latter are usually so little altered as hardly to be distinguishable from living specimens. The organic remains in the concretions, on the other hand, are completely penetrated by mineral, especially calcareous, matter; and they have perfectly the appearance of having been derived from some much older formation; so far from this being the case, however, all the organic remains belong to living species.

The most frequent organisms are shells of Molluscs, such as *Yoldia* (syn. *Leda*) *pygmæa* and *Nucula tenuis* (var. *expansa*), which are characteristic of the Norwegian marls. Both of these are often found with their valves united; still oftener heaped together in masses, or packed one on another in great numbers in the spherical, oval, or elliptical, more rarely in the long, kidney- or biscuit-shaped nodules. Occasionally a single *Tellina proxima* occurs in a nodule. In one long elliptical concretion lay the internal calcareous stem of a species of *Pennatula* or *Virgularia*, extending exactly through the longer axis of the nodule. In another very long, thin, and slightly curved concretion was a species of Worm, also stretched in the length of the stone. Very remarkable was the discovery of a Chætopode, or setose Annelid, in long straight elliptical nodules of the marl. Seven of these were found; one specimen in each concretion, and lying exactly in the longer axis of the stone. Finally, there was found a part of the back-bone of a Fish, which occupied the longer axis of a long slightly curved, but broken, concretion.

The marl extends up the Rauma for three or four miles. About three miles up Fish-remains seem to be frequent in the concretions; and some remains of Fishes of the family *Gadoidei*, among which is an entire *Merlangus*, preserved in the museum at Christiania, have probably been derived from this quarter.

Other similar concretions Dr. Sars procured from the Guuldal, in all respects like the former. In these he found: 1. A Chætopode, of the same species as that from Romsdal, occupying exactly the longer axis of an oval nodule. 2. A Chætopode, of another species, much longer than the former, found in the two fragments of an almost cylindrical concretion. 3. Seven specimens of *Osmerus arcticus* (*Salmo*), O. Fabricius (*Mallotus Groenlandicus*, Cuvier); all of which were entire. Each was in a separate nodule, long and narrow, generally nearly straight, but occasionally bent, slightly compressed on both sides, and a little rounded at the edge. The Fishes are from $4\frac{1}{2}$ to $5\frac{1}{4}$ inches long, and perfectly preserved. The back-bone is blackened and brightly lustrous; the other bones light-brown and slightly lustrous; and all are as hard as stone, except the thin shell-like bone of the head, the operculum, and the extremities of the rays of the fins, which are membranous and elastic. The operculum is light-bluish-grey, lustrous, and beset with numerous very small, but not adjacent, round black specks, as is also the case in some specimens from Greenland. The number of rays in the fins could be counted, and exactly tallies with Nilssen's and Kröyer's description of the living Fish.

Such skeletons of the *Osmerus arcticus*, inclosed in exactly similar marl-knots, have long been known in our museums under the Greenland name of 'Angmarset,' without anything being known of their particulars; and in the 'Boston Proceedings of Natural History' for 1851, pp. 29, 51, it is shortly stated that Mr. Logan had received a large number of fossil *Mallotus villosus*, which is the same fish, from the deposits near Bytown, not far from Ottawa, in Canada, at 180 feet above the sea-level; but in Europe they were hitherto unknown. It is therefore very interesting to know that they are also to be found in the Glacial formation of Norway, and that pretty frequently and universally distributed. In the Trondhjem Museum there are ten specimens of this Fish lying in a large piece of hard laminated clay. The *Osmerus*, as is well known, is an Arctic Fish occurring in incredible numbers in the Polar regions of the old and new world. Individual specimens have occasionally, though very rarely, been met with so far south as Finmark, and still more rarely at Söndmör, Bergen, or even the Christiania Fjord. In the Glacial epoch, however, it seems to have been diffused much further south than now.

In regard to the concretions containing these Fish, it is deserving of notice that there is always a single and entire fish in each nodule, and that the Fish, like the previously mentioned Annelids, occupies the whole longer axis of the concretion; and further, that the outer form, though roughly yet distinctly, answers to the shape of the fish within; even the fins, the anal one in particular, being indicated by projections of the surface, so that the external form of the concretion is plainly due to the contained fossil. On the other hand, a broad very flat concretion, with an irregularly rounded circumference, contained some vertebræ and other bones of the same Fish.

4. *Yoldia* (*Leda*) *pygmæa*; in one case associated with an Annelid, in another with a Fish.

5. *Ophiura Sarsii*; one specimen in a thin flat concretion, slightly convex on both sides, and which, though very hard, seemed less calcareous than usual, and was internally of a lighter colour and contained much mica. The circumference was prolonged into five flat points of different sizes, but corresponding to the arms, and presenting some of the spines and plates, from the form of which the species is determined. Judging by the thickness of the arms, this specimen must have been as large as or larger than those found living by Dr. Sars in Finmark; and had fully attained the size of the living Greenland form, which, according to Lütken, has a body 27 mm.$=1\cdot1$ inch in diameter. Here, as in the case of the Fishes, the form of the concretion was obviously determined by the shape of its contents; and here, therefore, we have a further illustration of the singular manner in which, during the process of decomposition, the particles of carbonate of lime contained in the clay were drawn together by the influence of the organic body, and concentrated around it in a hardened mass.

Among other facts of interest which Dr. Sars mentions in connection with the Glacial formation is the distinct diminution southwards of the Arctic character of the strictly Arctic Shells present in the clays. As they extend further south they fall off both in frequency and in size. Thus the *Siphonodentalium vitreum* is found living in Finmark and fossil as far south as Christiania; and the living specimens from the north and those fossil from the south of Norway agree very closely in size, being from $\frac{2}{5}$ to $\frac{1}{2}$ inch (10 to 12 mm.) long, by $\frac{1}{10}$ inch ($2\frac{1}{2}$ mm.) broad at the base, whereas the fossil specimens from further north, in the neighbourhood of Trondhjem, are $\frac{4}{5}$ inch (20 mm.) long, and $\frac{1}{7}$ inch ($3\frac{3}{4}$ mm.) broad, and some seem to have attained even 1 or 1·1 inch in length, and $\frac{1}{5}$ inch in breadth.

On the other hand, it is a very curious fact that some shells extended further north in the Glacial epoch than they do now; thus *Scrobicularia piperata*, which has never in a living state been found further north than Florö in the Bergenstift, appears in the Glacial Clay at Surendal and at Trondhjem. *Pecten maximus*, too, which is unknown living further north than Christiansund, is found in the clay at Steenkjær, at the very head of the Trondhjem Fjord, and sixty miles north of that town.

Saggio sulla Costituzione Geologica della Provincia di Pisa; del Prof. Cav. Paoli Savi. 1863. 4to. Pisa. pp. 42.

THIS account of the Geology of the neighbourhood of Pisa by its veteran Professor is accompanied by an elaborate general map, with excellent sections, and special maps of the neighbourhood of

Volterra, near which ancient town are the celebrated copper-mines of Monte Catini and the *soffioni boraciferi*, or hot vapours containing minerals, now conveyed into pools of water and yielding large supplies of the borate of soda (the borax of commerce). Few parts of Italy are more interesting to the geologist, and he could not find a guide more intelligent, lively, or trustworthy than M. Savi.

Almost the whole province lies to the south of the Arno, and it includes about seventy miles of coast, the width of the belt varying from ten to twenty miles. The Arno and the Cecina cross it at right angles; the coast is generally low, and often marshy, and there are ranges of hill parallel to the coast a few miles distant. Some idea of the geological interest of the district may be obtained from the statement, that it presents marked varieties of Palæozoic rocks, together with Liassic, Jurassic, Upper and Lower Cretaceous, Upper and Lower Eocene, very varied Miocene, Pliocene, and Post-pliocene deposits. Some of these are broken through by serpentines, trachytes, and porphyries, or are penetrated by modern volcanic vapours. The whole district is subject to earthquakes.

The result of a very superficial glance at the orographical structure of Tuscany shows—(1) that it presents three varieties of surface—mountains, hills, and plains; (2) that the mountains form geologically three chains—the Apennines, the metalliferous chain, and the serpentine chain; (3) that the hills are also of three kinds—Miocene, Pliocene, and Recent. All of these but the Apennines exist in the province of Pisa. The Palæozoic rocks are chiefly of the Carboniferous period, and of the kind known locally as *verrucano*, consisting of clayslate, talcschist, &c., and they are well marked by occasional fossils, both vegetable and animal. They are limited to the northernmost part of the province, where it adjoins the territory of Lucca, and the mountains enclosing the celebrated Baths of Lucca. Rocks apparently Triassic are present in small quantity between the verrucano and the River Serchio, and on both banks of the Serchio. They are covered with Liassic and Jurassic rocks to a limited extent. These recur on the flanks of Monte Calvi, at the southern extremity of the province, where they are brought up by trachytic and porphyritic rocks. Elsewhere they are covered by newer deposits. The Cretaceous rocks are also exhibited on Monte Calvi; the *alberese* overlying the Jurassic rocks on the southern side. Other examples were seen on the flanks of the serpentines near Monte Catini, and they doubtless extend below the Miocene and Pliocene rocks to the north. They occur again to the east of Volterra in similar position, but the whole amount exhibited at the surface is small, and the rocks are almost entirely Upper Cretaceous.

Eocene rocks, both Nummulitic Limestones and the rock called *macigno*, are much more extensively developed, and occupy large tracts in the districts south of the Cecina. It is chiefly the upper member that is seen. This rock also is called *alberese*; but it is quite distinct from the Cretaceous *alberese*. It is pierced through by the trachytes of Monte Calvi, and also by numerous smaller eruptions of serpentine. These are seen in three groups—one near the Soffioni, where borax is worked; another at and near Monte Catini, where copper exists in abundance; and a third on the coast to the east of the Monte Catini group. As it is through the Eocene deposits that the serpentines chiefly appear, so the Miocene beds, which cover them towards the east, are interpenetrated by the boraciferous vapours, and contain gypsum and salt. The Miocenes are, for the most part, recomposed rocks, derived from the serpentines and macigno. They are often highly bituminous. The Pliocene rocks occur between the alluvial valleys of the Arno and the Cecina, and the Miocene and Eocene rocks to the south and east. They cover a large space, probably a third of the whole area of the province. They are chiefly sand and clay, and they are loaded with fossil shells. The newer rocks are the alluvial clays and sands of the Arno and the coast.

The chain of serpentine hills, commencing a little to the south of Leghorn, with the littoral group from Montenero to Rosignano, continues towards the south-east, coming to the surface at intervals, and always of the same general nature. The rocks are essentially metamorphic, consisting of altered Upper Cretaceous and Eocene aqueous deposits, the limit betweeu the two having been determined in 1850 by Sir R. Murchison. This demarcation, says Prof. Savi, is the more important in Italian geology 'because the last Secondary and the first Tertiary rocks were deposited in conformable stratification at the bottom of the same sea, of which the fauna and flora changed gradually, not abruptly, insomuch that no precise line can be drawn between the two,' p. 15. It is well known that the Nummulitic Limestone forms this horizon; but, while it is unquestionable that the *pietra-forte*, immediately underlying the Nummulitic Limestone, and loaded with Upper Chalk fossils, is Secondary, and that everything above the Nummulitic Limestone is Tertiary, it is yet impossible to draw a precise limitary line between Upper Chalk and Lower Eocene, for the bands of schistose clay, limestone, and fine-grained sandstone among the Nummulitic Limestone are perfectly conformable both above and below, and present a mixture of fossils of the two epochs. The Eocene deposits form two distinct series.

Penetrating and altering these beds are erupted rocks, of probably two periods, both converting them into serpentines. The older is a dark-green ophiolite, with much diallage, generally confined to the Lower Eocenes, but also reaching the Upper. Large veins of euphotide belong to this eruption, and they have altered very extensively the Upper Cretaceous and Lower Eocene rocks, chiefly producing from them a rock known as *gabbro rosso*, abounding with zeolitic minerals, and often putting on all the characters of a plutonic rock. Argentiferous lead, copper, and zinc occur in the veins in this rock. Other veins penetrate the rocks metamorphosed by this first eruption. They are certainly more modern, and they affect the Miocene deposits. They present a peculiar rock, not containing diallage, but abounding with sulphurets of copper, lead, iron, and zinc, which have been accumulated in some veins in great quantities. Several minerals and veins are described by M. Savi as affecting these rocks.

The Miocene chain is interesting on three accounts: it contains (1) lignite, (2) rock-salt, and (3) alabaster. Each of these is economically important; but the reader must refer to the original memoir for a detailed notice of them. The Pliocene hills are also interesting, but they are less important.

Belonging to the later Tertiary periods are numerous volcanic rocks covering the Pliocene rocks. The extinct volcanos range from north to south, and connect the existing volcanos of South Italy and Sicily with the recent movements and modifications of the rocks in Tuscany. The greater part of these phenomena seem to range parallel with the metalliferous chain and that of the serpentine hills.—D. T. A.

Der Kulm in Thüringen. Von Herrn R. Richter, in Saalfeld. (Zeitsch. deutsch. geol. Gesell., vol. xvi. Heft 1, pp. 155–172. 1864.)

Two areas of 'Culm' (or Lower Carboniferous strata) occur on the slate of the Thuringian Forest. The northern Culm strata come from under thin beds of Roth- and Weiss-liegende, which are covered by the Zechstein (Magnesian Limestone); their boundary reaching from Saalfeld to Weida; the floor of the Culm consists of Upper and Middle Devonian rocks. The southern area reaches to the neighbourhood of Stockheim, where there are productive coal-measures; and the Culm here also reposes on Devonian rocks.

These Lower Carboniferous strata occur on the ridges of the hills, dipping away on both sides, the strike varying from NE.—SW. to E. by S.—W. by N. The beds are much disturbed. The total thickness is not clearly indicated, but is small. The rocks are throughout similar, the Culm-formation consisting chiefly of sandstone with shale-partings. There is also a conglomerate sparingly distributed. The conglomerate consists of rounded fragments of glassy and common quartz, of minerals resembling decomposed felspar, of mica, and fragments of schist. It is an irregular deposit; and the organic remains in it are rare and indeterminable. The sandstone, in beds several feet thick, is more regular. It is separated by shaly beds, loaded with fossils in good condition. Shales occur throughout the whole deposit, but they are rarely more than a few inches thick. These are composed sometimes almost exclusively of vegetable remains. The author believes that the Lehesten roofing-slates are not, as supposed by Gümbel ('Bavaria,' III.), of the Lower Carboniferous age. They seem distinctly Devonian, by the character of the vegetable remains as well as by position. Plutonic rocks are not known within the Culm-district.

The fossils found are for the most part fragmentary and in bad condition. They are as follow (figured in five plates):—

I. *Proetus posthumus*, sp. n.; *Cythere spinosa*, sp. n.; *Litorina*, sp.; *Cardiomorpha* (?) *tellinaria* (?), Goldf.; *Crinoidea*; several fragments, one resembling *Lophocrinus speciosus*, Meyer.

II. Plants—*Pinites Catharinæ*, sp. n.; a small seed, not unlike that of *Abies alba*, Mill., but larger. Several fragments of fossil coniferous wood probably belong to this species; *Megaphytum (Rothenbergia) Hollebeni*, Cotta; *Sagenaria transversa*, Göppert; *S. Veltheimiana*, Presl; *S. remota*, Göppert; *S.* (?) *cyclostigma*, Göppert; *S. minutissima*, Göppert; *Lycopodites*, sp.; *Odontopteris Stichleriana*, Göppert; *Calamites transitionis*, Göppert (in great variety of markings); *Fucoides bipinnatus*, sp. n. There are also two fossils figured, whose nature is doubtful; one of them allied apparently to *Harlania*.

The above fauna is exclusively marine; and one, at least, of the plants has had the same habitat; the rest of the plants, however, cannot have grown under water. We have thus indications of a sea not very far from land; Encrinites, belonging to deep water, being drifted up occasionally. A deposit of sand stretches up towards the north-east, from the present Thuringian Forest, as far as the outcrop can be traced; and there is a parallel formation of limestone at some distance. Thus the 'Culm' of Thuringia may be the equivalent of the Carboniferous Limestone.

The stratification of the Thuringian Culm is only here and there conformable, and it is faulted differently in different members; so that it appears that it is distinct in this respect both from the underlying Devonian and overlying Permian rocks.

The Culm-sandstone is available for walls and occasionally for paving, while thin slabs are useful for oven-plates. Neither the coal nor the iron would be good for speculation. The decomposed rock makes a tolerably good soil.—D. T. A.

Die Fauna der Braunkohlenformation von Latdorf bei Bernberg. Von C. Giebel. pp. 93. 4 plates. (From the Abhandlungen der Naturforschenden Gesellschaft zu Halle. Vol. viii. 1864.)

ALTHOUGH perhaps the only memoir which has hitherto been specially devoted to a description of the strata of Latdorf is that by Herr C. Zincken in the 'Zeitschrift für gesammten Naturwissenschaften,'* the fossils from this locality have furnished material, wholly or in part, for several papers. Thus the Bryozoa were first described by Dr. Ferd. Stoliczka,† and afterwards, with the Corals, by Dr. F. A. Roemer,‡ which memoir has since been rather severely criticized by Dr. Stoliczka, in a letter to the Editors of the 'Neues Jahrbuch,'§ these two palæontologists differing very materially in their views of the limits of specific variation, and on other points. Some of the Shells have been described by Dr. Semper in the 'Archiv der Meklenburger Freunde der Naturgeschichte,'‖ and others in Prof. Beyrich's work on the North-German Tertiary Shells, besides which most books and pamphlets on German Oligocene strata or fossils contain more or less direct references to those of this very celebrated locality.

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* Vol. xxi. 1863, p. 530, pl. 3.

† Sitzungsberichte der k. k. Wiener Akad. vol. xlv. pp. 71–79.

‡ Palæontographica, vol. ix. Heft 1.

§ See Neues Jahrb. 1864.

‖ Vol. xv. 1861, pp. 221–409.

The author of the present paper has from time to time published descriptions of new species from the Brown-coal of Latdorf in the 'Zeitsch. gesammt. Naturw.,' and in this memoir he reproduces these descriptions, adding others of new species, with notes on some old ones, giving figures of the forms now described for the first time, and of those which, though described by him before in the 'Zeitschrift,' had not yet been figured. He also gives lists of all the species of Shells, Bryozoa, and Corals that have been described from this locality, or have been noticed as occurring there.

Among the new species we notice one under the name of *Thecidea oblonga*, and, although the figure is so bad that it shews nothing besides the general form of the shell, that alone is sufficient to suggest the probability of its being the same species as that referred to by Mr. Davidson * as *Thecidium Mediterraneum*, var. *Latdorfiense*. Dr. Giebel considers it, however, a new species, but his description contains scarcely any allusion to the internal arrangements, he himself considering that 'the form and the condition of the surface are quite sufficient to distinguish this species from all others.' The surface is described as wrinkled and punctate (*wurmfrassig*), and exhibiting the lines of growth only towards the margin ; the shell is said to be oblong in shape, strongly vaulted, and becoming only a little narrower towards the beak, which is very thick ; the hinge-line is straight. Dr. Giebel also states that it is the only species found in the Tertiary beds of Germany.—H. M. J.

Sopra i Depositi di Piante Fossili dell' America Settentrionale, delle Indie, e dell' Australia che alcuni Autori riferirono all' Epoca Oolitica; Memoria del Cav. A. de Zigno. (From the Proceed. Acad. Sciences of Padua. 8vo. 1863.)

In every group of natural objects, or natural phenomena, which has been the subject of classification, there must be certain members having such mixed characters that it is difficult to say to which of the two or more neighbouring groups they more properly belong. Geology furnishes many such instances, some of more than usual difficulty, and especially the case of the age of certain plant-bearing strata, occurring in several distant regions, and having all a greater or less community of character, as exhibited in the facies of the fossils they contain.

The Baron de Zigno, who has before written on the subject, has recently published in the paper before us a *résumé* of the facts and opinions current respecting the age of these several plant-bearing strata, which have been referred by some to the Oolitic Period. From the title it will be seen that the deposits in question occur in North America, India, and Australia ; but strata containing similar fossils to those occurring in India and Australia occur also in South Africa, though Sign. de Zigno does not mention them.

The chief conclusions of Sign. de Zigno, and the facts adduced in support of them, may be thus stated. The flora of Rajmahal

* Geological Magazine, No. 1, p. 18, Pl. I., figs. 6–9.

(Bengal) he considers to have, on the whole, a Liassic facies, although it contains one species (*Tæniopteris ovalis*) which occurs in the Oolitic strata of Scarborough, and another, which he cannot distinguish from the *Dictyopteris Brongniarti* of the Carboniferous (!) rocks of Saxony. Some of the species of Cycads are allied to those found in the Oolite, others to Liassic species, and some to species occurring in Triassic rocks; but the Liassic forms are said to be most prevalent. Respecting the North American beds, the author evidently inclines to the opinion that they are Triassic; he denies the correctness of Prof. Rogers's determinations of the plants, but accepts those of Dr. Heer; the former geologist endeavoured to show that these North American deposits were comparable with the Oolitic coal-bearing beds of Whitby, while the latter referred them either to the Keuper or the Lower Lias. The Australian strata are more difficult to deal with, for while Professor M'Coy considers the plants to be Oolitic, the Rev. W. B. Clarke asserts that he has found associated with them a true Carboniferous *Lepidodendron*, with Shells belonging to the same period. Sign. de Zigno coincides and Prof. M'Coy in believing that the *Lepidodendron* and the Palæozoic shells found by the Rev. W. B. Clarke came from deposits much lower in the series than the strata which furnished the remaining plants; but he differs from the Australian Professor as to the age of the latter, believing them to be either Trias or Lias. Thus it will be seen that Sign. de Zigno considers all these deposits as referable either to the Trias or the Lias. This conclusion is not new, and, excluding the Australian beds, the age of which cannot as yet be considered determined, it is probably right, although the author's arguments, derived from the very conflicting evidence of the Plants, are by no means so convincing as those of Professor Rupert Jones, which are drawn from the occurrence, in the Indian and American strata, of certain species of *Estheria*, a genus, by the way, which Sign. de Zigno does not even mention, referring to the Richmond specimens of *E. ovata* as shells allied to '*Posidonomya*' *minuta*. Not less remarkable in the Memoir is the absence of all allusion to the remarkable *Glossopteris Browniana*, which is said to occur in India, Australia, and South Africa; for even if Sign. de Zigno prefers another generic name, the specific appellation ought still to remain; but these omissions, with the absence of allusion to the South African deposits, convince us that the author has not yet got to the bottom of this very intricate subject.—H. M. J.

Ueberblick über die Trias, mit Berücksichtigung ihres Vorkommens in den Alpen. Von Dr. Friedrich von Alberti. Stuttgart, 1864. 8vo. pp. 353. 7 Plates.

THE object of this work is to give an outline of the present state of our knowledge of the Trias, and thus to complete or to correct the remarks made by the author in his memoir entitled 'Beitrag zu einer Monographie des bunten Sandsteins, Muschelkalks und Keupers, und die Verbindung dieser Gebilde zu einer Formation (Trias),' which was published in 1834, and in which the name 'Trias' was first given to this formation.

The author divides his subject into three portions, to each of which he assigns a special chapter. In the first chapter he treats of the various groups composing the Swabian Trias, coupled with remarks on the mineralogical components and contents of the rocks, chiefly from a geological point of view. In the second part of the work he describes the organic remains of the Triassic strata, including some new species of Mollusca, giving figures of the latter, and of some of the former that have not been adequately illustrated before. In the third chapter he discusses the distribution and range of the fossils in the Trias of Swabia and other countries, and combats some of the published classifications of this group for the Alps and other districts.

The following is the classification he adopts:—

Swabia, &c.	Alps.
C. Keuper.	
cc. Upper Keuper.	
p. Täbingen Beds	Upper Dachstein. Kössen Beds. Lower Dachstein. Bleiberg Beds.
bb. Middle Keuper.	
o. Coarse-grained Sandstone. *n.* Gansingen Beds. *m.* Fine-grained Sandstone. *l.* Keuper-gypsum.	(?) Raibl Beds.
k. Cannstatt Beds	Esino Beds. Arlberg Limestone. Hallstadt Limestone. St. Cassian Beds. Wengen Beds. Partnach Beds. Mendola Dolomite.
aa. Lower Keuper or Lettenkohlengruppe.	
i. Upper Dolomite. *h.* Lettenkohle and Sandstone. *g.* Gypsum and Rocksalt. *f.* Lower Dolomite.	(?)
B. Muschelkalk.	
e. Friedrichshall Limestone . .	Virgloria Limestone. Guttenstein Limestone. Recoaro Limestone.
d. Anhydrite Group . . .	Gypsum of the Muschelkalk of Lombardy.
c. Wellenkalk	Campiler Beds. Seiss Beds.
A. Bunter.	
b. Upper Bunter Sandstone. *a.* Vosges Sandstone.	Grödner Sandstone.

The author states that in the Trias there are four principal

Coprolite-beds ('Cloake'), besides others of less importance, namely: 1. Below the Lettenkohlensandstein. 2. Between the horizon of Beaumont and the Keuper-gypsum. 3. In the Keuper-sandstone (*o*). 4. In the Kössen beds (Täbingen) immediately below the Lias.

These deposits (Cloake), he observes, have all the same character; they form great layers in the beds in which they occur, and contain teeth, bodies, and scales of various Fishes and Reptiles, mixed and cemented together with Coprolites.—H. M. J.

Leonhard und Geinitz's Neues Jahrbuch für Mineralogie, Geologie, und Palæontologie. Jahrgang 1864. Heft 4.

BESIDES the usual notices of Mineralogical, Geological, and Palæontological memoirs, the last number of the 'Jahrbuch' contains the following papers:—

1. Vorläufiger Bericht über krystallinische Silikatgesteine des Fassathales und benachbarter Gegenden Südtyrols, von Herrn T. Scheerer. (Preliminary notice on the Crystalline Siliceous rocks of the Fassathal and neighbouring districts of South Tyrol.)

In this paper the author divides the different rocks occurring in the district under consideration into two great classes, namely, the Hochsilicirte Gesteine (or Plutonites) and the Niedrigsilicirte Gesteine (or Vulcanites). These classes are again subdivided, so that all the rocks of the Fassa Valley are arranged as follows:—

		Average per-centage of Silica.
I. Highly silicated rocks (Plutonites).		
1. Upper	Plutonite, or Red Gneiss	75
	Gneiss.	
	Quartz-porphyry (remelted gneiss).	
2. Middle	Plutonite, or Middle Gneiss	70
	Granite of Brixen.	
	Granite of the Cima d'Asta.	
3. Lower	Plutonite, or Grey Gneiss	65
	Tourmaline-granite.	
	Quartz-porphyry.	
II. Subsilicated rocks (Vulcanites).		
A. Plutovulcanite.		
1. Upper	Plutovulcanite, or Quartziferous Syenite	63
	Quartz-syenite.	
2. Middle	Plutovulcanite, or ordinary Syenite	60
	Monzon Syenite.	
	Syenite-porphyry.	
	Micaceous Syenite.	
3. Lower	Plutovulcanite, or Melaphyr	55
	Melaphyr.	
B. Vulcanite.		
1. Upper	Vulcanite, or Augite-porphyry	48
	Augite-porphyry.	
	Uralite-porphyry.	
	Monzon Hypersthenite.	
2. Middle	Vulcanite, or ordinary Basalt	42
	Basalt.	
3. Lower	Vulcanite, or basic Basalt	36
	Basic Basalt.	

2. Auszug aus der Denkschrift des Herrn Alphons Milne-Edwards über die geologische Vertheilung der fossilen Vögel. Zusammengefasst von Herrn A. Fr. Grafen Marschall. An abstract of this paper has been already given in the GEOLOGICAL MAGAZINE, No. 2.

3. Chemische Untersuchung einiger Gesteine von Java. Von Herrn Otto Prölss. This contains analyses and descriptions of some volcanic rocks from Java, by a young Heidelberg doctor, a pupil of Blum and Bunsen.

4. Der Erloschene Vulkan Ringgit in Ost-Java und sein angeblicher Ausbruch 1586. Von Herrn Emil Stöhr. (The Extinct Volcano Ringgit, in Eastern Java, and its pretended Eruption in 1586.) In this paper the author attempts to prove that the eruption of this extinct volcano, asserted by Houtman to have occurred in 1586, and to have caused the death of 10,000 people, did not really take place; but that an eruption of the Raun Mountain, which is still active, occurred in that year, and was mistaken by Houtman for an eruption of the Ringgit.

In a letter, Dr. J. A. Roemer gives a sketch of a new classification of the Sponges, which he is about to use in his forthcoming Monograph of the North-German Cretaceous Sponges, to be published in the 'Palæontographica,' illustrated by 18 plates. The numbers *after* the genera indicate the number of species.

1. Family *Coeloptychidea.*

1. Cœloptychium, 6.
2. Camerospongia, 7.
3. Cephalites, 8.
4. Cystispongia, 7.
5. Porospongia, 2.
6. Lepidospongia, 1.

2. Family *Cribospongidea.*

7. Cribospongia, 17.
8. Coscinopora, 3.
9. Pleurostoma, 7.
10. Retispongia, 4.
11. Oscillaria, 12.
12. Ventriculites, 10.
13. Dendrospongia, 3.
14. Cylindrospongia, 11.
15. Diplostoma, 6.

3. Family *Siphonidea.*

A. *Eudeidea.*

16. Hippalimus, 2.
17. Placospongia, 4.
18. Eudea, 3.
19. Siphonia, 5.

B. *Siphonocœlidea.*

20. Siphonocœlia, 14.
21. Polycœlia, 10.
22. Elasmocœlia, 2.

C. *Jereidea.*

23. Jerea, 18.
24. Polyierea, 6.
25. Marginospongia, 1.

4. Family *Limnoreidea.*

26. Limnorea, 4.
27. Epeudea, 1.
28. Epithebes, 4.
29. Polenydostoma, 3.
30. Endostoma, 2.
31. Tremospongia, 4.
32. Actinospongia, 2.
33. Enaulofungia, 3.
34. Lecospongia, 3.

5. Family *Chenendoporidea.*

35. Chenendopora, 12.
36. Verrucospongia, 4.
37. Elasmostoma, 5.

6. Family *Sparsispongidea.*

38. Monothebes, 2.
39. Disthebes, 4.
40. Oculispongia, 4.
41. Stellispongia, 10.

7. Family *Amorphospongidea.*

42. Copulospongia, 13.
43. Mæandrospongia, 4.
44. Thalamospongia, 1.
45. Amorphospongia, 12.

H. M. J.

REVIEWS.

Handbook to the Geology of Weymouth and the Island of Portland; with Notes on the Natural History of the Coast and Neighbourhood. By Robert Damon, F.G.S., &c. London, E. Stanford. 1864. 8vo. pp. 199, with 33 illustrations.

THIS deservedly popular Handbook was published in 1860, and we have just received the reprint in 1864. We are sorry to find that it is *only a reprint*; for no handbook can be in print for four years and not need re-editing, however carefully it may have been brought out at first. We have compared the two editions, and, with the exception of the title-page, no change has been made.* This is the more to be regretted on account of the evident public appreciation the book has received, which is attested by the sale of the first edition since 1860. A careful notice of this book, by one who evidently knew the geological features of the country well, appeared in the 'Annals and Magazine of Natural History' for December, 1860; and the author would have done well had he profited by the suggestions and corrections therein furnished. We add a few fresh suggestions to the list therein given, confining our remarks to palæontology. Among the fossils figured from the Portland Stone (p. 79) is a curious example of a mass of *Isastræa*, a coral most abundant in the Oolite, which had been bored into by a burrowing mollusk (*Lithodomus*). The burrows afterwards became filled with fine calcareous mud, which penetrated also between the *septa* of the coral. The coral was eventually in great part dissolved away, leaving the casts of the borings of the *Lithodomi* exposed to view, their surfaces sometimes covered by the star-like impressions of the coral. Mr. Damon says (p. 78) the coral only coated the rock in which the *Lithodomi* bored, whereas his figure shows that it was *in the substance of the coral itself* that the burrows were made. The fossils of the Portland Stone occurring in the 'Roach' beds are all in the same condition of casts, *Trigonia gibbosa* and *Cerithium Portlandicum* being the two most abundant forms. Speaking of the recent *Trigonia pectinata* (p. 82), the author says it occurs in 'Swan River, New South Wales;' it should be Sydney Harbour. Another variety occurs on the coast of Tasmania.

At p. 165 we find '*Trigonellites* is now regarded either as the gizzard of the animal, or the *operculum* or valve.' In the 'Geologist' for September, 1860, p. 328, Mr. S. P. Woodward published a figure of *Ammonites subradiatus* from the Inferior Oolite of Dundry, near Bristol, with the *operculum in sitû*. Of their true nature we did not think any one was now ignorant. The author also quotes the exploded hypothesis of the use of the siphuncle in the Ammonite and Nautilus, as an apparatus for adjusting the specific gravity of the

* A woodcut (Vertebræ of *Ichthyosaurus*) printed upside-down, at page 168, remains still in the same position.

shell 'by the ejection of a fluid into the siphuncle or pipe which passes through the chambers,—a few drops suffice to sink animal and shell, and *vice versâ*.' The siphuncle has *no connection* with the air-chambers (which are only the earlier tenements grown too small for the animal); its real function is to keep the shell alive, no part of an animal being dead while the animal is in a healthy state.

We mention these points to show that no book of the kind, however well 'got up,' will bear the test of time sufficiently well to dispense with re-editing. We hope Mr. Damon's Guide-book may be only one of many more that will be written to illustrate the Natural History, and especially the Geology, of our coasts.

Physical Geography for Schools and General Readers. By M. F. Maury, LL.D., &c. London: Longmans, 1864. 8vo. pp. 141.

This little work is rather intended for schools and young people than as an original contribution to science. It places some of the peculiar views of the author in a pleasing and prominent light; but it is rather desultory, and far from complete. It has an admirable chart of the principal marine currents, including a few other physical phenomena, and a second as a frontispiece, whose utility to the general reader is less clear, although it no doubt represents to the eye the result of a large number of observations.

In a science like Physical Geography there is much to be taught, and there are many departments, each possessed of its own special interest and importance. To the geologist almost every department is necessary; but looking at the book before us as geologists, we do not find that it affords much direct help. Of the mountain-systems, their influence, history, and relative value, there is hardly anything said; and of river-basins, not much more. Of volcanos and earthquakes there is absolutely nothing. Hydrography and certain departments of Meteorology are alone discussed.

Still the book is not without claims to attention in this place. The great problems of climate must ever possess deep interest for the geologist, for on them must ultimately depend the question as to how far the various conditions of the earth indicated by fossil remains are capable of being produced without any violent or complete change in the physical conditions of the earth as a planet. So vast and complete are the differences that now exist between the animal and vegetable inhabitants of places in similar latitudes—so varied are the conditions of climate where the mean quantity of sun-light and sun-heat ought to be identical—that every fact with regard to the modification and destruction of races cannot fail to possess deep interest; and we know that change of climatal condition and change of inhabitants are matters that always go together.

Capt. Maury or Dr. Maury—we hardly know in what capacity to speak of him—has done so much good work in teaching navigators how best to direct their ships in crossing the Atlantic, that his account of the vibrations of the principal belts of prevalent winds

(Book iv. § 193, *et seq.*) is well worth reading. From these vibrations it results that, wherever seasons are divided into wet and dry, 'it is the rainy season when they have the sea to windward of them, and the dry when they have the sea to leeward of them," p. 47. The directions of the prevalent winds in connection with the form and features of the land are shown to account for the extremely discordant vegetations of Australia and South America. In the latter the trade-winds, loaded with moisture as they arrive from the sea, strike the land to leeward of them, nearly at right angles to their course, and penetrate up the great valleys to the mountains, draining as they go. In the former the SE. trades coast the land, and never enter far, fringing only a narrow strip near the shore with occasional showers. Further illustrations of the same nature are equally interesting. Considerations like these should not be lost sight of when geologists are speculating on the possible modifications of climate and the form of land at distant geological periods, when the distribution of land and sea may have been altogether the converse of those that exist at present in given latitudes.

The Alpine Guide: The Central Alps, including the Bernese Oberland and all Switzerland, excepting the neighbourhood of Monte Rosa and the Great St. Bernard, with Lombardy and the adjoining portion of the Tyrol. By John Ball, M.R.I.A., F.L.S., &c., late President of the Alpine Club. London: Longmans, 1864. 8vo. pp. 502.

MR. MURRAY and one, at least, of his familiar red-books have found a formidable rival in the 'Alpine Guide,' of which the second part is before us. Provided with an excellent and accurate general map, on a scale of ten miles to an inch, five maps of small districts on a larger scale, and an important geological map, besides sundry views, it gives the experience of one of the most indefatigable of Alpine travellers, and one who has travelled with his eyes open and with every advantage of circumstance. For the carriageable tour of a month's duration, and the more exhaustive pedestrian tours of three months or more, clear outlines are given, and the knowledge and experience of the author ensure the strictest accuracy. The definite routes are at once so numerous and so well grouped as to include almost everything that a traveller requiring a published guide can need. Mr. Ball is well acquainted with what has been done in the Alps both by natives and foreigners, and has done much himself.

The essential and, as it seems to us, the characteristic difference between the new Alpine Guide and the Swiss Hand-book is that the former is more purely suggestive and descriptive with regard to the travelling and the scenery; while the latter is more didactic, giving more notices of history and art than description. No doubt some travellers look for and prefer one method, and others the other; *chacun à son goût.* To geologists we recommend the guidance of Mr. Ball.

It would be altogether impossible in a brief notice to give any abstract of what is in itself a most careful abstract of everything important known of some 2,000 places, 1,500 mountain-peaks, and 250 passes. The completeness is indeed something marvellous; and though, of course, there is no such thing as a perfect work, and some accounts and statements may have to be modified by personal experience, we have seen nothing, in a rapid survey of the work, that calls for complaint. We recommend it without hesitation as the best companion to the geological traveller in the Central Alps, merely suggesting that in future the colouring of the geological map should be assisted by figures or letters of reference, since in maps printed in colours it is almost impossible to compare by the eye the shades of colour used in colour-printing; and in the repeated printing necessary the blocks do not always exactly fall into their proper places.

On the New Red Sandstone and Permian Formations as Sources of Water-supply for Towns. By Edward Hull, B.A., F.G.S., of the Geological Survey of Great Britain. 8vo. 1864, pp. 20. (From the Mem. Lit. Phil. Soc. Manchester, 3rd sec. vol. ii.)

The red sandstones and clays of Lancashire, Cheshire, Staffordshire, Warwickshire, Worcestershire, and the south-west of England have of late years received much attention from the Geological Surveyors, on account of their covering the coal-measures; and in some districts the more perfect knowledge obtained as to the exact relations of these beds, which, often shifted by faults, and varying in thickness over the coal, still appear to an unpractised eye as one uniform mass of 'red ground,' has benefited coal-owners very considerably. Not only, however, are these red rocks important as regards their relation to the coal-beds, but also with respect to the great water-holding properties of some of their beds. In early geological days these red sandstones and clays were all comprehended under the name 'New Red Sandstone,' and divided into 'Upper' and 'Lower;' the latter, recognized by Phillips as having older fossils in it than those of the higher division, was divided off by Murchison and grouped, as Permian, in the palæozoic system, the other remaining as the New Red Sandstone formation or Trias. Now these Permian red clays and sandstones are not nearly so porous and capable of holding water as the Triassic beds above, which latter readily take in rain- and river-water, filter it, and freely yield it in wells, sometimes to the amount of $1\frac{1}{2}$ millions of gallons a day from one well. The bleach-works, factories, and breweries of Manchester and Salford (Mr. Hull says) pump six millions of gallons every twenty-four hours from the New Red Sandstone. Lancashire, however, has a thicker set of 'New Red' beds than some other districts; in fact, they thin out as we go to the south-east; being about 1,200 feet thick in the north-west, they are about 600 feet in Derbyshire and Staffordshire, and only 250 feet at the utmost in Leicestershire and Warwickshire; hence an enormous difference as to what we may expect from deep wells at Rugby as compared with those of Manchester,—at the former place the New Red Sandstone is reduced to a minimum, and the lower red marls and sandstone (Permian) hold comparatively little water. The varying inclinations of these attenuated strata, more or less disturbed, at different places, complicate the conditions of local water-supply; but with the maps and sections of the Geological Survey in hand, the engineer has (or ought to have) little difficulty in avoiding errors and securing the object in view.

Mr. Hull has carefully worked out, and drawn especial attention to, this south-easterly thinning-out of the Triassic and overlying formations, as may be seen by his paper on the subject in the Quart. Journ. Geol. Soc. vol. xvi. p. 63; and the memoir before us cleverly adapts his facts and theory to practical uses.

REPORTS AND PROCEEDINGS.

Address to the Section of Geology at the Opening of the Thirty-fourth Meeting of the British Association, in Bath, September 15, 1864. By John Phillips, Esq., M.A., LL.D., F.R.S., F.G.S., Professor of Geology in the University of Oxford.

THE age of geological discovery is, by many persons, thought to have passed away with Hutton and Werner, Humboldt and Von Buch, Smith and Cuvier, Conybeare and Buckland, Forbes and De la Beche; and they regard as almost final the honoured researches of Sedgwick and Murchison and Lyell. Yet in this very district, the most carefully examined perhaps of all the richly fossiliferous tracts of England, our friend Mr. C. Moore is finding a multitude of interesting forms of life of the later Triassic age, and is thus enriching in an unexpected manner the catalogue of fossils in Britain. Nor is the practical application of our science less actively exercised. In this very district Mr. Sanders has just completed that admirable survey of the strata on the large scale of four inches to a mile, and showing every field, which is suspended before you. Sir R. Murchison has informed us of the further proof of the extension of coal under the Permians of Nottinghamshire; and at this very meeting we receive through the same channel, from Mr. M'Kenzie, the news of the finding of an additional bed of coal in Australia, thirty miles from any former known site of coal, the bed being 38 feet thick and of good quality.

Nothing is better settled than the series of great events in our geological history; yet even now we are rejoicing over the large addition made to this history by the discovery of the richly fossiliferous beds of St. Cassian and Kössen, by which the Triassic fauna is enlarged, and the means of comparing Palæozoic and Mesozoic life augmented by some hundreds of forms, including some genera of the older, and others of the newer systems. The Director of the National Survey has decided to give to these strata in England and Wales a distinct colour on his map and a definite name (the Penarth beds).

But a few years since, the varied strata of marine and freshwater origin above the Chalk were carelessly, if not contemptuously, classed as 'superficial deposits;' now they have acquired a large and regular history, embracing a great succession of organic life, in the sea and on the land, which is appropriately crowned by the works of intelligent man. Not long since, the 'diluvium' or 'drift' was merely an ill-understood basis for ill-considered speculation: now we have classified its parts; have begun to survey the movements of land and sea which preceded and accompanied these latest superficial accumulations; and have even ventured to apply to them measures of time, in a continuous chronology.

The new problems opened by these researches, the inferences to which they lead, and the speculations which they suggest, require only to be named. How to explain the all but universal glaciation of the mountain-regions of Europe—once, or perhaps twice, since the era of the Crag; how to trace the course and limits of those gelid waters which since that era rose to half the height of Helvellyn and Snowdon; how to account for the changes of physical geography which allowed Hippopotami to be buried in the sediments of a Yorkshire river, troops of Mammoths to crowd the Cotswold Hills, and the mingled remains of Reindeer and Man to fill the caverns of the South of France,—these and many more questions of equal importance occupy the attention of geologists, and give a special interest to the later geological periods.

In each of these cases, and in all which come before geologists for interpretation, there is one general rule:—we compare always the ancient phenomena with the most similar effects we can find of forces now in action.

As in existing nature the amount of effect produced by known causes varies with the conditions of each case—as the sun's effect varies from hour to hour, from day to night, from summer to winter, and from year to year, as the force of moving water is greater or less according to the slope of the ground, and the sea's movement is modified by the age of the moon and the position of land—so in earlier nature the combinations of phenomena varied, and the measures of effect were modified accordingly. In another point of view the aspect of nature is found to be variable, and subject to cycles of change, periods of greater and less effect of particular forces which in their own nature are constant. The distance of the earth from the sun is not constant, the form of its orbit is not constant, it was not always nor will always be nearer to the sun in winter than in summer. From these varied conditions, which are measured by long astronomical periods, cycles of greater and less heating effect on the earth in general, and on parts of it in particular, arise; so that speculations as to the causes of the differences of climate during geological periods are entirely incomplete if we leave out of view these real and definite sources of terrestrial vicissitude. Whether they are sufficient, and justly applicable to the facts established in geology, is a proper subject of deliberate inquiry.

Among the facts put in evidence by geology regarding the former condition of the land and sea, none are so convincing of great change and systematic diversity as the remains of plants and animals. By appeals to these innumerable witnesses, conclusions of much importance are maintained, touching the greater warmth of the Carboniferous land, and the colder climate of the later Cænozoic seas. By the same testimony, it appears that over every part of the earth's surface, in every class of organic life, the whole series of created forms has been changed many times.

Have we measured these changes of climate, and assigned their true physical causes? Have we determined the law of the successive variations of life, and declared the physiological principles on which the differences depend? No! the variations of climate must be further investigated, the limits of specific diversity more surely defined, before we can give clear answers to these critical questions.

Late researches, partly archæological and partly geological, both in England and France, have been held to prove the contemporaneity of Man and the Mammoth in the northern zones of the world. Have we, then, been too confident in our belief that the human period was long posterior to, and strongly marked off from, that of the Cavern Bear and the woolly Rhinoceros? Did the races of Hyæna and Hippopotamus remain inhabitants of Europe till a comparatively modern epoch, or was Man in possession of the earth in times far earlier than history and tradition allow?

The prevalent opinion seems to be, that, as variations of the forms of life are extremely slow in existing nature, for every case of considerable change in the predominant types of ancient plants and animals, very long intervals of time must be allowed to have elapsed. If in some thousands of years of human experience no very material change has happened in our wild plants or wild animals, or in cultivated grains, or domestic birds and quadrupeds, it is evident that no considerable changes of this kind can arise from such causes as are now in action without the aid of periods of time not contemplated in our chronology. Estimated in this way, the antiquity of the earth grows to be inconceivable—not to be counted by centuries, or myriads of years—not to be really compassed by the understanding of men, whose individual age is less than a century, and whose histories and traditions, however freely rendered, fall short of a hundred centuries. The whole human period, as we have been accustomed to view it, is but a unit in the vast sum of elapsed time: yet in all those innumerable ages the same forces were seated in the same particles of matter; the same laws of combination prevailed in inorganic and in living bodies; the same general influences resided on the surfaces or governed the masses of the planets, in their ever-changing paths round the sun.

All natural effects are performed in time, and when the agency is uniform, are in proportion to the time. And though the agency be not uniform, if the law of its variation be known, the time consumed in producing a given effect can be determined by calculation. Geological phenomena of every order can be expressed in terms of magnitude, as the uplifting of mountains, the deposition of strata, the numerical changes of the forms of life. The time required to produce these effects can be calculated if we know at what *rate* in time, whether uniform or not, they were produced: if we know, not the true rate, but the *limits* within which it must have operated, the result of the calculation will have a corresponding uncertainty; if we have no knowledge of the rate, calculations are out of the question.

In applying this general view to the history of the earth, philosophers of eminence in physical science have employed different considerations and obtained a variety of results. The conclusions of two eminent mathematicians which have lately appeared may be cited with advantage.

A careful computation by Professor W. Thomson, on selected data, which determine the rate of cooling of earthy masses, assigns 98,000,000 years for the whole period of the cooling of the earth's crust from a state of fusion to its present condition; so that, in his judgment, within one hundred millions of years all our speculations regarding the solid earth must be limited.*

On the other hand, Professor Haughton finds, from the data which he adopts, 1018 millions of years to have elapsed while the earth was cooled from 212° F. to 122° F., at which temperature we may suppose the waters to have become habitable; and 1280 millions of years more, in cooling from 122° to 77°, which is assumed to represent the climate of the later Eocene period in Britain. Computations of this kind cannot be applied except on the large scale here exemplified; and they lose all their value in the eyes of those who deny the general doctrine of a cooling globe.† Much as these periods exceed our conception, they appear to be in harmony with the results of astronomical research, which contemplates spaces, motions, and cycles of periods too vast for words to express, or numerals to count, or symbols to represent.

The greatest difficulty in obtaining trustworthy results as to elapsed time is found where it was least expected—among the later Cænozoic deposits from rivers and lakes, and on the variable shores of the sea. This is the more disappointing because within this period falls the history of the human race. Taking as its earlier limit the latest wide prevalence of glaciers in Europe, attempts have been made to measure its duration by several processes. Quite recently Mr. Croll ‡ recalls attention to an astronomical cause of change of temperature—the varying excentricity of the earth's orbit—by which in a small degree the total *quantity* of heat received in the earth in a year, and in a much greater degree the *distribution* of this heat on the opposite circumpolar spaces, are altered. § The effect of this at particular epochs would be, on one hemisphere an approximate equality of summer and winter heat, on the other an augmented difference between them. If at the epoch of maximum excentricity the earth was in

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* Phil. Mag., Jan. 1863.

† Appendix to a Lecture on Geology, in the 'Reader,' Feb. 1864.

‡ Phil. Mag., Aug. 1864.

§ Consult on this subject generally the valuable communication of Sir J. Herschel to the Geological Society, Proc. vol. i. p. 244, for Dec. 1830.

aphelion during our winter, a great accession of snow might arise and be continued for ages, and glaciers have a large augmentation; under the contrary circumstances, less snow and shortened glaciers. To this latter condition the present state of the north corresponds; and by consulting the astronomical tables, it appears that a condition of extreme glaciation, dependent on the maximum excentricity of the earth's orbit, cannot have happened within the last 100,000 years. This, it will be remembered, corresponds with the conjecture of our President regarding the possible antiquity of the fluviatile gravel-beds with flint implements at St. Acheul; and with the computation of M. Morlot, of the age of the oldest gravel-cone of La Tinière on the Lake of Geneva, which he supposes to have followed the latest extreme extension of glaciation in the Alps.

Quite a different conclusion, however, was presented a few years since by a German mathematician, Herr Adhemar,* who, reflecting on the difference of mean annual temperature of the two hemispheres of the earth—dependent on the inequality of the half-yearly periods, *our* hemisphere having now the advantage of position—finds that within each half 'tropical' period (about 10,500 years) snows would gather and glaciers thicken round one pole, to be afterwards melted while glaciation was spreading round the other. Thus, periodical deluges, at intervals of 10,500 years, are found by this inquirer to be part of the system of nature.

The opinion, however, has long been growing among geologists, that it is rather by rising and falling of the land and displacement of the sea, that the alternations of snows and floods must be explained, which are admitted to have visited the mountain regions of the north. In Switzerland two great extensions of ice in former times have been traced by Escher and the eminent geologists of that country,—the latter one corresponding perhaps to the age of our Glacial Drift.

The melting of snow and ice in the valleys of the Alps is far more rapid under the influence of certain winds than by the direct effect of sunshine. Withdraw the hot Föhn for a season, the glaciers would renew their advance; let it cease, or lose its specific action for a century, the progress of the ice would be considerable. In many centuries the Rhone glacier might reach again to Sion, Villeneuve, and Lausanne; in many thousands of years, all the valleys, and lakes, and borders of the Alps might be reoccupied by ice.

Now the southerly wind, which so rapidly strips the alpine peaks of their snows, draws its melting power from the hot northern tracts of Africa. Were these tracts again covered, as once they were, with an expansion of the Mediterranean, the wind would lose its excessive dissolving power,—snows would gather above, and glaciers extend below to levels and distances now quite unattainable without some great physical change.

Great physical change, then, is the inevitable antecedent to extensive glaciation and abundant dissolution of ice round the moun-

* Revolution des Meeres. Leipzig, 1843.

tains of the north. Astronomical vicissitudes returning in cycles of long duration, changes of level of the land, expansions and contractions of the sea, deviations of the currents of the ocean, alterations in the prevalent direction and quality of the winds—whichever of these causes we assume, and however we combine them, it is evident that we are appealing from the existing order of nature and the present measures of effect in time, to some other combination of natural agencies, some other standard of physical energy. The conclusion is obvious. Inductive geology refuses to accept definite periods for phenomena produced under conditions not yet really determined.

I will not, by any further observations, discourage you from exploring this attractive field of research, or restrain the freedom with which you will desire to discuss it. Only let me add, that to one fresh from the Alps,—from the old Pfahlbauten of the lakes, and much older monuments of overspreading snow and gliding ice, the later ages of geology and the earlier ages of mankind seem to be fairly united in one large field of inquiry. That it must be trodden with heedful steps, and demands all possible care in the scrutiny of facts, in the estimation of natural agencies, and in the choice of right measures of time, before the Pleistocene, Quaternary, or Human period can be said to be accurately known by natural phenomena, even in this the best-examined part of the world, is obvious.

But the same remark applies to every one of the many perplexing questions which have been considered by geologists. By following the same good processes of strict inquiry and cautious interpretation which have settled those difficulties, we may hope to settle this. Let every one join in the effort, and bring selected materials to the growing fabric; so that we may not erect a rude and barbarous cairn, the memorial of dead opinions, but construct a temple of well fitted stones, in which we may worship with delight the God of Truth, and be followed in the same pleasing duty by many successors.

The following Papers were read before the Geological Section of the British Association for the Advancement of Science, at Bath, Sept. 15—21, 1864:—

The President's (Prof. Phillips) Opening Address. See above, p. 175, &c.

W. Sanders.—A brief Explanation of a Geological Map of the neighbourhood of Bristol and Bath.

Professor Phillips.—Measures of Geological Time by Natural Chronometers, with a communication from M. Morlot.

H. C. Sorby.—On the conclusion to be deduced from the Physical Structure of some Meteorites.

H. Woodward.—On the family Eurypteridæ, with descriptions of some new genera and species.

H. C. Salmon.—On the Geognostic relations of the auriferous quartz of Nova Scotia.

F. Von Hauer.—A notice of the latest labours of the Imperial Geological Institute of Austria.

Sir R. I. Murchison.—Note on the occurrence of the same fossil plants in the Permian rocks of Westmoreland and Durham.

W. Pengelly.—On Changes of Relative Level of Land and Sea in south-western Devonshire, in connection with the Antiquity of Mankind.

C. Moore.—Remarks on the Geology of the south-west of England.

H. B. Brady.—On the Foraminifera of the Middle and Upper Lias of Somersetshire.

Professor Harkness.—On the Lower Silurian rocks of the south-east of Cumberland and the north-east of Westmoreland.

Rev. G. F. Browne.—On the formation and condition of the Ice in certain Ice-caves of the Jura, Vosgian Jura, Dauphiné, and Savoy.

W. W. Stoddart.—On the Lowest Beds of the Clifton Carboniferous series.

Handel Cossham—On the geological formation of the district around Kingswood Hill, with especial reference to supposed development of Millstone-Grit in that neighbourhood.

W. H. Baily.—On the occurrence of Fish-remains in the Old Red Sandstone of Portishead, near Bristol.

Rev. P. B. Brodie.—Remarks on two outliers of Lias in South Warwickshire, and on the presence of the Lias or Rhætic Bone-bed at Knowle, its furthest northern extension hitherto recognized.

C. W. Peach.—On Traces of Glacial Drifts in the Shetland Islands.

C. W. Peach.—On Boulder-clay Fossils.

J. Leckenby.—On the Boulder-clay and Drifts of Scarborough and East Yorkshire.

Dr. Daubeny.—On the cause of the extrication of Carbonic Acid from the interior of the earth, and on its chemical action upon the constituents of Felspathic Rocks.

Commander B. Pim, R.N.—Notes on the Volcanic Phenomena and Mineral and Thermal Waters of Nicaragua.

J. W. Salter.—On the old Pre-Cambrian (Laurentian) Island of St. David's, Pembrokeshire.

J. W. Salter.—On some new forms of Olenoid Trilobites from the lowest fossiliferous rocks of Wales.

W. H. Baily.—On some new points in the structure of *Palæchinus.*

Rev. H. B. Tristram.—On a Bone-breccia with Flints found in the Lebanon.

Rev. H. B. Tristram.—On the Formation of the Jordan Valley and the Dead Sea.

Rev. H. B. Tristram.—Notice of a Bitumen and Sulphur Deposit at the south-west corner of the Dead Sea.

Rev. H. B. Tristram.—On the Geology of Palestine.

Dr. Hector.—On the Geology of Otago, New Zealand.

W. Keene.—On the Coal-measures of New South Wales, with Spirifers, Glossopteris, and Lepidodendron.

J. Mackenzie.—On the New South Wales Coal-field.

J. Randell.—On the Position in the Great Oolite, and Mode of Working, of the Bath Freestone.

H. Seeley.—On the Significance of the Sequence of Rocks and Fossils.

E. R. Lankester.—On the Species of the genus *Pteraspis.*

Dr. T. Wright.—On the White Lias of Dorsetshire.

Preliminary Report of the Committee.—On the Distribution of the Organic Remains of the North Staffordshire Coalfield.

Sir W. Logan, Dr. Dawson, and Dr. Sterry Hunt.—On Organic Remains in the Laurentian Rocks of Canada.

W. A. Sanford.—Notice of Carnassial and Canine teeth from the Mendip Caves, which probably belong to *Felis antiqua.*

W. Boyd Dawkins.—On the newer Pliocene Fauna of the Caverns and River-deposits of Somersetshire.

Dr. Falconer.—On Fossil and Human Remains of the Gibraltar Cave.

Professor Phillips.—On distribution of Granite blocks from Wasdale Crag.

Professor Phillips.—On excavation of Valleys near Kirby Lonsdale.

Professor W. B. Rogers.—On a cast of a peculiar fossil found in the Mesozoic Sandstone of the Connecticut Valley.

W. Bristow.—On the Rhætic (or Penarth) beds of the neighbourhood of Bristol and the south-west of England.

Professor Hennessey.—On Geological Climate.

Dr. T. Hodgkin.—Notice of some Geological Appearances in the north-west of Morocco.

Dr. R. N. Rubidge—On the Relations of the Silurian Schist with the Quartzose rocks of South Africa.

Dr. T. Wright.—On the Development of Ammonites.

H. Seeley.—On the Pterodactyle as evidence of a new sub-class of Vertebrata.

M. Hébert.—Note on some of the Oolitic strata seen at Dundry.

W. W. Smyth.—On the Thermal Water of the Clifford Amalgamated Mines of Cornwall.

A. Bassett.—On the South Wales Mineral Basin.

E. S. Higgins.—On Otolites.

H. C. Hodge.—On the origin of certain Rocks, and on the Ossiferous Caverns of the South of Devonshire.

Dr. P. Carpenter.—On the connection between the Crag formations and the recent North Pacific Faunas.

The Severn-Valley Naturalists' Field-club.—The second Field-meeting this season was held in the Forest of Wyre on the 30th June last. The place was chosen chiefly for the benefit of Botanical and Entomological members, being the habitat of many rare plants and insects; but it is not without interest to the Geologist. The Forest was formerly much more extensive than it is at present, and nearly entirely stands on Carboniferous strata. These are almost horizontal; but in the cuttings of the newly made railway from Bewdley to Tenbury, and in the gorges of streams which traverse the Forest, good sections are to be seen; and from them it appears that the beds are those of the Upper Coal-measures, very rich in Plant-remains, and much fractured; and the coal-seams are very thin and of poor quality. Few (if any) sinkings have been made in the present Forest; but, from pits and trial-shafts in neighbouring parts of the same field, it would appear that the lower and more productive coals are wanting, and that the measures rest on the Old Red Sandstone; the Carboniferous Limestone and Millstone-grit being absent, though well represented in the Oreton beds of the Titterstone Clee Hill Coal-field not seven miles distant. A sinking at a place called Shatterford on the north-west margin of the Wyre Forest Coal-field, made some few years ago, may perhaps afford a type of the whole field; the undertaking was a most enterprizing one, but resulted in sad disappointment and loss to all concerned; the depth actually attained was upwards of 450 yards, in the course of which eight seams of coal were met with, the aggregate thickness of which amounted to only about seven feet; one thin nodular bed of limestone was met with in the upper part of the sinking, and no ironstone worth mentioning. The shaft finally terminated in a mass of basaltic greenstone, said to be very similar to that of Kinlet Hill, another outlying spot in the same Field.

The day's proceedings consisted of an examination of the sections in the railway-cuttings, and concluded with dinner at Bewdley, after which an address was given on the passage-beds and overlying Carboniferous Limestone of Farlow and Oreton, and in illustration of the fine collection of Mr. Weaver Jones, of Cleobury Mortimer, from those beds adverted to in the GEOLOGICAL MAGAZINE for August. Subsequently, Mr. Busk, F.R.S., handed round for the inspection of the company a variety of flint and other implements from Denmark, the Somme Valley, and elsewhere, and gave a very clear and able address on the subject of the evidences of the 'Antiquity of Man.'

On August 4th the third meeting of the Club was held at the Stiper Stones. The day's proceedings commenced with an examination of the Snailbeach Lead-mine, worked in the Llandeilo beds on the western slopes of the hill. In this mine the lead-ore is found in great purity and abundance; and associated with it occur sulphide of zinc, sulphate and carbonate of baryta, and, though rare, bisulphide of iron, and other minerals. On the summit of the hill an address was given by the Rev. J. D. La Touche, M.A., on the geological features of the district, in the course of which he adverted to the remarkable difference and want of conformity between the Lingula-flags, which crop out on the eastern side of the hill, and of the Llandeilo beds, which formed its western slopes, and argued that, in accordance with Professor Ramsay's views on 'Breaks,' which he freely endorsed, there must be a considerable *break in time* between the two formations. The singular quartzose rocks which form the summit of the hill, so well described by Murchison, and which constitute the dividing line between the Lingula and Llandeilo beds, he was inclined to refer to the Lingula-flags, although some considered them a lowermost band belonging to the Llandeilo series. Descending by one of the pretty dingles on the western side of the hill, the party returned to Minsterley, where, after tea, an interesting paper was read by the Rev. Fred. Smithe, M.A., F.G.S., on 'The Trilobite and its affinities:' it was illustrated by a variety of specimens, foreign and native, chiefly from Lower Silurian rocks and their equivalents, including several from the very Llandeilo beds that day visited.—C. J. C.

A field-meeting of the Dudley and Midland Geological Society was held on the 3rd August at Dudley and the neighbourhood, in connection with the Warwickshire Naturalists' Club.

The party assembled at the Dudley Geological Society's Museum, and spent some time in examining the Silurian and other fossils contained in that collection. They proceeded thence to Windmill Hill, near Shaver's End, where some interesting examples of artificial metamorphism were noticed, caused by the combustion of the coal-measures many years ago. From this point the geological features of the western portion of the Dudley coal-field are well displayed, particularly several knolls of greenstone, of which the most important is Barrow Hill. The next point of interest was the Lower Ludlow measures of Parkes's Hall, where a considerable number of organic remains. chiefly shells, were obtained. The peculiar fossils found showed clearly that these beds have been correctly laid down as the equivalent of the Ludlow rocks. The reservoir of the Old Dudley Waterworks Company is situated in the same measures, and has yielded valuable specimens of the Upper Silurian fossils. The Wren's Nest Hill was gained at the northern extremity, and some time was spent in examining the contorted measures now being worked. Several faults here intersect each other, and one in particular appears to cut off the limestone to the north-west of the hill. The party descended into the lower workings, which Mr. Hollier lighted up with coloured fires, and by this means the vast proportions of the excavations were well displayed. After this the upper line of caverns was examined; and, though but few fossils were here obtained, the remarkable inclination of the beds and the facilities afforded for studying the physical geology of this dome of Silurian upheaval, made the walk extremely interesting, to the visitors especially. Near the southern end of the hill many characteristic Dudley fossils were found, and a few valuable specimens, chiefly Corals. After examining the southern extremity of the hill, a careful search was made along the deep ravine on the eastern side, and here numerous Corals (some very large and perfect), Shells, and fragments of rarer remains were obtained. Several fine specimens of *Heliolites*, *Favosites*, *Chœtetes*, *Thecia*, and *Acervularia* were found; but the majority were too massive to be easily bagged, though one or two enthusiastic geologists carried away a good spoil for their day's work. The last point visited was the new sinking at Old Park, where the Ludlow beds have again been penetrated. A long halt was made at this place, as the fossils, though not particularly numerous, are highly important and characteristic. The examples procured were true Ludlow forms, especially *Serpulites longissimus, Chiton Grayii, Theca*, &c. The near approach of the dinner-hour compelled the party to abandon their field-work, and a most welcome adjournment was made to the Dudley Arms Hotel. After the usual loyal toasts, the Secretary of the Warwickshire Club read an interesting account of their recent meeting at Cleobury Mortimer and the locality. The President then proposed the health of the 'Dudley Society,' and in doing so invited them to hold a meeting at Warwick at an early date. Mr. Hollier expressed the pleasure the Dudley Club had felt in being favoured with a visit from the Warwickshire Society, and was glad that the visitors had been able to see the principal fossils of the Dudley rocks in the Museum, which he hoped would, ere long, become a most valuable scientific collection. He hoped that on some future occasion the Warwickshire gentlemen would inspect the district again, and look at the coal-measures of the locality. Mr. Jones, in proposing the health of the Warwickshire Club, said that he thought a field-meeting at Warwick would be most acceptable to the Dudley Club; and hoped that early next year such a gathering might be held. The meeting then broke up.—The third general field-meeting of the same Society for the present year was held on August 15, at Cheltenham. The party, including several ladies, proceeded by special train, which reached Cheltenham about nine o'clock. After examining the various points of particular interest in the town itself, the party took conveyances to Seven Springs, passing through Charlton Kings, and over the spur of Leckhampton. At the head of the classic Isis, which commences its course in the once-sequestered dell known as the 'Seven Springs,' a considerable halt was made. Unfortunately the hand of a ruthless innovator has been at work here of late, and the crystal streamlet, doomed to labour so nobly before it reaches its parent ocean,—the little brook destined to bear upon its broader waters the merchandise of the world, has been turned to a utilitarian purpose ere it has well come to the light of day. The little wooded dell, where once grew the rare *Elymus Europæus* and *Thesium linophyllum*, has now given place to glaring red brick houses, potato-plots, gas-works, and a pond, apparently for machinery-purposes, while overlooking all is the mansion of a northern cotton-spinner, who has made this classic spot his home, but who has failed in a singular degree to produce anything in keeping with the association of the place. The party next proceeded in the direction of Leckhampton, picking here and there a rare plant, though the recent hot weather has robbed the botanist of many of his best treasures. The Ragstone quarries on the summit of the hill afforded the first work for the hammers. This division is the upper layer of the Inferior Oolite, and abounds in organic remains, particularly Oysters, which crowd almost every lump of stone, *Trigonia, Ammonites, Belemnites, Pleurotomaria, Terebratula, Rhynchonella, Nucleolites, Serpula*, &c. Here, among the débris from the workings, grow the *Anagallis cærulea, Papaver Argemone, Galeopsis ladanum, Lycopsis arvensis*, &c. A short walk from this point led to the brow of the hill overlooking the extensive plain of North

Gloucestershire, with the town of Cheltenham in the foreground, situated as it were in a sheltered bay of the Cotswold Hills. The scene was bounded on the north-west by the faint outlines of the Malvern range, which, though infinitely older in a geological point of view than the Cotswolds, is intimately associated with them as forming at no very remote period the western boundary of the sea which then rolled from what is now the British Channel to the Irish Sea. Indeed the 'ancient Straits of Malvern' is now an expression with which few geological readers are not familiar. Had the day been fine, the Old Red Sandstone hills of the Black Hills, and the blue outlines of many Welsh peaks, would have been discernible. The interesting geological features of the extensive scene were here laid before the party in a remarkably distinct manner. The flat, agricultural, and well-wooded district is Lower Lias Clay, which beneath Cheltenham is said to be about 600 feet in thickness. Above this, just at the fork of the hills, a gentle slope leads up to a well-defined platform. These are the two divisions of the Middle Lias, the upper or rock-bed forming the terrace above mentioned, while the sandy beds shade off gradually into the plain below. The next member of the Lias is a layer of blue shale and clay, which on the other side of the hills throws out the 'Seven Springs,' and may be generally traced better by the water which escapes from the line of junction with the upper strata than by any evidence to be obtained from the face of the hill. The overlying deposit, only a few feet in thickness, is a most remarkable bed, and one which has afforded a considerable number of organisms which do not pass upward into the Oolite rocks above. This has been termed by some the 'Ammonite-bed,' but it is now familiarly known to geologists as the 'Cephalopod-bed,' and is now taken as the upper member of Liassic formation, and as one of our best illustrations of the breaks which frequently occur in the rocks, and where a total change in the fossil remains, even within a few inches of vertical space, indicates a vast lapse of time which must have intervened between the formation of adjacent deposits. This peculiar bed has been traced from Cheltenham to the Dorsetshire coast, and also into the North of France. The Oolite series, well seen in the Leckhampton quarries, consists, in ascending order, of (1) pea-grit, so called from the large particles of carbonate of lime of which it is composed; (2) lower freestone, a considerable thickness of softish, white stone, easily worked, and showing the oolitic character very clearly; (3) a thin layer of marl; (4) the upper freestone, much similar to the lower; and (5) the ragstone, already mentioned. But not only are the above geological features presented to view from the summit of this eminence; the evidences of the nature of the changes by which the present configuration of the district was originally produced are clearly exhibited. The Lias plain is dotted here and there by rounded, isolated hills, having the same structure as the typical Leckhampton mass, and evidently due to denudation. At one time no doubt they existed as islands in the ancient sea whose eastern beach was on the flanks of what is now the Cotswold Range. But attractive as was this vantage ground both in a scientific and merely picturesque point of view, the party had to descend as best they could the steep incline which leads to the quarries in the freestone. Here again stone-chipping became the order of the day, and some very interesting and perfect specimens were obtained, amongst which *Terebratula fimbria* appeared to be the most abundant. Several good plants were also procured, as *Arabis hirsuta*, *Hypericum hirsutum*, *Hieracium* sp. (?), *Epilobium angustifolium*. The last point examined was the junction-beds of the Inferior Oolite and the Upper Lias, but no good exposure could be found. The Lias Clay was, however, easily found *in sitû* with the brown sandstone of the 'Cephalopod-bed' overlying it, and several characteristic fossils were obtained. At five o'clock a cold collation was provided at the Queen's Hotel. On the removal of the cloth, a few business-matters were discussed and arranged, after which the Rev. J. H. Thompson gave a short account of his recent visit to the Tyrol and Northern Italy. He alluded to the great facilities which will be afforded for giving ready access to this highly picturesque locality, owing to the formation of railways. He had found the district particularly rich in botanical treasures, and it was no uncommon thing to be able to collect in a single day upwards of fifty species unknown in the British flora. He noticed also the remarkable tenacity of plants to their habitats, especially with reference to altitude. He had met with numerous plants at a height of 9,000 feet, just on the confines of perpetual snow, that he could not find a few feet lower down. *Ranunculus glacialis* indeed grows only where it can spread itself over the ice of the mountain-glacier. The geological features of many portions of the Tyrol are also exceedingly remarkable and interesting. In one district there is a wide tract of country composed for miles of columnar basalt. He trusted that members of the society would be induced to visit the Tyrol instead of 'doing' Switzerland several times. In conclusion, he promised that at some future time he would exhibit the flora of the Tyrol at one of the evening-meetings of the society. After a vote of thanks to the rev. gentleman for his address, the day's proceedings were brought to a close, and the party returned shortly before eight o'clock.—J. J.

The East Kent Natural History Society met at Folkestone on August 30th, under the command of the president, Major Cox, to examine the well-known cliff-section. A field-lecture was given by Mr. Whitaker (of the Geological Survey of Great Britain), the substance of which will be given in our next number. The members and their friends dined together at the Pavilion, after a pleasantly spent afternoon.

The fourth excursion for the present session of the Belfast Field-naturalists' Club was made to Colin Glen on the 6th of August. In the walk up the Glen, the great development of the variegated marls of that portion of the Triassic series known as the Keuper formation was passed over. The principal point of interest was a natural section, by the stream, of the *Avicula-contorta*-beds, which contain a thin stratum known to geologists as the 'Fish-bed,' containing abundant Fish-remains. A detailed account of these beds was read before the Society during the last session, by the late Secretary, R. Tate, Esq., F.G.S. — its fossils being named and its proper place in the geological scale assigned. Those, however, who desired to see the stratum for themselves, and obtain some of its fossils *in sitû*, were disappointed, as it was covered by débris, the bank having lately fallen. A number of fossils were obtained characteristic of the *Avicula-contorta*-zone, as *Ostrea liassica*, *Modiola minima*, *Axinus cloacinus*, *Pecten Valoniensis*, *Cardium Rhæticum*, and *Avicula contorta*.

Ascending the Glen still higher, the party came upon the Upper Greensand formation, and the hammers were set to work with success ; many relics of the life of this period being exhumed. The only rare fossils found here were the limbs and claws of a new Crustacean species, probably a *Karnassia* (?). Good specimens were obtained of *Pecten æquicostatus*, *Ostrea semiplana*, *Exogyra columba*, and *Cucullæa fibrosa*. The Upper Chalk reposes here upon the Upper Greensand.—R. T.

The Bristol Naturalists' Society.—The third and concluding excursion for this season took place on August 15th. The locale chosen was the well-known Aust Cliff, especially interesting to geologists from its containing a thin bed with fossil bones, which has also been discovered cropping out at Axmouth, in Devonshire, and Westbury, places fully sixty miles distant.

On this occasion the number was more limited than usual, only twenty-four members being present, and no ladies. They left by the 12.30 train for the New Passage, and, after a slight lunch at the Hotel, walked along the shore in the direction of the cliff. On account of the drought scarcely any plants of interest were found, and the hardness of the ground prevented the beetles peculiar to such localities from making their way to the surface: the scientific interest of the walk therefore was solely geological. At the distance of a mile the clearness of the air enabled the various strata to be readily discerned, the cliff presenting the appearance of a coloured geological sectional map. On arriving at Aust, the President, Mr. W. Sanders, F.R.S., F.G.S., gave a description of the strata thus admirably displayed. These comprise the highest beds of the New Red Sandstone, and the lowest of the Lias formation. The red marls at the base support about 10 feet of pale greenish marls, including a six-inch bed of marly sandstone. Resting on these marls the Lias commences with a thin bed containing remains of Fish. The next 12 feet consist chiefly of black laminated shales, and they include three thin beds yielding remains of Fishes, Insects, and various Bivalve Molluscs. The following 25 feet are composed of alternations of thick marly clays and thin beds of limestone—the highest of which is known as Cotham Marble. This portion of the Lias formation has received various appellations : the older geologists called it the Lower Lias Clays ; next it was termed the *Avicula-contorta*-beds, that shell being limited to these strata ; subsequently it has received the name of Rhætic beds, on account of its geological affinity with strata which occur in great force near the Rhætian Alps. At the distance of a half-a-mile further along the shore the red marls presented a thickness of nearly 100 feet, at about 60 feet below the upper limit of which abundance of fibrous gypsum (sulphate of lime) occurs in horizontal layers, intersected by nearly vertical veins and threads; strontian, too, occasionally occurs in this stratum. At this part of the cliff it was observed that the fish-bed resting on pale green marls, which at the southern end of the cliff was seen to be very thin, had gradually expanded to a thickness of eight or ten inches, and consisted of a conglomerated mass of rounded portions of the subjacent marly sandstone, coprolitic nodules, detached vertebræ and other bones of the *Plesiosaurus*, parts of Fishes, especially teeth, and some Shells. It is this bed which is famous in all text-books on geology under the name of the Aust Bone-bed.

In the course of the walk three examples of dislocation of the strata were seen; the nature of these faults were explained, and they were shown to possess all the characteristics of normal faults as they occur in coal-mining. Many of the party worked hard with hammers and chisels, and were fortunate in obtaining good illustrations of the Bone-bed, and other specimens. A portion of a vertebra and other bones of a *Plesiosaurus*, a spine-bone of a fish, *Nemacanthus*; teeth of *Ceratodus*, *Saurichthys*, and *Hybodus* were found, together with various fossil shells, as *Pecten Valoniensis*, *Cardium Rhæticum*, *Modiola minima*, *Anatina*, *Avicula longispinosa*—a very rare shell in this locality, and *Ostrea liassica*.

On the return to the New Passage, that characteristic phenomenon of tidal rivers possessing a rapid down stream, the bore, or aeger, was well seen, like a perpendicular wall of water, about three feet high, advancing up the river. At the New Passage Hotel a most comfortable dinner awaited the party, and when they had done justice to it the members returned to Bristol by the 6.45 p.m. train.

We understand that the Council of the Society are endeavouring to form Geological, Botanical, and Chemical sections, for the special advancement and study of these branches of science. The first meeting of the next session will take place on the first Thursday in October.—W. W. S.

CORRESPONDENCE.

ON ESKERS OR KAIMS.

To the Editor of the Geological Magazine.

The Kaims, or Eskers, as we call them in Ireland, seem to be receiving attention, as I find them mentioned in nearly every recent geological publication;* but the observers all seem to examine only

* See Geological Magazine, No. 1, pp. 34, 45; and No. 2, p. 89.

a part, and not the whole system of Kaims. In Ireland the Esker systems extend sometimes for over a hundred miles, but are modified by local circumstances. On low ground they are well defined ridges, which break into *Shoal-eskers* (consisting of irregular mounds and short ridges), crossing high ground, but again becoming well defined when the high ground is passed. If a hill occurs, the Esker will be either deflected and form a *Fringe-esker* round it, or there will be a break in the Esker system, as it ends on or near one side of the hill, but sets on again at the other side.

The Esker-drift seems to be *washed* Boulder-drift, or 'Post-drift Gravels;' and in sections which expose the two kinds a well-marked line of demarcation will be observed between them, which would seem to prove that they are different kinds of Drift. Of course if the 'Post-drift Gravels' were formed by the washing of the Boulder-drift, we shall not always find the latter entirely washed, as sometimes the washing power would not have been strong enough ; and in these places the two kinds of Drift would seem to blend one into another. This is not the proper place to examine the 'Post-drift Gravels;' but where they are well developed they always have a marked boundary. In the basal beds of an Esker, or in an Esker in which the gravel is unstratified, blocks will be found that are striated and polished ; but this does not prove that they are of the same age as the Boulder-clay; since these blocks may have been polished before they were removed from the Boulder-clay, and were not afterwards rolled enough to obliterate the old marks. That this is the case seems likely, as the marks on them are not nearly as fresh as if they were taken direct from a bank of Boulder-drift.

I would suggest to observers that they should trace *Kaims* or *Esker Systems* across a wide expanse of country, and that they should carefully note the different changes that occur ;—what effect high land has on the Esker Systems ; what is the height of the land on which they are in well defined ridges ; what the height when they break into Shoals ; when they break into shoals, is the Drift 'Post-drift Gravels' or Boulder-drift, denuded into ridges and mounds, or partly one and partly the other ? They should also note carefully all junctions between the two kinds of Drift. The 'Post-drift Gravels' sometimes form a gently undulating country, and do not break into ridges ; and an observer ought to be careful not to confound it with a much older gravelly Drift which underlies the Boulder-clay (the Drift of the country before the Glacial Period), for which I would propose the name '*Preglacial Drift.*'—Yours, &c.,

G. H. Kinahan.

EXELISSA *v.* KILVERTIA.

To the Editors of the Geological Magazine.

Mr. Lycett* has given to *Cerithia* having an entire aperture the generic title of *Kilvertia*; and has referred *C. strangulatum*, D'Arch.,

* Supplementary Monograph, Moll. Great Oolite, p. 93. 1863.

and three new species to that genus. *C. strangulatum*, D'Arch., had been previously used as a type-species by Piette* for his new genus *Exelissa*.† The characteristics of the genus, as pointed out by Piette, are—Shell scalariform; aperture orbicular, entire; last whorl cylindrical, contracted at the base, with a tendency to separate from the axis. *Kilvertia* is therefore a synonym of *Exelissa*. All the shells of this genus, which is allied to *Rissoa* and *Scalaria*, are very small; they occur in the Inferior Oolite and upwards to the Great Oolite.—Yours, &c., RALPH TATE, F.G.S.

COLONEL G. GREENWOOD has favoured us with a letter on the improbability of the existence of real Meteoritic stones. The study of the subject of Meteorites in a good Cyclopædia, or in Somerville's 'Connexion of the Sciences,' or, better still, if possible, in the many papers in the 'Philosophical Magazine,' and an examination of the specimens themselves in the British Museum, will serve our correspondent far better than putting his doubts on paper.

MISCELLANEOUS.

THE GEOLOGICAL SOCIETY OF FRANCE will hold its Extraordinary Meeting this year at Marseilles, commencing on the 9th of October. Excursions will be made to localities where a considerable portion of the Triassic, Jurassic, Cretaceous, and Tertiary formations can be studied. It is also purposed to examine the porphyritic masses of Esterel (Toulon). The well-known geologists MM. Coquand and Matheron will act as local guides.

AMONG THE PRIZE-QUESTIONS proposed by the Imperial Academy of Sciences, Vienna, at the Anniversary Meeting, May 30, 1864, the following relates to Geology. The Academy requires 'a precise mineralogical and, as far as necessary, a chemical investigation of the greatest number of Eruptive Rocks occurring in the Secondary deposits of the Austrian Empire, and a parallel of these rocks with known older and younger eruptive rocks of Austria and other countries.' The papers are to be transmitted to the Academy before December 31, 1866; the name of the prize-holder is to be proclaimed at the Anniversary Meeting in May 30 of the following year. The prize is 200 Imperial ducats in gold (about £100 sterling).

A BED OF COAL, said to be eight feet thick, and supposed to be of Oolitic age, has been found in the bed of a stream running into the Kawa-kawa River, in the Bay of Islands, New Zealand. The coal burns freely, with a bright flame, very little smoke, and scarcely any residue.—*Daily Southern Cross*, Auckland, N.Z., April 30, 1864.

* Bull. Soc. Géol. France, 2e sér. vol. xviii. p. 14. 1861.

† From Ἐξελίσσω, I unfold.

Gold in Nova Scotia.—The 'Report of the Chief Gold-commissioner for the Province of Nova-Scotia, for the year 1863' (8vo. Halifax, 1864), shows that the total yield of gold for the year, according to the official returns, is 14,001 oz. 14 dwt. 17 gr., equivalent, at $18·50 per oz., to $259,032·06; very nearly doubling the yield of 1862. This is the product of 877 men, whose labour was also directed to the formation of roads and to the works preparatory or accessory to mining; and 'the yield to each man engaged during the year (averaging $296) is very much higher than has yet been attained in quartz-mining in any other country.' The yield per ton from crushing was nearly (average) 16 dwt. 12 gr.

The Greensand of Vorarlberg, North-west Tyrol, is highly developed and far spread in Western and Eastern Switzerland, becomes subordinate in the Vorarlberg, until, at last, it disappears completely in its eastward range. The only known locality for Greensand fossils in the Vorarlberg is the Margarethenkopf, near Feldkirch, where Mr. T. Sholto Douglas collected some, which he presented to the Museum of the Imperial Geological Institution. Among them are:—*Ammonites Milletianus*, and *Discoidea Rotula* (already quoted by Escher from this locality), also *Belemnites semicanaliculatus*, Blainv., *Ammonites Mayorianus*, D'Orb., *A. dispar* (?), D'Orb., *Terebratula Dutempleana*, D'Orb., besides some others not yet determined.—Count M.

Meteoric Iron from California.—Director Haidinger (Proceed. Imp. Acad. Vienna, Oct. 8, 1863) states that the city of San Francisco (California) has presented to the Imperial Museum of Vienna a portion of the Tucson Meteorite, weighing 13 ounces, together with a photograph of the whole block, which was brought by General Carleton from Tucson (Avizana Territory, U.S.) to San Francisco, and presented to that city. The length of the block is 4 feet 1 inch (English); its weight 632 pounds. This meteorite, containing, like other meteoric irons, minute particles of silicates disseminated throughout its mass, is conspicuous for its peculiar texture, which gives it the aspect of a genuine granular iron-rock. Another block from the same place, weighing between 1200 and 1600 pounds, has for a long time been the property of the Ainsa family at Hermosillo (Sonora), and is to be offered to the Smithsonian Institution at Washington.—Count M.

M. Lipold (Proceed. Imp. Geol. Instit. Vienna, Dec. 1, 1863) describes the Coal of Berzaska, Military Frontier, Austria, as having been opened eighteen years since, and having been worked to a maximum depth of 300 feet. It overlies gneiss, striking NNE.—SSW., and dipping westward. The three coal-seams hitherto penetrated can be worked in a thickness of 2–3 feet. The roof is a fossiliferous limestone, cropping out in a great number of localities, and containing *Cardinia concinna*, *Mytilus decoratus*, *M. Morrisi*, *Pholadomya ambigua*, *Pecten liasinus*, *P. æquivalvis*, *Terebratula Grossulus*, *T. Grestensis*; it may the reforebe considered as Liassic. In 1863 the quantity of coal extracted reached the amount of 22,200,000 Vienna pounds (about 9,900 tons).—Count M.

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ORIGINAL ARTICLES.

I. On *Involutina liassica* (*Nummulites liassicus*, Rupert Jones).

By Henry B. Brady, F.L.S.

[Plate IX.]

IN the 'Annals and Magazine of Natural History' for October, 1853 (2 ser. vol. xii. p. 272), there appeared a short memoir on the Lias at Fretherne (Gloucestershire) by the Rev. P. B. Brodie, and to it is appended a Note by Mr. T. Rupert Jones relative to certain *Foraminifera* which had been obtained from that formation. One of these *Foraminifera*, an organism of some interest and importance in a palæontological point of view, was partially described by Professor Jones in the Note alluded to, with the provisional name *Nummulites liassicus*. The general form of the shell is similar to that of the Nummulite, though its average size is somewhat less than even the smaller fossil varieties of that genus; and the way in which the specimens are crowded together in some portions of the strata, as though the rock was almost composed of them, may have suggested by its appearance an analogy to the Nummulites in the Nummulitic limestone.

In working over the *Foraminifera* of the Lias formation, I have met with the same organism in various localities and under different circumstances. The specimens from Fretherne Cliff, which, through the kindness of Professor Jones, I have now before me, are too firmly embedded in the compact limestone to admit of their easy examination except in thin sections of the rock itself; but in the Lias Clays of Worcestershire the same species exists in considerable abundance, and the character of the matrix offers unusual facilities for procuring specimens in a condition suitable for study. Again, in certain shales which abound in Warwickshire, these little fossils are so loosely impacted that they can be easily picked out; and the largest specimens I have seen were collected in this way near Rugby by the Rev. Fred. Smithe, F.G.S., of Noake Court.

The structure of the organism and its relationships are most easily recognized in the middle-sized and smaller specimens washed out of clays. It consists essentially of a tube, somewhat increasing in diameter, coiled upon itself in a horizontal plane,—or perhaps, more correctly speaking, of a tube, with a portion of its periphery cut out, coiled upon itself, as it is only a tent-like covering for the sarcode, increasing in length with the growth of the animal. The shell-wall is not double between the successive coils of the spire, as is the case in the true *Rotalinæ*. Much exogenous deposit of shell-substance takes place upon the disc thus formed, sometimes covering the entire surface, but more usually leaving the outermost circle of the tube bare. This thickening does not occur with evenness or regularity; but, in addition to its general tendency towards the centre of the disc (which gives the bi-convex contour), it takes the form of irregular tubercles, which sometimes almost cover the sides.

The peculiar structure of the shell-walls may be seen in the outermost whorl of the spire, or in any portions which remain free from external deposit. Microscopical examination shows that it is not homogenous in texture, but composed of arenaceous grains embedded in the calcareous shell-substance, indicating, together with certain other characters shortly to be mentioned, a much lower organization than that possessed by the Nummulitic group.

The open end of the tube seems to act as the general aperture; but if a horizontal section be made, by grinding away a portion of the two sides of a specimen, we have distinct traces of pseudopodial perforations on the inner surface of the walls, though these are concealed externally by sandy particles, more or less incorporated in the shell-substance (see Pl. IX. fig. 6). A glance at the same section also shows the very partial and irregular development of the septa; indeed many specimens appear to be almost devoid of any division into chambers. Some horizontal sections seem to indicate that the septa, or imperfect partitions, are not formed on the same plan that prevails in the higher forms of *Foraminifera*, but that they are essentially plaits or infoldings of the outer shell; and their irregularity in number, extent of development, and position, are dependent on their peculiar mode of growth. The accompanying wood-cuts explain more fully what is meant. Fig. 1 is a diagrammatic representation of one of the sections alluded to; and fig. 2 is a more highly magnified diagram of a portion of the shell-wall, showing the mode in which the infolding occurs, forming the septa.

The transverse section (Pl. IX. fig. 5) gives evidence only of the course taken by a simple tube, rounded or more or less semicircular in section, as it forms the central disc of the shell, the remainder being, at any rate in the Fretherne specimens, occupied by irregularly crystalline masses, giving no evidence of structural peculiarity. There are, however, some few transverse sections which present a series of ill-defined parallel lines running from the median line to the upper and lower surface; an appearance which has doubtless been associated with the 'columnar' structure of the Nummulite when the organism was supposed to belong to that group.

Fig. 1. Diagram-outline of the horizontal section of *Involutina Liassica*, showing how the infoldings of the semi-tubular shell form the imperfect septa.

Fig. 2. Diagram-outline of the shell-wall of *Involutina* forming the septa by infoldings.

One of the most important characters in the true Nummulite (*Nummulina*) is the mode in which the chambers are prolonged laterally into two alar processes, which completely embrace the row lying immediately within them; we also find in the various members of the group evidences of a higher type of organization in the system of canals which traverse the shell-substance. It will be seen that these peculiarities are entirely wanting in the specimens before us.

There seems little difficulty in placing the Foraminifer in question in Dr. Carpenter's family *Lituolidæ*; and in its structure and mode of growth it has obvious affinities to the genus *Trochammina*, P. & J., falling into its place most naturally between the lower *Rotalinæ* and the sandy free-growing *Trochammina squamata*, P. & J. We constantly notice in *Foraminifera* a tendency in some of the members of a group, especially the lower members, to simulate in appearance those of corresponding development in other and distinct groups. The result is that varietal forms have often a greater general resemblance to varieties of genera from which they are far removed than to their own immediate congeners. In this way *Involutina liassica* may be regarded as an isomorph of *Pulvinulina vermiculata* in its exogenous deposit. This latter peculiarity, which, as far as I have been able to observe, is invariably present to a greater or less extent, is sufficiently characteristic to distinguish it from *Trochammina*, the genus to which I have said it has nearest affinity.

I will now refer to M. Terquem's second paper on the 'Foraminifera of the Middle and Lower Lias' (Mém. de l'Acad. Imp. de Metz, 1860-1861), in which two species of *Foraminifera* are described and figured under the names respectively of *Involutina silicea*, Terq., and *Involutina Jonesi*, Terq. & Piet. The first of these seems to be *Trochammina incerta*, d'Orb. sp., a very variable species, not uncommon in the Lower Lias, though seldom showing the septa so regularly or so completely developed as they are given in the figure. To the character indicated by the specific name '*silicea*,' appended to the description, but little importance need be attached; for, though the original shell-substance is calcareous, the amount of siliceous sand embedded in it may easily be sufficient to preserve the form of the shell even after it has been treated with strong acid. The latter, *Involutina Jonesi*, is the little shell to which Professor Jones had previously given the name *Nummulites liassicus*; but, as I have shown that it is not in any respect a Nummulite, it must bear the generic name assigned to it by M. Terquem.

I have as yet met with the species only in the *Lower Lias*. The specimens vary in size from $\frac{1}{15}$ down to $\frac{1}{70}$ of an inch in diameter.

I cannot close this notice without acknowledging the kind assistance I have received from my friend Mr. W. K. Parker, F.Z.S., whose many suggestions have been invaluable in determining the history of the little organism which has formed the subject of the present notice.

EXPLANATION OF PLATE IX.

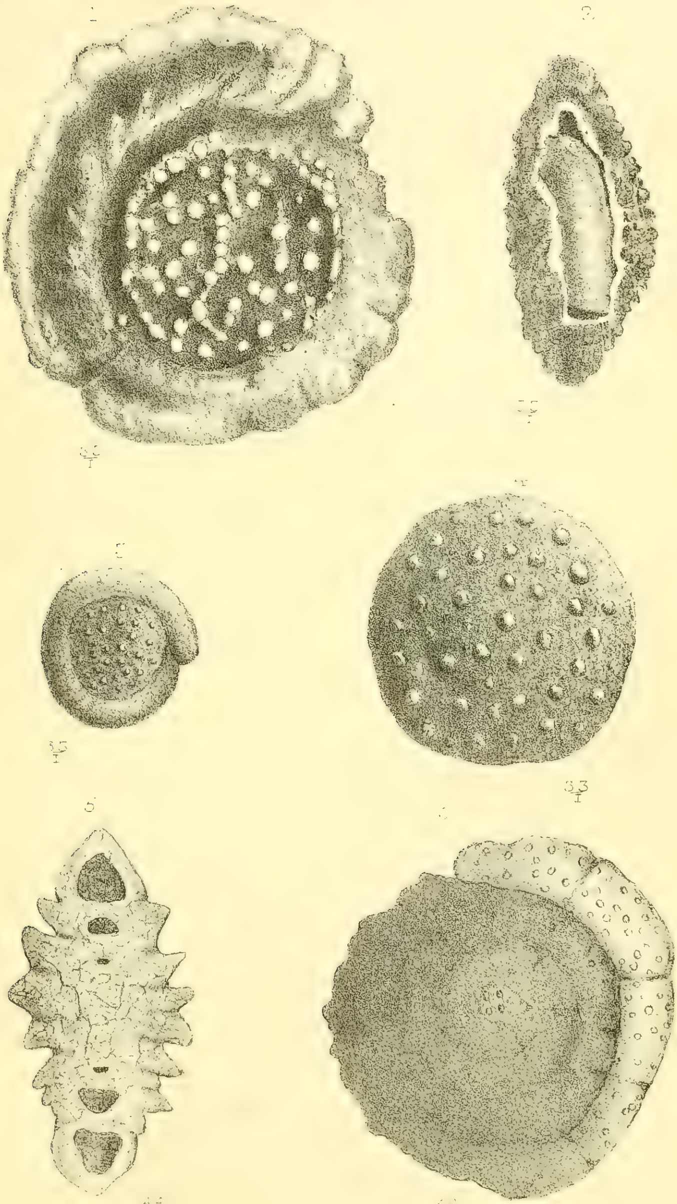
Fig. 1. *Involutina liassica*, Rupert Jones sp. Large specimen from the Lias Shale near Rugby, Warwickshire; side-view; magnified 33 diam.
2. Similar specimen from the same locality; end-view; magnified 33 diam.
3. Young specimen, out of Lias Clay from Defford, Worcestershire; magnified 33 diam.
4. Specimen from the same locality, having the exogenous deposit covering the entire shell; magnified 33 diam.
5. Transverse section, in a piece of the rock of Fretherne Cliff, Gloucestershire; magnified 44 diam.
6. Horizontal section of a specimen from Worcestershire, showing irregular septation and indications of pseudopodial perforations on the inner surface of the shell-wall; magnified 44 diam.

II. Descriptions of some New Palæozoic Crustacea.

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

[Plate X.]

We are indebted to Mr. David Page for having first pointed out two very well marked genera of Palæozoic Crustacea of the family *Eurypteridæ*, namely, *Slimonia* and *Stylonurus*. I gave a description of *Slimonia* in the 'Intellectual Observer'



H.B. Brady del. ad nat. Hanhart imp. G. West lith.

INVOLUTINA LIASSICA (*magnified*)

for November, 1863; and I now propose to point out the characters of *Stylonurus*.

Since Mr. Page figured *Stylonurus Powriei* in 1856,* then the one only species known, much better specimens have been found by Mr. James Powrie, of Reswallie, in Forfarshire, and Mr. Robert Slimon, of Lesmahagow, in Lanarkshire. A specimen of a new species of this genus, from the last-named locality, furnishes us with such interesting details that I subjoin a detailed description.

1. Stylonurus Logani. Sp. nov. Pl. X. fig. 1.

Only one specimen, from Lanarkshire (Logan-Water, near Lesmahagow), is known of this genus, the *intaglio* half of which is in the Museum of Practical Geology, Jermyn Street, and the *relievo* half in the collection of Mr. James Powrie, of Reswallie. It is from the latter half that our figure (Plate X. fig. 1) is taken.

The specimen exhibits the carapace and the body-rings, as far as the 10th segment, united, and one of the long slender eight-jointed swimming-feet *in sitû* on the right side; whilst on the left are seen the bases and portions of two more long appendages. Lying upon the slab, in various positions around the head, are four spiny eight-jointed palpi, or foot-jaws, one of which still retains its attachment to the carapace, although twisted and bent from its natural position.

Upon referring to the figure of *Stylonurus Powriei* in Page's 'Advanced Text-book' (3rd edit., p. 190, fig. 1), it will be seen that it has *two pairs* of long slender swimming-feet upon either side of the head. In the specimen here figured, from Logan-Water, there is also evidence of a second pair of long limbs, making, with the spiny palpi, four pairs of appendages; the fifth pair (absent), being the antennæ, were probably much smaller, as in *Eurypterus* (see Geol. Mag., Pl. V. figs. 7–9). The form of the carapace in *Stylonurus* is well marked, and very different from any other genus in this singular family.

In the Logan-Water shales, although the finest and most delicate markings are often preserved, yet the specimens are so compressed as to give scarcely any idea of their original contour, except by comparison with those from the Old Red Sandstone of Forfarshire and elsewhere. The eyes are situated upon the surface of the carapace, somewhat near the anterior angles. They were reniform, and raised upon round prominent bosses; but these are now squeezed flat to the surface of the head.

The carapace is quadrate, with the anterior angles rounded; the sides present a slightly waving outline, contracting towards the posterior angles. The margin is double, having an inner ridge which circumvents the sides and front, and terminates in a rounded

* See Page's 'Advanced Text-book of Geology.'

elevation at the posterior angles. An inner border-line also passes up each side and around the front of each eye; reminding us of the cheek-sutures in the Trilobites.

No sculpturing is noticeable upon the surface of the carapace; but (as is the case with all the Logan-Water specimens) impressions of portions of organs are seen, the position of which is beneath the surface of the head.

The basal joints of several of the palpi are visible; and, underlying the 1st and 2nd thoracic segments, may be discerned the median appendage of the thoracic plate.

The body is extremely slender, as compared with *Pterygotus*; and the segments in this species (as in *St. Powriei*) had very small epimeral portions. The 11th and 12th segments, which are not preserved, were doubtless still narrower; and the telson was probably a long styliform appendage, as in *St. Powriei.*

Dimensions of *Stylonurus Logani.* — Swimming-foot: — Basal joint, 6 lines in length, and 5 broad; 2nd joint, 2 lines long, 4 broad; 3rd, 1 inch long, 2 lines broad; 4th, 10 lines long, 2 lines broad; 5th and 6th, each 8 lines long, 2 lines broad; 7th, 6 lines long, 1 line broad; 8th, 5 lines long, 1 line wide, terminating in a fine point. Carapace:—Greatest anterior breadth, 1 inch 3 lines; greatest length, 1 inch 2 lines; width between the eyes, 5 lines; breadth of inner raised margin, 1 line. Thoracic segments:—1st segment, 2 lines long, and 1 inch and 1 line wide; 2nd and 3rd, 3 lines long, and 1 inch wide; 4th, 4 lines long, and 1 inch 1 line wide; 5th, 3 lines long, by 1 inch wide; 6th, 2 lines long, and 11 lines wide. Abdominal segments:—7th segment, 2 lines long, by 10 lines wide; 8th, 3 lines long, by 9 lines wide; 9th, 3 lines long, by 8 lines wide; 10th, 3 lines long;—here the specimen is broken, and the 11th and 12th segments and telson are wanting. The posterior margin of each segment is ornamented by a row of minute spines along the border.

The form of the carapace and the position of the eyes are two very well marked features in this genus: these, and the two pairs of long slender oar-like feet, sufficiently separate them from the rest of the family; but even the long tail-spine is peculiar.

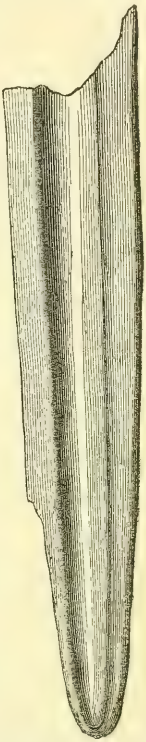
From the extreme rarity of its occurrence in a formation where other genera are so numerously represented, I am strongly inclined to believe this form to have been a *larval* condition of some other genus of the same group.

I have named it *Logani* after my friend Sir William Logan, the Director of the Geological Survey of Canada.

2. Stylonurus ensiformis. Sp. nov. Woodcut (nat. size).

A tail-spine of *Stylonurus*, $3\frac{5}{8}$ inches in length (probably longer when perfect), $\frac{3}{4}$ of an inch in width, and deeply channelled through its entire length, from $\frac{2}{8}$ at its widest part to $\frac{1}{8}$ of an inch at its extremity, was found in the Old Red Sandstone, at one of the Turin Hill Quarries in Forfarshire.

This spine is so peculiar in its form, and so distinct from any other specimen as yet met with, that I have ventured to name it *Stylonurus ensiformis.* The specimen is in the collection of Mr. James Powrie, F.G.S., of Reswallie.



Stylonurus ensiformis. Tail-spine (nat. size). Old Red Sandstone, Forfarshire.

3. Pterygotus minor. Sp. nov. Pl. X. fig. 2.

Associated with the great *Pterygotus anglicus*, in the Old Red Sandstone of Farnell in Forfarshire, Mr. Powrie has discovered the smallest *Pterygotus* known.

The specimen is only $2\frac{1}{2}$ inches in length, by $\frac{3}{4}$ of an inch in breadth.

It is evidently a new species, as it presents a remarkable difference from all other forms of this genus.

The eyes are within the margin; whilst in other species they are placed upon the latero-anterior angles. The position of the eyes has been considered by some palæontologists to be of generic importance; but I am inclined to believe it only of specific value; for in the larval stages the eyes do not occupy the same position as in the adult animal.

The specimen is entire, and exhibits the relative proportions of the head, thorax, and abdomen, as well as the telson or tail-joint, with its strong median ridge flattened down upon the surface of the shale. The swimming-feet can also be seen *in sitû.*

Dimensions of *Pterygotus minor.*—Greatest length of carapace, 4 lines, width 6 lines; space between the eyes 2 lines.

1st segment (thoracic=1st to 6th), 1 line long, 6 lines wide; 2nd, 2 lines long, and 7 wide; 3rd, 4th, and 5th, $1\frac{3}{4}$ lines long, and 8 lines wide; 6th, $1\frac{3}{4}$ lines long, and 7 lines wide; 7th segment (abdominal =7th to 12th), $1\frac{3}{4}$ lines long, and 6 lines wide; 8th, $1\frac{3}{4}$ lines long, and 5 lines wide; 9th, $1\frac{3}{4}$ lines long, and $4\frac{1}{2}$ wide; 10th, 2 lines long, by 4 lines wide; 11th, 2 lines long, and $3\frac{1}{2}$ wide; 12th, 3 lines long, and 3 wide; telson, or tail-plate, 7 lines long, and 2 lines wide. Total length of swimming-foot, 6 lines.

The impress of the specimen is so exceedingly delicate, that it presents rather the appearance of a 'ghost' than of an actual reality, and requires to be held obliquely in a good light in order to make out even these details clearly. The eyes are the only parts slightly elevated above the surface of the shale.

The specimen which is here described is unique, and was obtained from the indurated shale overlying the 'Arbroath Paving-stone,' and from which Mr. Powrie has obtained so many new and interesting species of Fishes. The shale is very finely laminated, and breaks up throughout into cuboidal fragments.

4. Eurypterus Brewsteri. (Powrie MS.) Sp. nov. Pl. X. fig. 3.

This new species of *Eurypterus* was obtained by the Rev. Henry Brewster, of Farnell, near Brechin, from the Old Red Sandstone of Kelly Den, near Arbroath, and it has been named after its discoverer by Mr. Powrie.

It consists of a carapace and a portion of the 1st thoracic segment, slightly displaced; close to which is seen an ovisac, in which are more than 20 ova, more or less compressed (fig. 3, *a*).

The carapace measures 2 inches 2 lines in breadth at its posterior border, and $\frac{5}{8}$ of an inch in length. The sides curve rapidly inwards, leaving the front border only 8 lines broad. The eyes, which are 1 line in length, are reniform, and within the anterior half of the carapace; they are 4 lines apart, and have their convex surfaces directed outwards. The margin of the carapace is slightly striated; and there is an inner elevated border in front, 1 line in breadth, which thins out and disappears on the lateral border. The surface of the carapace is slightly wrinkled, but not ornamented in any way.

This species agrees most nearly in general form with *Eurypterus lacustris* of Harlan,* from the Upper Silurian of New York; but the relative proportions differ considerably.

Interesting as this carapace is, it is rendered still more so by the ovisac associated with it. The so-called *Parka decipiens* may include many widely-different organisms; but I fully believe that the oviform bodies from the Old Red Sandstone are chiefly the eggs of Crustacea.

EXPLANATION OF PLATE X.

Fig. 1. *Stylonurus Logani*, sp. nov. From Logan-Water, Lanarkshire.

Fig. 2. *Pterygotus minor*, sp. nov. From Farnell, Forfarshire.

Fig. 3. *Eurypterus Brewsteri*, Powrie MS. sp. nov.; *a*, Egg-bag. From Kelly Den, near Arbroath, Forfarshire.

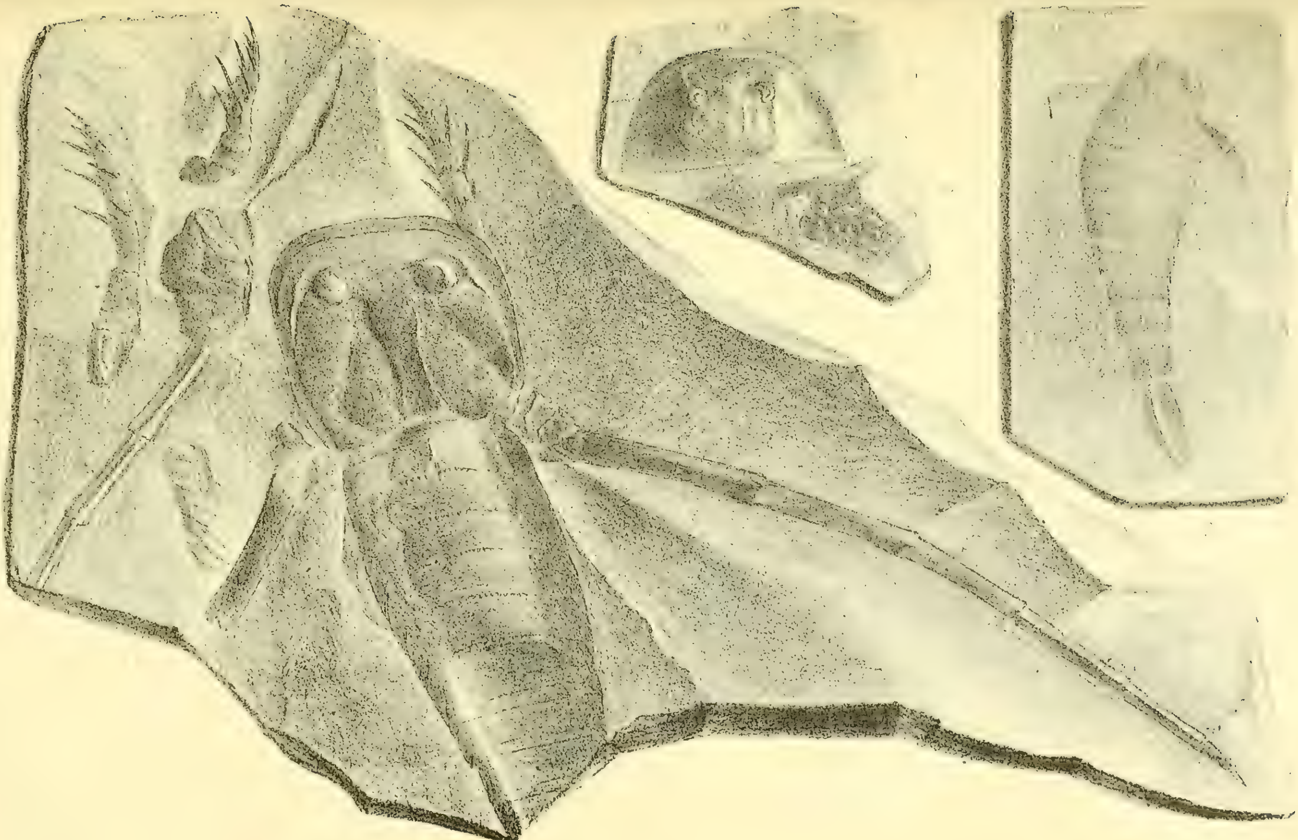
All three specimens are in the collection of Mr. James Powrie, F.G.S., and are figured of the natural size.

III. On the Laurentian Formation.† By J. J. Bigsby, M.D., F.G.S.—Part II. The Residuary Elements of Life in the Laurentian Group.

The Laurentian Group is as complex in its composition as the younger fossiliferous metamorphic rocks; silica, alumina, lime, and carbon compose its beds, together with phosphorus, fluor, barytes, &c.; and it develops the same accidental minerals—staurotide, garnet, pyroxene, metallic compounds, &c. Why then should there not be in it the buried forms of life? It is found that, as we descend in the great sedimentary column, the organic remains gradually lose

* See Hall's 'Palæontology of New York,' p. 407, pl. 81, fig. 3.

† Continued from p. 158.



G. West lith. ad nat.

M.& N. Hanhart imp

PALÆOZOIC CRUSTACEA. (*nat size*)

substance and form, until they wholly disappear, so that in the group with which we are now concerned (the very earliest we know of) not only has the original substance of the animal and its habitation vanished, but, for the most part, the very form also: and we have the residuary elements of the organisms—lime, phosphorus, &c., in masses sometimes extraordinarily large, corresponding with the extent and thickness of this great group, at least 30,000 feet in Canada (Logan), and 30,000 feet in Norway (Durocher).

The principal of these residuary elements, such as lime, silica, alumina, carbon, phosphorus, sulphur, fluor, iron, azote, exist in many forms and combinations in these rocks—as beds, seams, and veins, or minutely diffused in streaks, bars, or clouds, or altogether invisible, throughout certain mineral masses. According to Delesse,* a chief authority on this subject, all these elements are *essentially original*; although sometimes they may be contemporaneous with, or posterior to, the rocks containing them.

Lime.—The aggregate thickness of the great limestones of the Laurentian series of Canada and the northern parts of the adjacent State of New York is about 5000 feet, in bands of from 400 to 2500 feet, coarsely crystalline, rarely saccharoid, and slightly magnesian. In Scotland it is in considerable quantities; and in Norway and Finland Durocher† found it in beds and lenticular masses 1000 feet thick (often more), and traceable along the strike for many miles. This rock occasionally can only be distinguished from the newer fossiliferous marble (Silurian or Devonian) by its being more largely crystallized.

On the north side of the Lower Ottawa Valley Sir W. E. Logan finds the marble to emit, on being struck, an overpowering smell of carburetted hydrogen;—a fact taken to prove the presence of life at the time of deposit.‡

Almost all, if not all, the Laurentian beds, granite, gneiss, hornblende, anorthosite, &c., have lime in their composition. Bischoff§ and Hunt‖ agree with Delesse that lime had taken its place in the crust of the earth before the creation of animals and vegetables; and we infer the same from the observations of Sir C. Lyell (Princip. p. 797). So there always has been a rich provision of this element for organic purposes.

Silica and *alumina* are most abundant in the rocks of all ages. The important chemical services which these substances are now known to perform in some geological operations are clearly laid down by Dr. Percy in the Lectures already referred to. The subject is too manifold for present discussion.

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* Annales des Mines, 5 sér. vol. xxiii. p. 165.

† Mém. Soc. Géol. France, 2^me sér. vol. vi. p. 34–38; and Bullet. Soc. Géol. Fr., n. s. vol. iii. p. 619, &c.

‡ Dr. Percy, in his 'Swinian Lectures' of 1863 (Dec. 19), mentions a similar occurrence in the manufacture, by the humid way, of carbonate of magnesia from pure dolomite (so determined by chemical analysis)—so strong and unpleasant an odour arose in the process that it had to be abandoned, as a commercial failure.

§ Geological Chemistry, Engl. edit. vol. ii. p. 183.

‖ Observations on some points in American Geology. 1861.

Carbon.—This substance is indispensable to organic structure, and is in very great quantity in the Canadas, almost always near to, or imbedded in, marble, which is often at the same time rich in phosphate of lime, and contiguous to deposits of magnetic oxide of iron (forming small hills). Four of the principal constituents of animals and plants are thus brought together in the Laurentian group; and with every probability that they have been employed as such. The presence of carbon in the state of graphite, *unoxidized*, in metamorphic rocks, was first urged by Sterry Hunt on the attention of geologists as showing that a temperature of ignition was not required for metamorphism. Sir W. Logan* found carbon so largely disseminated in the marbles of the Lower Ottawa (Grenville, Chatham, and Gore Counties) that he proposes to call them 'plumbaginous marbles.' Durocher mentions four places in Sweden and Norway in which graphite is collected for economical purposes.† Carbon in all its forms is derived from vegetables, and usually by aqueous means. Therefore there must have been vegetation before the Laurentian rocks assumed their present condition.

Phosphorus is found in many shapes, and in great quantities in the Laurentian rocks, in union with lime, alumina, silica, fluor, lithia, soda, iron, copper, and zinc. This element presents an aggregate of combinations which must have taken much time to produce, if we are to apply to mineral processes the same reasoning that we do to the vital, inferring from the number and variety of organic remains in any given bed that it had endured long as a stage. Phosphorus is plentiful in almost every geological formation, excepting, perhaps, the Mid-silurian, the so-called Cambrian, and the Huronian. It seems to be a ubiquitous element, being found in iron, coal, granite, lava, most sedimentary rocks, soils, and all waters. (In the Appendix is given a list of its principal formations and localities.) Phosphorus generally occurs as a phosphate of lime, minutely disseminated through nearly all rocks, and in a vast quantity, viewed in the large. Chemical tests may be required for its detection; but sometimes the rock-surfaces are roughened with crystals of apatite. It is in the marbles of Canada‡ that this phosphate particularly abounds. In the coarse red marble of Burgess Township (River Ottawa) it forms (diffused as apatite) one third of the whole deposit, being intermixed with other common minerals. Beds similarly charged with phosphates are in the vicinity. The low country about the River St. Lawrence, south of these Laurentian deposits, as well as that between the Ottawa and Lake Erie, is strewn with blocks of phosphatic marbles. Near Prescott, I broke up one, weighing a ton, full of beautiful druses of apatite. Phosphate of lime occurs in the white marble of St. Paul's Bay and Malbay in Lower Canada. This mineral § is found in the marbles of Norway;

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* Geol. Survey, 1853–56, p. 641.

† *Loc. cit.* p. 39.

‡ Report, 1863, p. 26.

§ I allude to the two following deposits of this phosphate only with the view of showing the great quantities in which it occurs almost pure. At Logrosan, near Costanoza, in Spain, phosphorite (so called) occurs in vertical layers, 2–22 feet but not in the same profusion as in Canada. In the Isle of Pargas, near Åbo, Gulf of Bothnia, it is sky-blue and green, disseminated in whitish marble.*

Sulphur.—Its existence prior to animal life is doubtful. It appears to be derived in a free state from the animal kingdom.† It is an after-formation, says Coquand.‡ We have it in the Laurentian rocks of Canada § and Scandinavia in the sulphurets of copper, lead, and iron; while the Norwegian beds contain also the sulphuret of zinc, with the sulpharseniurets of iron and cobalt.||

In Canada both marble and gneiss are largely charged with iron-pyrites, the presence of which in metamorphic rocks is inimical to their having been altered by great heat, unless we suppose it to have been brought in by subsequent infiltration.

Iron.—According to Sterry Hunt,¶ one of the most successful labourers in chemical geology, and as confirmed by Bischoff, Ebelmen, and others, the presence of iron indicates the existence of organic substances when the oldest metamorphic rocks were being deposited; and in them the quantity in Canada, the United States, Norway, &c., is known to be immense.

Azote.—The remarkable investigations of Delesse on the relations of azote, or nitrogen, to rock-formations and their contents have led to important results. It is shown by him that the proportions of this gas in any mineral substance indicate, within certain limits, the age of any fossil it contains, animal or vegetable. Delesse says that, all things being equal, rocks and minerals have so much less of azote and of organic matters according as they belong to a more and more ancient period. He proves that azote is nearly universal throughout nature, and highly influential, especially as affecting the stability of organic substances.** All rocks contain more or less,—among others,†† granite, gneiss, marble, basalt, obsidian (volcanic rocks usually having the least). In soils it is very plentiful. In two specimens of Laurentian rock,‡‡ one of mica, the other of black porphyry with crystals of labradorite, the proportion of azote was found to be low—0·07 and 0·10 in 1000; and a granite from the Vosges (probably Laurentian) gave 0·15 in 1000. This ratio is, as Delesse expected, from the antiquity of the rocks examined. A Triassic dolomite gave 0·26, and bitumen from the lake in Trinidad

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thick, alternating with clay-slate (Silurian?) and a coarse quartz-rock. When pure it contains 81 per cent. of basic phosphate of lime. It is not worked. By far the most widely spread and continuous bed of this phosphate is that seen by Count Keyserling at the base of the White Chalk in Russia (Bull. Soc. Géol. Fr., n. s. vol. iv. p. 11); although only a few inches thick, it extends, with a varying breadth, to the distance of 550 miles.

* Durocher, *loc. cit.* p. 37.

† Bischoff, Chemical Geology, vol. ii. p. 344.

‡ Traité des Roches, p. 182.

§ Logan, Geol. of Canada, 1862, pp. 26, 37.

|| Durocher, *loc. cit.* p. 41.

¶ Quart. Journ. Geol. Soc., vol. xv. p. 493; Bischoff, Chem. Geol., vol. i. p. 42; Ebelmen, Bull. Soc. Géol. Fr., n. s. vol. ix. p. 223.

** Delesse, Mémoire de l'Azote, p. 17.

†† Annales des Mines, 5e sér. vol. xviii. pp. 196, 308, 309, 315.

‡‡ Mémoire, pp. 170, 171.

0·26 of azote. Delesse states, moreover, that this azote, generally speaking, is not the product of infiltration, but existed in the rocks at the time of their being laid down.*

Conclusion.—It appears, then, from the foregoing statements that there is in Laurentian rocks an abundance, both diffused and segregated, of the prime ingredients of organic structure,—lime, phosphorus, azote, carbon, and the like. How is it that no life-forms, no half-consumed relics of individual existences have been met with, or very few, and those obscure, in the greatly varied strata of Laurentian age? How is it that the Lingula-flags of Wales, the 'Primordial Zone' of Bohemia, the lowest beds of the Silurian of North America, are often full of remains of highly organized beings, while, if we descend the vertical scale only a few feet, there is little or no evidence of life? A little above us numerous groups, societies, and dynasties of living beings are represented, flesh-eaters and plant-eaters, that exercised the very functions of the present day; here, however, we meet a blank, sudden and almost perfect.

It is difficult to account for this: mere metamorphic action does not explain it; for abundance of instances are known where strong indications of past life are seen in the midst of intense metamorphism; † and although in general the Laurentian metamorphism is powerful, in parts it is weaker, necessarily so in a process dependent for its effects on the composition of the rock it attacks. An active search among the beds near the conglomerates may possibly be successful. Those who have hitherto been looking for traces of fossil life in rocks of this epoch may have been faint-hearted and unexpecting. Some have been ill-informed and unskilful; and it is as true in field-geology as in other pursuits, that a man will bring home with him according to what he takes out.

It now remains to add that in the Laurentians of Canada marks of life are supposed to have been met with in three separate places. The one is from a crystalline limestone of the Carrying Place of the Grand Calumet (River Ottawa), found by Mr. J. M'Mullen (Canada Geological Commission). The specimens from this place 'present parallel or apparently concentric layers resembling those of *Stromatopora rugosa*, except that they anastomose at several points. The layers are composed of crystalline pyroxene, while the interstices are filled with crystalline carbonate of lime.'‡

Secondly, Dr. James Wilson, of Perth, some years ago found loose masses of limestone in the vicinity of that town (65–67 miles SSE. from the Grand Calumet), which contain similar forms to those just described. They are 'composed of dark-green concretionary serpentine, while the interstices are filled with crystalline dolomite.' 'If both are to be regarded as the results,' says Sir W. Logan, 'of unaided mineral arrangement, it would seem strange that identical forms should be derived from minerals of such different

* Mémoire, p. 162.

† See a paper on Metamorphic Rocks in the Edinb. New Phil. Journ. n. s. April, 1863.

‡ Report Geol. Canada, 1862, p. 48.

composition. If the specimens had been obtained from the altered rocks of the Lower Silurian series, there would have been little hesitation in pronouncing them to be fossils.'

The third instance I found in the course of a geological excursion on the north shore of the St. Lawrence, at the base of Cape Tourment, a massive headland, 2000 feet high, and 36–40 miles below Quebec. Within 200 yards of a cascade, 400 feet high or more, and the only one for many miles in any direction, is a vertical face of a close-grained quartzose gneiss, which, in the body of the rugged headland, sometimes becomes granitoid. At 3 or 4 feet above high-water-mark is a circular, cup-like, organic (?) body, two or three inches in diameter, with much of the look, as well as the size, of a *Maclurea*, not, however, with gyrations, but with concentric rings, one within another; the summits are rounded and not sharp-ridged; no radiating striæ nor reticulations were observed in it, but they may exist. It might be very loosely compared to *Spongarium interlineatum*, or to a *Chætetes*. At first we took it for the effect of friction by pebbles; but its position forbids the idea. It is probably organic; and Sir W. Logan intends to examine the locality carefully. Near this fossil (?), and for some hundred yards around, the gneiss contains many small wandering veins of calcspar (tested); and here and there ragged scraps of dark blue limestone, of Lower Silurian age, adhere loosely to the Laurentian rock. Whatever may be the importance to which these appearances on the south base of Cape Tourment are entitled, they seem well worthy of some notice.

Note.—Since the above was written, the hope of recovering some traces of organic life has been realized in Canada, that geologically ancient and instructive land. Practised observers announce that a fossil has been detected, beyond all doubt, far down in the great Laurentian series. This is a discovery which concerns the deepest recesses of time, and points to extensive assemblages of life in primæval ages, instead of the blank desolation hitherto supposed. Principal Dawson's determination of this newly discovered, but most ancient fossil (*Eozoön Canadense*) as a Foraminifer has been already alluded to in the Geological Magazine, No. 1, p. 47; and I will only add the few following remarks, which are of great interest to naturalists, who know that somewhat similar changes in the structure of recent Foraminifera have been shown by Ehrenberg and Bailey to be taking place in the ocean in the present day. 'The calcareous septa,' says Sterry Hunt, 'which form the skeleton of this Foraminifer are unchanged, while the sarcode has been replaced by certain silicates, which have not only filled up the chambers, cells, and septal orifices, but have been injected into the minute tubuli, which are thus perfectly preserved. The replacing silicates are a white pyroxene, serpentine, and a dark-green alumino-magnesian silicate, near chlorite and loganite.'

Appendix.—*The presence of Phosphoric Acid and Phosphates in Rocks.*

Igneous Rocks.—Phosphoric acid abundant in augite-rock, porphyry, and vesicular lava (Rhine); white trachyte (Drachenfels); dark-red scoriaceous lava (abundantly) and an ancient lava (Vesuvius); nepheline rock; toadstone (Derbyshire); Rowley-rag (Dudley): Bischoff, Geol. Chem., Engl. edit. vol. ii. p. 25. Phosphate of lime in basalt and dolerite (Vogelsberg): M. Bromeis, Ann. Mines, 5e sér. vol. iii.

Laurentian.—Apatite in granite, zircon-syenite, hornblende-rock, marble, talcose, micaceous, and chloritic schists, dolerite, metalliferous veins traversing granite, in gneiss, diorite, porphyry, clay-slate, and beds of magnetic iron-ore; in various parts of Europe: Bischoff, *ibid.* vol. ii. p. 23. Also in marble in Westmeath and other townships on the Ottawa, Canada, and in St. Paul's Bay and Murray Bay, NE. of Quebec, and in Laurence County, State of New York: Rep. Geol. Surv. Canada, 1848–49, 62.

Silurian: Primordial.—Phosphatic shells of *Lingulæ*; Canada, Minnesota, &c. (Logan, D. D. Owen, and J. Hall). Black phosphatic nodules at R. Onelle, Lower Canada, in a calcareous conglomerate: Can. Geol. Rep. 1851, ii. p. 106. —*Calciferous Sandrock.* Dark phosphatic nodules (coprolites) in a conglomerate, resting transgressively on gneiss, Lake Allumettes: Geol. Rep. Canada, 1851, ii. p. 110.—*Chazy Limestone.* Black phosphatic nodules; Lochiel, Hawksbury, R. Ottawa: *ibid.*—*Trenton Limestone.* Phosphatic fossils in blue shell-limestone of Kentucky: D. D. Owen, Geol. Rep. Kentucky, p. 98.

Lower Silurian (?).—Immense deposits of Phosphorite in Spain (Logrosan, Estremadura): Bullet. Soc. Géol. Fr., n. s. vol. xvii. p. 15.

Carboniferous.—Phosphate of lime in clay-slate, Fins (Allier, France): Meugy, Ann. Mines, 5e sér. vol. xi. p. 150. In the many and large beds of iron-ores and of clay-iron-stone of Kentucky, 29·5 per cent. of phosphate in one of the latter (at Crittenden): D. D. Owen, Geol. Rep. p. 378.

Mesozoic.—Phosphoric acid very distinct in ten different Jurassic and Triassic limestones, none of it in others: Fehling, Quart. Journ. Geol. Soc., vol. vii. Misc. p. 90. Phosphate of lime in the marl-beds of the Lias (Calvados, &c.), in Jurassic, St. Thibault (Côté d'Or): Meugy, Ann. Mines, 5e sér. vol. xi. p. 150. Phosphate of lime, in a thin bed 550 miles long, under Chalk, Russia: Count Keyserling, Bullet. Soc. Géol. Fr., n. s. vol. iv. p. 11. In Lower Chalk, Greensand, and other rocks of nearly the same age; Wissant, Havre, Rethal near the Ardennes: Meugy, Comptes Rendus, vol. xliii. p. 755. The phosphatic beds of the Lower Greensand, Gault, and Upper Greensand of England.

Tertiary.—Phosphate of lime in the Lower Tertiary beds of the Paris Basin, particularly in the Plastic Clay of Auteuil: Meugy, Ann. Mines, 5e sér. vol. xi.

Recent.—Phosphate of lime exists in all waters running into the sea. The springs of Carlsbad, Bohemia, would, if it were collected, yield 55·6 pounds a year. Phosphoric acid in the sea-water of Copenhagen (Forchhammer). In the incrustations from steamboat-boilers (Volcher), Bischoff, vol. i. p. 109; ii. p. 27. Common in the soils of Kentucky (D. D. Owen).

ABSTRACTS OF FOREIGN MEMOIRS.

On the Baculite-beds of Böhmisch-Kamnitz, North-Western Bohemia. By Dr. Laube. (Proceed. Imp. Geol. Instit. Vienna, Feb. 16, 1864.)

These strata, the youngest of the Cretaceous Period, are rather extensively spread East of the Elbe, until above Böhmisch-Leipa and Reichenberg, overlying the Quader-Sandstone, without the interposition of the Pläner beds except at three localities, where they are but very imperfectly developed; so that local disturbances in the level of the Cretaceous sea must be supposed to have taken place even before the deposition of the Baculite-beds. The thickness of these strata, generally clays and argillaceous marls, very poor in organic remains, varies from a few to sixty feet. *Nucula striata*, Roem. (*N. pectinata*, Sow.), *Leda semilunaris*, and *Ostrea Proteus*, Reuss (*O. minuta*, Roem. ?), have been found in them.

They are best developed and richest in fossils near Böhmisch-Kamnitz, a locality already mentioned by Geinitz and Reuss. They are partly genuine clays, of yellowish-grey tints, laminated and soft, not plastic, nor adhering to the tongue, and partly argillaceous marls, greyish-blue, soft, and slightly adhering to the tongue. In their chemical constitution, the clays differ from the marls by being destitute of carbonate of lime, poorer in alumina and water, and richer in silica. These Baculite-strata, strikingly recalling to the mind the Gault of Folkestone (from which, however, they totally differ as to their palæontological character), rest immediately on Quader-Sandstone, without any intercalation of the Pläner. Their fossils, especially the Gasteropods, are generally in a very bad state of preservation. Sixty species (2 Fishes, 2 Annelids, 5 Cephalopods, 13 Gasteropods, 39 Bivalves, 2 Brachiopods, and one Coral), have been determined among the fossils from Böhmisch-Kamnitz. Of these 60 species, the number of those occurring in other Cretaceous localities is in the following proportions :—*Germany:* Priesen, 36 ; Luschütz, 33 ; Postelberg, 21 ; Strehlen, 19 ; Aix-la-Chapelle, 12; Kieslingswalda, 9 ; Quedlinburg and Coesfeld, 7 each ; Haldem, 5 ; Koschütz, Goslar, and Isle of Rügen, 4 each ; Gosau, 2. *Galicia:* Nagorzany, 15 ; Lemberg, 13. *Switzerland:* Perte du Rhône and Ste. Croix, 4 each ; Geneva, 1. *Sweden:* Köppinga, 9; Ingnaberg, 5. *Netherlands:* Limbourg, 8 ; Maestricht, 4. *France:* Rouen and Uchaux, 5 each ; Tournay and Ervy, 2 each. *England:* Lewes, 8; Sussex, 7 ; Folkestone and Isle of Wight, 2 each.

Count M.

Une Reconnaissance Géologique au Nebraska, par M. Jules Marcou. 8vo. pp. 15. 1864. (From the Bullet. Soc. Géol. France, 2e sér. vol. xxi. p. 132, &c.)

NEBRASKA is a new Territory of the American States, lying towards the Rocky Mountains, west of Iowa and Missouri, and occupying about the central part of North America. M. Marcou, who had visited Wisconsin to the north and New Mexico to the south, desired to examine the intervening country, and, in spite of trouble from civil war and Indians, he and his friend M. Capellini crossed the country in two directions in 1863, and gives the result of his traverse to the French Geological Society. As in 1862 Dr. Hayden, the State-Geologist, published the result of a great amount of detailed work in the same district, M. Marcou's observations are chiefly interesting in so far as they suggest modifications of Dr. Hayden's results. The *Dyas* (Permian) and the existence of what M. Marcou describes as islands in the Dyassic sea, are believed by him to be present in a highly characteristic form in Nebraska, with two members corresponding to the Rothcliegende and Zechstein respectively, and in true contact with the American Trias. Instances, he thinks, will be found in Kansas and also near Beavertown on the Canadian River.

M. Marcou also asserts his discovery of a true Miocene flora at the bottom of the Cretaceous series in Nebraska. The fossils occur in a freshwater formation, in which is a *Cyrena*, formerly found by the author in New Mexico; and he especially identifies *Laurus primigenia*, Unger, and a Fern, 'near the Lycopods,' among the fossils. This deposit is 'No. 1' of the Cretaceous series of Hayden, containing lignite, fossil wood, impressions of dicotyledonous leaves, *Equisetum* (?), *Pectunculus Siouxensis*, &c.

Lastly, M. Marcou objects to the use of Brachiopoda as characteristic fossils, and believes that their place in the animal series in this respect is even lower than that of Corals!—D. T. A.

REVIEWS.

MAN AND NATURE; OR, PHYSICAL GEOGRAPHY, AS MODIFIED BY HUMAN ACTION. By GEORGE P. MARSH. 8vo. pp. 560. London: SAMPSON LOW, SON, and MARSTON.

THIS volume is one of considerable interest to the geologist, although it does not profess to communicate original matter or new views. It is a somewhat expanded account by an exceedingly intelligent American writer, well acquainted with Europe and European literature, of various operations in nature, chiefly connected with human influence, by means of which the surface of the earth is now undergoing such changes as would be recognized hereafter among geological phenomena. Something of this has already been done by Sir Charles Lyell in his great work on the Principles of Geology; but other considerations, not less important, are here introduced, and numerous facts and inferences are put forward for the first time.

That climatic changes, in countries entirely or very largely occupied by man, have, in the course of time, been brought about by the various changes in the face of nature, induced by human wants and tastes, there can be no doubt; and it is certain that, of all these, the removal of forests has been the most important, both directly and indirectly. No one can travel in Greece or Asia-Minor, none can visit the North African shores, no one can even run through Italy, without being aware of modifications of the surface and of climate in places once very thickly peopled, but now almost without inhabitants. There is equally little difficulty in proving, that not only there, but generally throughout Central and Southern Europe, the climate on the whole, and within the historic period, has become more extreme; and the rivers have assumed more and more the character of torrents. This is well exemplified in the case of the Seine, a river which, owing to its great distance from any mountain-chain, can only be subject to the influences acting widely over France. In the fourth century, the Seine was a regular and gentle stream; it now varies its level to the extent of thirty feet. Yet more striking examples may be found in reference to the Var, and other rivers coming down from the Alps to the Mediterranean. The denudation of the mountains has in all cases been followed immediately by the destruction of the plains; and this to a very serious extent, and permanently. Much useful and detailed information on this head will be found in Mr. Marsh's book, and references are given to the authorities.

More than half the volume before us is devoted to the subject of forests, their influence on climate, and the inevitable result when they are destroyed. The author then proceeds to the consideration of changes produced by operations having for their object the reclaiming of marsh and other useless lands, whether from salt or fresh water. Great results of this kind have been produced in England, and much greater in Holland, by systems of dikes, whose total length is many hundred miles. By these means vast tracts of land have been retained or reclaimed. The recent case of the Lake of Haarlem is described. That body of water, about fifteen miles long by seven wide, was constantly encroaching, reaching even to Amsterdam and Leyden, and threatening to destroy much of Holland. In 1840, the first steps were taken for draining it. A ring of canal and dike was formed round it by 1848; and by 1853 the waters were pumped out by steam. The total cost exceeded £750,000. The changes thus effected, and generally the changes that have taken place since Holland began to be cultivated, have unquestionably been accompanied by great and increasing alterations of climate. These must in some measure tend to bring back the former climate, when the forests of Germany had not been removed.

In Italy, the lowering of lakes, and the alteration made in some swampy districts by draining off the waters of upland valleys, has rendered the climate much less unhealthy than it previously was. So aqueducts, reservoirs, and canals may all be traced to have had climatal effects on the surrounding country. Draining and irrigation are both important agents; and in Mr. Marsh's volume several remarkable and authenticated instances are quoted.

Lastly, our author treats of dunes and sand-plains,—of the mischief effected by them when shifting,—of the means of forming and protecting them artificially,—of their uses and general results. He concludes with a speculative chapter on the probable result of great engineering works, such as cutting through isthmuses, connecting lakes, and diverting rivers, very few of which have yet been really completed.

On the whole, we may safely refer to this book the physical geographer and geologist in search of trustworthy information as to the actual measured quantity of results obtained in the prosecution of some of the most important alterations of the physical features of the earth, that have been brought about by the agency of man, whether directly or indirectly.

The Yield of the Ten-yard-coal, and the best Mode of increasing it, having regard to the Safety and Economy of the Working. By Rupert Kettle, Esq. 8vo. pp. 23. Dudley, Mills, 1864. (From Proceed. Dudley and Midland Geol. and Scient. Soc. and Field-club.)

THIS is a paper read, April 13, by the Vice-President of the Dudley and Midland Geological Society, at a Conference of Mill-owners, Colliery-proprietors, Mine-agents, and Members of the Society. Assuming from the ordinary data that there are 48,400 tons of the Ten-yard-coal per acre in the earth, Mr. Kettle estimates that 24,493 tons only, or little more than half the quantity, is got by the present method of 'square work;' and he complains that the working is carried on with extreme want of system and great irregularity. He urges that the adoption of the 'long-wall' system would give a much larger proportion, with better ventilation, and greater safety both against accident from fire and falling of roof. Few who are familiar with coal-mining in different districts will doubt that South Staffordshire has long been behind the rest, and that the neglect of intelligent and systematic mining leads to mischief of every kind.

Coal-Produce of the United Kingdom for 1863.*

WE turn with interest to the yearly statements collected and arranged by Mr. Hunt, of the Mining Record Office, regarding the Mineral Produce of our country, in order to see whether we are still advancing in mining industry, or have at length reached that state of equilibrium between the powers of production and extent of demand which will certainly arrive sooner or later. Though we confine our observations here to the section of Coal-produce, Mr. Hunt's labours only stop short with the number of different minerals raised in these countries, from gold down to clay, comprising tin, copper, lead, silver, zinc, pyrites, wolfram, uranium, gossans, arsenic, iron, and coal; and the enormous mass of statistical information under these heads is truly amazing, and of great value to the country at large.

The quantity of coal raised in the United Kingdom in the year 1863 amounted to 86,292,215 tons; an increase of 4,653,877 tons as compared with 1862, but a decrease of 125,726 tons as compared with 1861, the year in which the production reached the highest point yet attained. This was the year preceding the cotton-famine; and there can be no question that this national calamity has sensibly affected the raising of coal in Lancashire, and is in part the cause of the decrease in the quantity during the two years following. Under ordinary circumstances, the quantity would have been increased for 1863 by one million of tons, which would have made the produce for that year greater than any preceding it, and thus have shown an advance. We are of opinion that this advance may con-

* Mineral Statistics of the United Kingdom of Great Britain and Ireland for the year 1863, with an Appendix. By Robert Hunt, F.R.S., &c. 8vo. London: Longman & Co. 1864.

tinue, with occasional oscillations, until the amount reaches one hundred millions of tons; but at this point (or thereabout) a maximum caused by the capabilities of the coal-fields for producing will in all probability have been attained. The following are the results for the last three years:—

Coal-produce for the years 1861 *to* 1863 *inclusive.*

	1861.	1862.	1863.
England and Wales . .	72,809,871	70,434,838	75,064,665
Scotland	11,081,000	11,076,000	11,100,500
Ireland	123,070	127,500	127,050
Burnt or wasted* . .	2,404,000		
	86,417,941	81,638,338	86,292,215

The number of collieries open in 1863 amounted to 2,634 for England and Wales, 480 for Scotland, and 46 for Ireland. This gives for the first three countries an average of 27,670 tons for each colliery yearly; or, taking the number of working days at 260, a daily out-put of 107 tons; and for Ireland, of 103 tons, which is a larger average than might have been expected; but in all probability the number of working days in that country approaches nearer 300 in each year.

Taking the last ten years, the increase in the quantity of coal raised in the United Kingdom has been about 23 millions of tons,† being at the rate of about 2·3 millions yearly. In the same period the number of collieries has increased by 783, or at the rate of 78 yearly; and, while (as above stated) the out-put for each colliery in 1863 was 27,670 tons, for each colliery in 1853 it was only 26,491 tons; showing that, on an average, there is a gradually increasing quantity raised by each colliery—a fact we might have inferred from the increasing depth at which the seams of coal are reached, and the consequently larger scale on which collieries are now laid out than formerly.

Of the coal-producing counties, Durham and Northumberland, embracing what is called 'The Great Northern Coal-field,' takes the lead, 22,154,146 tons having been there raised in the past year. Since the reign of Queen Elizabeth, and up to the last quarter of a century, London has been entirely dependent on this district for fuel; but since the opening of the railways, Yorkshire, Derbyshire, Leicestershire, Warwickshire, and South Wales have poured in of their abundance into this great market. Next in importance, in point of production, are Yorkshire, Derbyshire, and Notts; then Scotland, which raised 11,100,500 tons; after this ranks South Wales and Monmouth, all one coal-field, and the others in succession, until we come down to Warwickshire, which raised only 685,500 tons. This

* In the Returns for the year 1861 the estimated quantity of coal burnt or wasted is given separately; in the following years it is included in the quantities raised.

† Taking 63,500,000 tons as the produce for the year preceding the publication of the first number of the 'Mineral Statistics.'

coal-field is remarkable as being the nearest to London, and being capable of enormous extension, by mining beneath the Permian Beds.

There are four principal heads under which the consumption of Coal may be arranged. 1. Household, including gas; 2. Manufactures; 3. Ironworks; 4. Export. During the past year, the consumption under the first three of these has increased, and under the last declined; so that we conclude that the enormous supply raised from our mines, which is valued by Mr. Hunt at more than £20,000,000, has been employed in warming and lighting our homes, turning our machinery, and developing our manufactures.

REPORTS AND PROCEEDINGS.

A JOINT meeting of the COTTESWOLD and MALVERN FIELD-CLUBS was held at Cheltenham on the 17th of August. The party proceeded in a 'drag' to the Seven Springs, where the Thames takes its rise, and thence walked to the Leckhampton section. In the absence of Dr. Wright, Mr. Etheridge, of the Royal School of Mines, very kindly explained the character of the strata, and their position in the Inferior Oolite. After dinner at the Queen's Hotel, Mr. Beach read an interesting paper, very well illustrated, 'On Fungi, and on some of the esculent species found near Cheltenham.' He made some remarks on the strong prejudice which exists against all kinds of *Fungi* except the Mushroom, and on the immense quantities consumed by all classes on the Continent, where they are well understood and appreciated; and then enumerated the best kinds he had found in the district. The President of the Cotteswold Club, Major Guise, who has paid particular attention to Fungi, spoke in high praise of Mr. Beach's paper. Dr. Bird read a paper on some Mammalian remains found in the Drift-gravel at Beckford, near Evesham; and, at Major Guise's request, Mr. Etheridge gave an address on the district visited in the morning, which was rendered very interesting from the admirable series of sections he exhibited, shewing the Lias and Oolite of Lyme, Yorkshire, and Gloucestershire.—W. C. L.

EAST KENT NATURAL HISTORY SOCIETY.—The following is the substance of a Field-lecture, *On the Cliffs at Folkestone*, given to this Society on August 30th, by Mr. W. Whitaker, B.A., F.G.S., of the Geological Survey, and Hon. Mem. of the E. Kent Nat. Hist. Soc.:—

The formations shown on the coast near Folkestone belong to the 'Cretaceous' Series, including (in ascending order) the Lower Greensand, the Gault, the Upper Greensand, and the Chalk, all sea-deposits. There is a slight northerly dip, so that higher and higher beds come on in that direction.

The Lower Greensand forms the cliff from Hythe to Folkestone. As a general rule, the beds of which this formation consists are not green; but it owes its name to the fact that in some places it is deeply coloured by green sand, which, however, is present in many other formations. In this neighbourhood there are four divisions of the Lower Greensand, the lowest of which is known as the 'Atherfield Clay,' whilst to the others the following names have been given by the Geological Survey:—the 'Hythe Beds,' the 'Sandgate Beds,' and the 'Folkestone Beds.' Of these the Hythe Beds are the most important, as containing the layers of grey limestone known as 'Kentish Rag,' and much used for building. The overlying Sandgate Beds are generally of a loamy nature and form a damp soil. The highest division, the Folkestone Beds, consists of sand, sometimes containing concretionary limestone. The junction of this with the Gault above is well shown at the foot of the cliff at Copt Point, where there is at the very top of the Lower Greensand a hard bed, from six inches to a foot thick, of concretions of iron-pyrites.

After the deposition of this formation, some change in the sea-bottom (most likely an increase of depth), and in the nature of the deposit, took place.

The Gault consists for the most part of a stiff bluish-grey clay, sometimes with many and beautiful fossils, especially at this spot, which is indeed the most noted place for them. These fossils, however, are somewhat hard to find; and when found they are hard to get out of the clay. In some places the Gault contains small phosphatic nodules, which are largely worked for the manufacture of manure. It is this formation that has given rise to the rough slopes of the cliff here, as it constantly gives way and slips down in large masses. The upper part of the Gault is rather sandy.

The Upper Greensand is again a deposit of more shallow water; indeed many geologists think it nothing more than a shore-deposit belonging to the Chalk. Here it is said to be some 25 feet thick; but it can rarely be seen in place, owing to the great falls of the overlying Chalk. The upper part of this formation is a true green sand, whilst the rest of it is a sandy sort of chalk.

The Chalk is so well known as to need no description of its composition. It must have been deposited in a deep sea, in like manner that a chalky mud is now being deposited in the depths of the Atlantic. The section of the Chalk from Folkestone to Walmer is one of the finest in the kingdom; and the total thickness here shown has been given as more than 1000 feet. This formation may here be divided into the 'Grey Chalk' or 'Chalk-marl,' the 'White Chalk without flints,' and the 'White Chalk with flints.'

Connection of Geology and Physical Geography.—All these formations occur in the same order inland, each giving rise to some distinct 'form of the ground,' by which it can easily be known by the practised eye. The most marked of these features is that of the Chalk ridge of the 'North Downs,' with its gracefully sweeping curves and bold scarp, which runs westward through Kent and Surrey into Hampshire, where it bends round and again runs eastward through Sussex, forming the 'South Downs,' to the sea. Now there can hardly be a doubt that these chalk-hills once joined together, and that those millions of millions of cubic feet of solid matter have been removed, by some sort of denudation, from off the country that now forms the 'Weald' of Kent and Sussex. How this denudation took place, and what was the agent of it, have long been debated questions in geology. There is a tendency at present to think that this great work, or rather the latter part of it (which has given the present form to the country), has been done by the long steady action of the many streams which now wander through the district, and which once perhaps were larger than now. Certain it is that the streams do now, and must always, wear away the rocks, though such wearing may not be apparent to our eyes.

One of the most marked features of this coast is the 'undercliff,' where huge masses of chalk have fallen from the top to the bottom of the lofty cliffs, forming a rough broken picturesque surface. This has been caused most likely in the following way:—The Chalk allows a passage to water through its countless small fissures, and the underlying Upper Greensand is also permeable; but the stiff Gault clay next below stops the water, which then flows out seawards. The sandy top of the Upper Greensand is of a yielding nature, and is perhaps slightly carried away by the water; the moist Gault forms a slide; and down therefore comes the massive Chalk.

Newer Deposits. Besides the Cretaceous beds there are traces of much later deposits, resting unconformably on the former. The older Tertiary formations, which come on above the Chalk near Canterbury, &c., are not now present here (their absence being caused simply by denudation); but at the higher parts of the Chalk cliffs there may be seen irregular patches of reddish sand, filling 'pipes' in the Chalk, and contrasting strongly in colour with the glaring white of that rock. This sand has been thought to belong to the '*Crag*,' a formation of late Tertiary age, which occurs in Norfolk and Suffolk. One cannot, however, yet feel sure of such being the case, as the evidence is not conclusive.

A still newer bed has been found at Folkestone, namely, a 'brick-earth,' with remains of *Elephant*, *Mastodon*, *Horse*, *Stag*, and *Ox*, and most likely of the same age as those valley-beds in France and England which have been of late so much talked of, from their yielding those peculiar 'flint-implements,' that were most surely made by the hand of man.

Note.—A detailed account of the beds below the Chalk, by Dr. Fitton, may be seen in Trans. Geol. Soc., 2nd ser., vol. iv. p. 105, &c., and of the Chalk, by Mr. W. Phillips, in Trans. Geol. Soc., 1st ser., vol. v. p. 16 (or in Conybeare and Phillips' 'Geology of England and Wales,' p. 90). The Crag (?) has been described by Mr. Prestwich in Journ. Geol. Soc., vol. xiv. p. 322; and the Brick-earth, in vol. vii. p. 257, by Mr. Mackie, who has also published notes on the Geology of Folkestone and its vicinity in the 'Geologist.' A description of the Geology of Folkestone and the district to the south will be given in the 'Geological Survey Memoir on Sheet 4,' now nearly through the press, by my friend and former colleague Mr. Drew, who surveyed that neighbourhood. Remarks on the denudation of the Weald have been lately published by Professor Ramsay in the 2nd edition of his 'Physical Geology and Geography of Great Britain;' and the writings of Lyell, Hopkins, and Prestwich should also be consulted.—W. W.

Belfast Field-naturalists' Club.—The Fifth Excursion was made on the 17th September; Shane's Castle Park, Antrim, was the locality visited. The park was traversed, and the course of the River Main followed, reaching the shore of Lough Neagh, the members occupying themselves during the ramble (which was continued as far as the ruins of the old castle) by a search after the rare plants reported to grow there. At the Quarry Head, near the Castle, the highly interesting lignite-bed, so strangely interstratified with the basalt, was visited. It is one of those carbonaceous deposits which occur so frequently in the Co. Antrim in connection with the trap-rock. A bed of this kind, 2·6 feet thick, is regularly worked at Killymorris, Ballymena, and sold by the ton for fuel; a thicker band, but not so available, is found at the Giant's Causeway; and beds of less importance occur in several other localities. The bed of carbonaceous matter or lignite occurring at Shane's Castle is not very clearly marked, being mixed up with a thick bed of decomposed trap; but the solid semi-columnar trap-rock that overlies this bed is remarkable for the quantity of small globular fragments of jet that it contains. Silicified wood, also derived from the basaltic rocks, was found upon the shores of the Lough.

The Sixth and last Excursion of the season was made on the 8th of October, to the Cave Hill. Belfast is one of the finest geological centres in the British Isles, for there is presented within an area of 15 miles radius an epitome of most of the formations; only the Upper Silurian, the Oolitic, and the Eocene deposits being absent. In the short distance embraced in the walk in the line of the Cave Hill Railway, the following formations were passed over and studied:—Newer Pliocene deposits, on the shore between Belfast and Greencastle,—these constitute shell-banks uncovered at mid-tide; Glacial drift, at the Reservoirs, at an elevation of about 40 feet,—resting on the New Red Marls, which continue up the hill to an elevation of 546 feet; the Rhætic series, consisting of Black Shales, with *Avicula contorta* and *Gyrolepis*, succeeded by indurated marls, with *Cardium Rhæticum*, *Modiola minima*, &c.; the Upper Greensand, the lithological divisions of which are well exposed in the quarries,—1. Glauconitic sands, in which were found, in profusion, *Exogyra conica*, var. *lævigata*, Sow., and *Pecten orbicularis*,—2. Grey marls, in which *Ostrea carinata* was almost the only fossil found,—3. Chloritic sandstone, the 'mulatto' of the workmen, in which was found, hitherto unknown as a British fossil, *Epiaster crassissimus*, Defr., together with *Ostrea canaliculata*, *Pecten quinquecostatus*, &c. Also the Upper Chalk, the common fossils of which were obtained in plenty—*Ammonites Gollevillensis*, *Belemnitella mucronata*, *Rhynchonella octoplicata*, *Terebratula carnea*, *Ananchytes ovatus*, and Paramoudras. Trap-dykes, here of unusual size, are seen intersecting the formations, giving rise to faults, of a minor character, and alteration of the strata in immediate contact. Lastly, the basalt is seen superimposed, with the intervention of a bed of rolled flints in an ochreous paste, on the Upper Chalk.

The Summer-session having now terminated, the Committee have to make arrangements for the vigorous prosecution of the work for the Winter-session, which consists of papers on scientific subjects, read fortnightly by the Members. The Council of the Natural History and Philosophical Society have kindly granted to the Club the use of one of their lecture-rooms in the Museum for the evening-meetings.—R. T.

Glasgow Geological Society.—The Annual Meeting of this Society was held in the Andersonian University on the 6th October; Mr. E. A. Wünsch, vice-president, in the chair. The Treasurer's statement showed—Receipts, chiefly Members' subscriptions for the year, £61 3*s.* 8*d.*; Expenditure, including cost of Books and Diagrams, &c., added to stock, £52 10*s.* 6*d.*; leaving a balance of £8 13*s.* 2*d.* in hand. The Chairman, in a short sketch of the proceedings of the past season, referred to the Introductory Lecture delivered by Mr. D. Page, the subject of which had since been expanded, and published by him, under the title of 'The Philosophy of Geology,' a work which could not fail to familiarize students of Geology with the broad principles, and the truly philosophic basis for enquiry, laid down for their favourite science. The other lectures for the Session had been conceived with the intention of forwarding the knowledge of the Members in Geological subjects; and although circumstances, over which the Council had no control, had prevented some of them being delivered, it was matter for congratulation that the 'Elementary Class-meetings,' instituted last winter, had proved so complete a success as to compensate in a great measure for the disappointment thus experienced at the hands of some of the lecturers. These meetings, ably conducted by Mr. John Young, had succeeded beyond expectation, had imparted a confidence never experienced before as to the efficiency of the Society in conveying useful practical knowledge to the Members, and would be continued this Session with unremitting zeal.

The Excursions of the Society during the summer months had not been so well attended as they might have been; and it would be for the Council to consider whether this feature in their programme could be made more attractive and successful. Various Members of the Society had, however, been zealously engaged during the year in those explorations of the Carboniferous Strata of the West of Scotland, by which in former years they had succeeded in greatly extending the lists of Scottish Carboniferous Fossils.

The Monthly Meetings—a new feature in the proceedings of the Society—for the reading of short papers, illustrative of local researches and discoveries, and for the exhibition of new or rare specimens of Fossils, Minerals, &c., would doubtless prove that some progress had been made during the past season. These meetings would be specially cared for by the Rev. H. W. Crosskey; and any of the Members of the Society having material for them were desired to communicate with him or with Mr. Young.

The Chairman stated, that the arrangements for the exhibition of the Society's Collection of Rocks, Fossils, &c., within the Museum of the Andersonian University, the accommodation of which had recently been largely increased, were all but completed. He also referred to the approaching Introductory Lecture by Mr. Geikie, on 'The Origin of the Present Scenery of Scotland'—a subject which, in his hands, could not fail to interest the Members of the Society, and to prove attractive to the general public.

The Meeting then proceeded to the election of office-bearers; and the following were declared duly elected:—President; James Smith, of Jordanhill, F.R.S., F.G.S. Vice-presidents; Edward Alfred Wünsch, Rev. Henry W. Crosskey, James Thompson. Hon. Secretary; James Farie. Hon. Treasurer; James Horne. Council; James Armstrong, Andrew Armour, Peter Halliday, Angus Kennedy, C.E., J. W. Young, John Young, Thomas Naismith, James Dairon, John Dougall, Joseph Kerr, John Dennison, M.E., John Sutherland. Hon. Librarian; James Armstrong.

The Rev. H. W. Crosskey briefly explained the mode in which the Monthly Meetings would be concluded, and urged the Members to do their best to support them, by preparing short papers, and bringing forward specimens to illustrate subjects of local interest.

On the motion of Mr. John Young, it was resolved to subscribe to the Palæontographical Society, and to complete the Society's set of the Monographs, so far as published,—also to subscribe for the 'Geological Magazine.' Communications from Mr. Henry Woodward, relative to the latter publication,—from Mr. Simons, of Whiteinch (a member of the Society), in reference to his work on 'Our Stones, Metals, and Minerals,' about to be published,—and from Mr. Croll, of the Andersonian University, with a copy of his recent paper, 'On the Physical Cause of the Change of Climate during Geological Epochs,' were then laid on the table; and, after a vote of thanks to the Office-bearers, for their services during the past year, the Meeting separated.—J. F.

Liverpool Geological Society.—The members of this Society held a field-meeting at Bidstone Hill, near Liverpool, on August 27th. The chief object of interest was the base of the Keuper formation, which is there very well exposed, and consists of a coarse conglomerate. Beneath it is the Bunter Sandstone; and Mr. Morton, the Honorary Secretary of the Society, pointed out the very strong appearances of unconformity between the two formations. He referred to the instance described by Mr. E. Hull as occurring near Ormskirk, in Lancashire; and, having carefully examined that section, was of opinion that the one at Flagbrick (which is close to Bidstone) is in every respect as conclusive as the other. The same general description applies to both localities; for in each section there are false-bedded yellow sandstones, without any very distinct dip, with a flat surface, covered by the conglomerates of the Keuper.

The site of the glacial marks discovered at the same place was shown; but the rock is now almost covered up: and, after some time spent in the quarries, the proceedings terminated with tea at the village inn.

The first Evening-meeting of the Session was held on October 11th last, at the Royal Institution, Colquitt Street. Mr. G. S. Worthy presided. The Honorary Secretary read the minutes of the concluding meeting of the previous session, reports of the field-meetings held during the summer months at Llangollen and Bidstone, and also a list of works presented to the Library of the Society. A letter was read from the Rev. Henry Griffiths, stating his regret at leaving Liverpool and being obliged to withdraw from active fellowship with the Society. Several members having spoken of the loss sustained by the President's retirement, the ballot commenced, and the following officers were elected:—Mr. Henry Duckworth, F.G.S., F.L.S., president; Mr. R. A. Eskrigge, vice-president; Mr. S. B. Jackson, treasurer; Mr. G. H. Morton, F.G.S., honorary secretary; and Messrs. Marratt, Moore, Worthy, Hall, and Dr. Ricketts, members of the council. The Treasurer read his report for the past year, from which it appeared that the Society is in a very good position; and several new members were proposed. Mr. Gregson exhibited a beautiful pair of perfect horns of *Cervus elaphus* that he had lately obtained from the old land-surface projecting from under the sand-hills at the mouth of the Alt, Formby. Several other members exhibited fossils of interest; a tooth of the *Labyrinthodon*, by Mr. Worthy, being perhaps the most important. The paper of the evening was then read by Mr. G. H. Morton, F.G.S., 'On the Records of Geological Time.' The author reviewed some very important conclusions regarding the earth's past history. He referred to the many instances of unconformity throughout the stratified series of geological formations, and considered them to prove that no country presented a perfect and continuous series of deposits;—that in every quarter of the world there are formations representing successive, though isolated, periods of time; but they would seldom be, if ever, exactly co-ordinate; and, consequently, the strata in one country may represent the breaks in the succession of the rocks in another: so that it is only by an examination of wide regions of the earth's surface that we can hope to obtain a tolerably correct history of geological progress.

G. H. M.

MEETING OF THE BRITISH ASSOCIATION AT BATH,
September, 1864.

In his Address to the British Association, Sir Charles Lyell, Bart., the President, briefly referring to the neighbourhood of Bath as of high interest to the geologist, at once took up the subject of its thermal and mineral waters, 'to the sanatory powers of which the city has owed its origin and celebrity. The great volume and high temperature of these waters,' he said, 'render them not only unique in our Island, but perhaps without a parallel in the rest of Europe, when we duly take into account their distance from the nearest region of violent earthquakes or of active or extinct volcanos.' The historical evidences of Saxon and Roman occupation were then briefly alluded to, especially the coins, pavements, monuments, and temples of the imperial troops and rich colonists from Rome sojourning at 'Aquæ Solis' for some 300 years. Then, as now, and probably long before, the hot-springs here, as at Aix-la-Chapelle, Baden-Baden, Naples, Auvergne, and the Pyrenees, had a persistent temperature, constant volume, and identity of mineral ingredients (as remarked by Daubeny), though exceptions have at times occurred, especially with earthquakes. 'How long has this uniformity prevailed? Are the springs really ancient in reference to the earth's history; or, like the course of the present rivers and the actual shape of our hills and valleys, are they only of high antiquity when contrasted with the brief space of human annals? May they not be like Vesuvius and Etna, which, although they have been adding to their flanks, in the course of the last 2000 years, many a stream of lava and shower of ashes, were still mountains very much the same as they now are in height and dimensions from the earliest times to which we can trace back their existence? Yet, although their foundations are tens of thousands of years old, they were laid at an era when the Mediterranean was already inhabited by the same species of marine shells as those with which it is now peopled; so that those volcanos must be regarded as things of yesterday in the geological calendar!'

Thermal waters in the Pyrenees, Alps, and elsewhere spring forth along great rents in the earth's crust; just as volcanos, active and extinct, have burst out on similar great lines of fissure; hot springs and emanations of gas and steam abound, too, 'in regions where volcanic eruptions still occur from time to time;' and where the fiery energy has ceased, as among the extinct volcanos of Eifel and Auvergne, such springs exist, and, like the rain-furrowed cones and river-worn lava-streams, 'indicate that the internal fires have become dormant in comparatively modern times.'

Thus connected with volcanic phenomena, the issue of thermal waters is comparable with 'the vast clouds of aqueous vapour which are copiously evolved for days, sometimes for weeks, in succession, from craters during an eruption.' Their power, too, of raising solid matter, and of transferring gases from the interior to the surface, 'is far more considerable than is commonly imagined. . . . Professor Ramsay has calculated that if the sulphates of lime and soda, and the chlorides of sodium and magnesium, and the other mineral ingredients that the Bath Waters contain, were solidified, they would form in one year a square column nine feet in diameter, and no less than 140 feet in height.' According to Daubeny, 250 cubic feet of nitrogen, besides carbonic-acid, is evolved daily from these waters. Both of these gases escape freely also from volcanos. The former may be derived largely from the nitrogen of atmospheric air carried down by percolating rain-water, and deoxidated at great depths, as well as to some extent from organic matter in the rocks. 'If we adopt the theory already alluded to, that the nitrogen is derived from the deoxidation of atmospheric air carried down by rain-water, we may imagine the supply of this water to be furnished by some mountainous region, perhaps a distant one, and that it descends through rents or porous rocks till it encounters some mass of heated matter by which it is converted into steam, and then driven upwards through a fissure. In its downward passage the water may derive its sulphate of lime, chloride of calcium, and other substances from the decomposition of the gypseous, saline, calcareous, and other constituents of the rocks which it permeates. The greater part of the ingredients are common to sea-water, and might suggest the theory of a marine origin; but the analysis of the Bath springs by Merck and Galloway shows that the relative proportion of the solid matter is far from agreeing with that of the sea, the chloride of magnesium being absolutely in excess, that is, 14 grains of it per gallon for 12 of common salt; whereas in sea-water there are 27 grains of salt, or chloride of sodium, to 4 of the chloride of magnesium. That some mineral springs, however, may derive an inexhaustible supply, through rents and porous rocks, from the leaky bed of the ocean, is by no means an unreasonable theory, especially if we believe that the contiguity of nearly all the active volcanos to the sea is connected with the access of salt water to the subterranean foci of volcanic heat.'

With respect to the presence of carbonic-acid at great depths, Sir Charles referred to Bischoff's belief that its action on the deep-seated silicates, giving rise to carbonates, must tend to an increase of bulk in the altered rocks, causing local expansion and compression, with alteration and displacement of the neighbouring strata; but, accepting this agency as probable, he still looks on alternate heating and cooling of the rock-masses as the chief cause of oscillations and other movements in the earth's crust.

'The temperature of the Bath Waters varies in the different springs from 117° to 120° F. This, as before stated, is exceptionally high, when we duly allow for the great distance of Bath from the nearest region of active or recently extinct volcanos and of violent earthquakes. The hot springs of Aix-la-Chapelle have a much higher temperature, viz. 135° F., but they are situated within forty miles of those cones and lava-streams of the Eifel which, though they may have spent their force ages before the earliest records of history, belong, nevertheless, to the most modern geological period. Bath is about 400 miles distant from the same part of Germany, and 440 from Auvergne – another volcanic region, the latest eruptions of which were geologically coëval with those of the Eifel. When these two regions in France and Germany were the theatres of frequent convulsions, we may well suppose that England was often more rudely shaken than now; and such shocks as that of October last, the sound and rocking motion of which caused so great a sensation as it traversed the southern part of the island, and seems to have been particularly violent in Herefordshire, may be only a languid reminder to us of a force of which the energy has been gradually dying out.'

The President then pointed out that the known and the probable dislocations in the strata in the environs of Bath are numerous; one of them 'has shifted the strata vertically as much as 200 feet.' The rent through which the hot water rises traverses in its upper part, 300 feet of horizontal beds of Lias and Trias, and, lower down, inclined and broken strata of the subjacent Coal-measures; as determined by William Smith in 1817. The fissure existed in the lower rocks long prior to the formation of the unconformable horizontal beds above; and these have been broken, along the old line of weakness, by a shock, perhaps, at a not very remote period, geologically speaking.

Among the solid contents of the Bath Waters, Professor Roscoe has lately discovered, by means of spectrum-analysis, minute quantities of copper, strontium, and lithium; and after mentioning this interesting fact, and explaining the nature of the process in which the spectroscope is so successfully used, Sir C. Lyell described a remarkable hot spring issuing deep down in the Clifford Amalgamated Mines (formerly the United Mines), near Redruth, in Cornwall, from a metalliferous fissure known as the Wheal-Clifford Lode, which had been pierced at the depth of 1350 feet from the surface. Mr. Warington W. Smyth found the temperature of the spring to be 122° F. (possibly 124° F. a little further east), and the lode, from 6 to 12 feet wide, to have elvan on one side and killas on the other, with a vein-stuff composed chiefly of cellular pyrites of copper and iron, through which the hot water freely percolates; whilst higher up the vein is filled with 'quartz and other impermeable substances which obstructed the course of the hot spring, so as to prevent its flowing out on the surface of the country.' Professor W. A. Miller finds the quantity of solid matter in this hot mineral spring to be four times as much as that in the Bath Waters. 'Its composition is also in many respects very different; for it contains but little sulphate of lime, and is almost free from the salts of magnesium. It is rich in the chlorides of calcium and sodium, and it contains one of the new metals—cæsium, never before detected in any mineral spring in England; but 'its peculiar characteristic is the extraordinary abundance of lithium,' which constitutes 'no less than a twenty-sixth part of the whole of the solid contents.' 'According to a rough estimate which has been sent to me by Mr. Horton Davey,' observed the speaker, 'the Wheal-Clifford Spring yields no less than 250 gallons per minute, which is almost equal to the discharge of the King's Bath or chief spring of this city. . . As to the gases emitted, they are the same as those of the Bath Water—namely, carbonic-acid, oxygen, and nitrogen.' Had the Wheal-Clifford Spring reached the surface, Sir Charles calculates that it would have issued with a temperature little inferior to that observed in the mine; and its poorness in magnesium, he regards as an objection to its being supplied by sea-water, unless the magnesium is 'left behind in combination with some of the elements of the decomposed and altered rocks through which the thermal waters may have passed.'

Some remarks were incidentally made on the probability of the several widely disseminated metals, the presence of which in mineral waters has only of late been discovered by the spectroscope, having real therapeutic value.

The infilling of fissures with mineral matter by hot springs was next touched on; and it was suggested that metallic substances may possibly be given off by the highly heated waters at profound depths, there forming the metalliferous portions of lodes, which, in course of time, when lifted upwards with the enclosing rock-masses, and exposed by denudation, come within the miner's reach.

The metamorphism of sedimentary rocks, on which the study of thermal waters has thrown some light, was the subject which next engaged attention. Metamorphic rocks are largely composed of minerals that are now regarded as having been derived from liquid solutions of far less temperature than that of the state of igneous fusion from which they were once supposed to have crystallized. Thermal waters are known to be 'powerful causes of decomposition and chemical reaction in rocks through which they percolate;' and their partial interference with strata at different horizons (the possibility of which Sir Charles illustrated by reference to the obstructed hot spring in the Wheal-Clifford lode) was alluded to as a probable cause of alternate altered and unaltered rock-masses. Sir C. Lyell mentioned Sénarmont, Daubrée, Delesse, Scheerer, Sorby, Sterry Hunt, G. Rose, and Bunsen as investigators of the effects of hydrothermal agencies; and he warned geologists not to be too ready to impugn 'the Huttonian doctrine as to the intensity of heat which the production of the unstratified rocks, those of the plutonic class especially, implies.' In a few words, the shifting of volcanic areas, thought by some to be a proof of the general distribution of internal heat, was then doubtfully associated with the local chemical changes with which mineral waters are concerned.

Referring to the comparatively modern date at which he had intimated that the Bath Waters may have sprung forth, Sir C. Lyell explained that 'mighty changes' had come over the western part of Britain even within the period during which the existing species of Testacea had inhabited the British seas, lakes, and rivers. Of Sir R. Murchison's 'Malvern Straits,' hypothetically spoken of by him a quarter of a century ago, actual proofs had lately been seen in marine shells of recent species found in Drift on that area, deposited when the site of Bath was water-covered at the foot of islands which are now the Cotswold Hills. The uprising of land that gave the present relation of sea and land was not so striking as that manifested, for the same period, by upraised marine shells on the top of Moel Tryfaen, on the flanks of Snowdon; where Mr. Trimmer, in 1831, found fossil Arctic shells, of existing species, at 1360 feet above the present sea-level. Lately this interesting bed has been again exposed. Sir Charles, who has seen this deposit lately, with Mr. Darbyshire and the Rev. W. Symonds, said that 'a considerable portion of what is called the Glacial Epoch had already elapsed before the shelly strata in question were deposited on Moel Tryfaen, as we may infer from the polished and striated surfaces of rocks on which the Drift rests, and the occurrence of erratic blocks, smoothed and scratched, at the bottom of the same Drift.'

The great cold of this Glacial Period was next treated of; and full justice done to Escher von der Linth's hypothesis, advanced eleven years ago, that, the region of the Sahara having but recently dried up (as Ritter had suggested), the Alpine Glaciers, and Europe in general, have felt the effects of a southern dry hot wind, the Sirocco or the Föhn, in place of the cool water-laden wind that came over that region, then a sea, within Post-tertiary times. The researches and observations of Desor,* Martins, C. Laurent, Denzler, Escher, Irscher, and of Sir Charles himself, bear on this subject; and the Rev. H. B. Tristram has traced evidences of old sea-margins in Northern Africa; the ancient sea stretching from the Gulf of Cabes, in Tunis, to the north of Senegambia, with a width here and there of perhaps 800 miles; the high lands of Morocco, Algeria, and Tunis, being then connected with Spain, Sicily, and South Italy, but separated from the rest of Africa by sea. So also Egypt shows a succession of river-terraces (Adams and Murie), and the Red Sea has 'raised beaches,' that point to alterations of level in the same Post-tertiary times.

The hydrographic arrangements of North Africa will thus have tended to increase the cold of Europe; and there are reasons for supposing the Alps to have been 2000 or 3000 feet higher then than they are now—another cause for greater glaciers there; the Gulf-stream also probably had not the same course as at present: and Sir Charles reminds us further 'that the height and quantity of land near the north pole was greater at the era in question than it is now,' and thus 'go far to account for the excessive cold which was developed at so modern a period of the earth's history.' That period, though full of great changes, in a long eventful succession, was but brief, geologically speaking,—'a mere episode in one of the great epochs of the earth's history; for the inhabitants of the lands and seas, before and after the grand development of snow and ice, were nearly the same.'

Though it has not been proved that Man existed in the Glacial Period, yet evidences of his existence are found in early Post-glacial times, when the climate was colder than now, and when the configuration of the surface differed much from that which now prevails. 'Valleys have been deepened and widened, the course of subterranean rivers, which once flowed through caverns, has been changed, and many species of wild quadrupeds have disappeared' since the Flint-folk left their implements of stone to be mingled, in the fluviatile Drifts of the Somme and elsewhere, with the bones of the extinct Elephant, Rhinoceros, Bear, Tiger, and Hyæna. Flint implements of the same old fashion have been found near Madrid, by De Verneuil and L. Lartet, with fossil teeth of the African elephant, which species lived also in Sicily, probably with Man (Baron Anca). 'We have now, therefore, evidence of Man having co-existed in

* See GEOLOGICAL MAGAZINE, No. 1.

Europe with three species of Elephant, two of them extinct (namely, the Mammoth and the *Elephas antiquus*), and a third, the same as that which still survives in Africa.'

The immensity of time to be allowed for even the Post-glacial and Glacial Periods is so great that Sir Charles warned his hearers that they must not be fettered by old traditional beliefs, but be ready to make liberal grants of time to the Geologist.

The President, in conclusion, alluded 'to two points on which a gradual change of opinion has been taking place among Geologists of late years. First, as to whether there has been a continuous succession of events in the organic and inorganic worlds, uninterrupted by violent and general catastrophes; and secondly, whether clear evidence can be obtained of a period antecedent to the creation of organic beings on the earth. I am old enough,' he said, 'to remember when geologists dogmatized on both these questions in a manner very different from that in which they would now venture to indulge. I believe that by far the greater number now incline to opposite views from those which were once most commonly entertained. On the first point it is worthy of remark that although a belief in sudden and general convulsions has been losing ground, as also the doctrine of abrupt transitions from one set of species of animals and plants to another of a very different type, yet the whole series of the records which have been handed down to us are now more than ever regarded as fragmentary. They ought to be looked upon as more perfect, because numerous gaps have been filled up, and in the formations newly intercalated in the series we have found many missing links and various intermediate gradations between the nearest allied forms previously known in the animal and vegetable worlds. Yet the whole body of monuments which we are endeavouring to decipher appears more defective than before. For my own part, I agree with Mr. Darwin in considering them as a mere fraction of those which have once existed, while no approach to a perfect series was ever formed originally, it having never been part of the plan of Nature to leave a complete record of all her works and operations for the enlightenment of rational beings who might study them in after-ages.

'In reference to the other great question, or the earliest date of vital phenomena on this planet, the late discoveries in Canada have at least demonstrated that certain theories founded in Europe on mere negative evidence were altogether delusive. In the course of a Geological Survey, carried on under the able direction of Sir William E. Logan, it has been shown that northward of the River St. Lawrence there is a vast series of stratified and crystalline rocks of gneiss, mica-schist, quartzite, and limestone, about 40,000 feet in thickness, which have been called Laurentian. They are more ancient than the oldest fossiliferous strata of Europe, or those to which the term "primordial" had been rashly assigned. In the first place, the newest part of this great crystalline series is unconformable to the ancient fossiliferous or so-called primordial rocks which overlie it; so that it must have undergone disturbing movements before the latter or primordial set were formed. Then again, the older half of the Laurentian series is unconformable to the newer portion of the same. It is in this lowest and most ancient system of crystalline strata that a limestone, about a thousand feet thick, has been observed, containing organic remains. These fossils have been examined by Dr. Dawson, of Montreal, and he has detected in them, by aid of the microscope, the distinct structure of a large species of Rhizopod. Fine specimens of this fossil, called *Eozoön Canadense*, have been brought to Bath by Sir William Logan, to be exhibited to the Members of the Association. We have every reason to suppose that the rocks in which these animal remains are included are of as old a date as any of the formations named "azoic" in Europe, if not older: so that they preceded in date rocks once supposed to have been formed before any organic beings had been created.

'But I will not venture on speculations respecting "the signs of a beginning," or "the prospects of an end," of our terrestrial system,—that wide ocean of scientific conjecture on which so many theorists before my time have suffered shipwreck. Without trespassing longer on your time, I will conclude by expressing to you my thanks for the honour you have done me in asking me to preside over this meeting. I have every reason to hope, from the many members and distinguished strangers whom I already see assembled here, that it will not be inferior in interest to any of the gatherings which have preceded it.'

Notices of Geological Papers read before the British Association.

On the Occurrence of Organic Remains in the Laurentian Rocks of Canada. By Sir W. E. Logan, F.R.S., F.G.S.; with communications by J. W. Dawson, LL.D., F.R.S., On the Structure, and by T. Sterry Hunt, F.R.S., On the Mineralogy of the same Remains.

THE Laurentide Mountains in Canada, and the Adirondachs in New York State, are composed of the oldest known rocks in North America; and these have been recognized by the Geological Survey of Canada as a great metamorphosed mass of crystalline strata, quartzose, aluminous, calcareous, and magnesian, divisible into two groups, the Lower and the Upper Laurentian rocks, probably more than 30,000 feet thick. These also, though not recognized separately, occur also in North Britain, as well as in Norway. In both the Upper and Lower Laurentian groups are limestones, of great thickness, as well as bands of graphite and iron-oxide,—all of which have been referred by the Canadian Geologists, on hypothetical grounds, to an organic origin. Something like fossil Corals had been observed years since in the Laurentian limestone of the Grand Calumet and of Burgess; but no definite organic structure was found in them. Lately, a marble from the Lower series in Canada has yielded to the microscope evidence of organic structure, which Dr. Dawson identifies as being represented among known organisms—1stly, by small, cellular, sessile shell-growth, like that of the *Foraminifera* known as *Polytrema* and *Carpenteria*; and, 2ndly, by radiating and otherwise arranged tubuli in the shell-walls, only represented in recent or fossil forms by the 'vascular system' of the shells of some *Foraminifera.* Hence, although the organism that has given mass to the limestone in question had a wide-spread growth, with layer after layer in considerable thickness, forming a reef by itself, yet Dr. Dawson finds it to be Foraminiferal in its character, and therefore refers it to the Rhizopods, with the name of *Eozoön Canadense.* The structure of this fossil is often lost in the altered limestone, especially when dolomitic; but in some cases magnesian silicates (augite, serpentine, &c.) have replaced the sarcode or jelly-flesh of the Rhizopod, even in the tubuli or 'vascular system.' Hence the order and shape of the chambers are more or less distinctly traceable, and the tubuli are replaced by threads of mineral matter, remaining after the calcite has been removed by dilute acid. Dr. Dawson, however, in transparent slices under the microscope, made out the structure of *Eozoön*, before specimens that could be dissected by acid had been experimented upon; and the latter confirmed the results he had arrived at.

The silicates replacing the sarcode of the original animal are white pyroxene, serpentine, loganite, and pyrallolite or rensselærite. The pyroxene and serpentine are often found in contact, filling contiguous chambers in the fossil, and were evidently formed in consecutive stages of a continuous process. Sometimes the shell-skeleton has been replaced by dolomite, and then the finer details of structure are lost. The infilling of the chambers with the silicates in *Eozoön* is strikingly analogous to the replacement of the sarcode of recent and fossil *Foraminifera* by glauconite.

In one of the limestones (Grenville), the thin wavy laminæ of calcite and serpentine are traceable in patches, about a square foot in extent, and 5 or 6 inches thick. Beyond these, a granular mixture of the two substances, sometimes with the peculiar minute structure, represents, it would appear, ruined masses of *Eozoön*, passing off into calcareous rock; whilst the whole is both based on and covered by white pyroxene in irregular masses, some of them 20 yards long by 4 or 5 yards wide, full of small patches of calcite, also showing the structure of *Eozoön.* The upper surface of each pyroxenic band generally bears a layer of serpentine, from $\frac{1}{16}$ inch to 6 inches thick. Sometimes other modifications of these minerals occur, together with lenticular quartzites, 1 foot thick and several yards in diameter, containing flakes of graphite. The pyroxenic masses characterize a thickness of about 200 feet in the marble, which is one of the lowest bands in the Grenville zone, 1500 feet thick altogether, but subdivided by great bands of gneiss. The authors state that the structure of this serpentinous marble suggests that it has been built up as a great Foraminiferal reef; the pyroxenic masses representing the older portions, successively broken up and worn down, and covered by new growths of *Eozoön*, represented by the calcareo-serpentinous portions. Mr. Sterry Hunt observes that this marble shows that the formation of magnesian silicates was not incompatible with the existence and preservation of organic forms, and that these silicates have resulted, not from subsequent metamorphism at great depths, but from reactions going on at the earth's surface, as he has already pointed out in published papers, with regard to the deposition of silicates from natural waters,—the Tertiary beds of sepiolite with neolite, and the formation of glauconite (hydrous silicate of protoxide of iron and potash, often with alumina), in all ages from the Silurian upwards, especially in company with organic forms (*Foraminifera*, &c.), as observed by Ehrenberg, Mantell, Bailey, and Pourtales. When dissolved silica comes in contact with iron-oxide rendered soluble by organic matter, the resulting silicate (glauconite) is formed in the cavities of minute sea-shells; so, probably, the magnesian silicates associated with the *Eozoön* may have been formed, Mr. Hunt suggests, by the direct action of alkaline silicates, either dissolved in surface-water or in those of submarine springs, upon the calcareous and magnesian salts of the sea-water; and he is now conducting experiments towards the elucidation of the facts.

On the Measure of Geological Time by Natural Chronometers.* By Professor Phillips, F.R.S., F.G.S.

DISTINGUISHING, in the first place, between the history of operations in the sea and on the land, by which the succession of ancient phenomena is determined, from the attempts to ascertain, first the relative, and finally the absolute chronology of these events, the author noticed several orders of natural effects which, being traceable through the later geological periods, and still in progress, seemed the fittest to be employed in the measure of Cænozoic time. Examples are found in the action of streams wearing away their channels, or depositing sediment; in the formation and growth of peat-moor; in the filling up of lakes; and, finally, in the accumulation of detritus in conical mounds at the foot of precipices by falling of rocks or torrents of water. The last case was illustrated by drawings, and a description of the remarkable mounds of La Tinière on the Lake of Geneva, near Villeneuve, which have been investigated by M. Morlot. At this place one of the mounds, the least ancient, has been cut through by the railway to a depth of between 20 and 30 feet. The section exposes the materials usually found in such mounds—large and small pebbles and sand; but, in addition, three bands of loamy nature, six to eight inches thick, are seen to range parallel to the general surface, one 4 feet below the surface, another 10 feet, the third 19 feet. The bands contain charcoal, and have rather the aspect of vegetable earth, in part stained yellow. With the upper one were found Roman reliquiæ—fragments of tiles and a coin; the middle one yielded no such objects, but some bronze articles; the lower one, coarse pottery, also fragments of bones of men and animals. Professor Phillips was so fortunate as to obtain from this lowest band, by his own research, a portion of cranial bone, which, by the help of Mr. C. Robertson of the Oxford Museum,

* 'The Reader,' Oct. 1, 1864.

he finds to be, as he had conjectured, part of the occipital bone of man. From these facts M. Morlot inferred that at three successive epochs the action of the torrent spread the reliquiæ of human occupation over the growing delta of La Tinière,—that the epochs may be approximately calculated at 1600, 3800, and 6400 years ago. And he refers these dates to particular points in the 'Roman,' 'Bronze,' and 'Stone' periods; so that the earliest trace of man in this delta is between 6000 and 7000 years old. No stone implements occurred in this mound. The age of the whole mound is estimated at 10,000 years. M. Morlot also applied the same method of computation to the earlier and larger conical mound of La Tinière, which was deposited while the Lake of Geneva was maintained at a higher level. The result gives for this cone one thousand centuries; and M. Morlot regards it as a fair approximation to the length of 'Post-glacial' time—the term 'Post-glacial,' as we employ it in England, being supposed to agree with the end of the last great extension of ice in the Alps.

On Glacial Distribution of Granite Blocks. By Professor Phillips, F.R.S.

FOR more than thirty years the attention of the author has been earnestly fixed on the remarkable facts which have been observed by Professor Sedgwick and himself in regard to the dispersion of granite blocks, from Wasdale Craig, over high and low ground across Yorkshire and certain tracts of neighbouring counties. While in the drainage of the Eden and the large tracts embraced by the northern and eastern branches of the Humber, and the long depression on the western side of the Carboniferous chain of Yorkshire and Lancashire, these blocks occur even plentifully, they are quite unknown in every part of the country to the westward of the parent rock. In tracing the course of the blocks from the extreme southeast of Yorkshire back to their origin, it is found that they by no means follow the valleys and avoid the heights, but that, on the contrary, with little or no difference, they occur alike on hills and dales, though not on the very highest, until on Stainmoor, at the extremity of Yorkshire, they appear on surfaces raised 1,400 feet above the sea. Through this Pass of Stainmoor, which, though so much elevated, is in fact a great transverse depression in the Carboniferous chain, the blocks have passed on through a strait of an ancient sea. At no other point have the blocks crossed the chain. Turning now to the west, we remark that in all the intermediate country, whether elevated to about 1,000 feet above the sea, or only to about 500, blocks of the granite are frequent; and on approaching the site from which all have passed, they grow so numerous as even to be counted by hundreds and thousands.

The blocks are often of very large size: some within two or three miles of the Craig are 12, 14, 18 feet, and even more, in the largest dimensions; and at Thirsk, 70 miles off, a block was found 13 feet in diameter. They seldom appear to have been rolled, but yet, perhaps by ordinary surface-waste, they have often become blunted at the angles. On the whole, the author is convinced, by his frequent examination of the phenomena, that the distribution to such great distances, in directions not conformed to natural courses of drainage, can be best explained by the agency of ice; 2. That it cannot be effected by glacier-movement on the land at its present absolute elevation; 3. That it cannot have been performed by iceberg-flotation in an ocean, if the present relative elevations of the country were then the same as now; 4. That the excessive abundance of blocks near the Craig, and in the region fronting it to the east, seems to require the supposition of a considerable disturbing force, which greatly shattered the Craig, and provided a large quantity of removable blocks before the ice-action came on. On the whole, the author supposes that during the Glacial Period such a disturbance took place; that the Lake-district was depressed; that icebergs formed from shore-ice, and at moderate depths in the sea, carried away many of the loosened blocks, over the region far away to the east, while that was relatively lower than it is at present, and that afterwards the distribution of the blocks near Wasdale Craig took place while the land was rising. He computes roughly, that if the blocks now visible in the region round Wasdale Craig were restored to it, and placed in the granitic area now exposed, they would cover it in every part to the depth of about three feet. The blocks of stone now seen to be loosened around the Craig, and lying against its steeps, would not amount to 1000th of this quantity; from which the author draws an argument in support of his views, of the preparatory concussions necessary to provide enough masses for the ice to transport. On another point of some difficulty he offered a few remarks. Both near the Craig, and at small distances from it, the quantity of other stones distributed with the granite is relatively very small, and the masses are of small magnitude. At very great distances, as 60 or 80 miles away in Yorkshire, this disproportion as to quantity is less remarkable; but the granite blocks are still usually the largest. The author believes that the difference of magnitude between the granitic and the schistose blocks may be understood by the much greater prevalence of joints in the latter, which produces now, on some slopes near Wasdale Craig, pretty extensive 'screes,' while the sides of the granitic cliffs are encumbered with large rock-masses. The difference of quantity he supposes to be explicable by the peculiar conditions of the formation of the ice, which he conceives to have generally picked up the blocks by adherence to the lower surface of the freezing mass, and not, as in glaciers, to have received them on the upper surface.

On the Formation of certain Valleys near Kirby Lonsdale. By Professor Phillips, F.R.S., F.G.S., &c.

THE author desired to call the attention of geologists, who were engaged in considering the theory of the origin of the valleys, to the necessity of keeping in view, not only all the real causes which have been concerned in changing the level and modifying the surface of the solid land, but also the peculiarities of the rocks themselves, in regard to the resistance they might offer to the waste occasioned by the mechanical and chemical agencies of water. He proposed to show, in regard to certain great ridges and hollows which limit the drainage of the Lune and its branches, that these were plainly sketched out by ancient subterranean movements; that in regard to particular streams, as the Lune and the Rother, there must have been valleys on part of their course before the age of the Old Red Sandstone; and that the courses of others, as Leck Beck and Barbon Beck, were marked out by great faults; while others, not in directions of such faults, were yet traceable to lines of weakness in rocks, occasioned by joints, having a determinate relation to these fractures. The conclusion from the whole being, that the main features of the inequalities of the earth's surface were always referable to displacements of the rocks and lines of weakness dependent on them; and that the agencies of waste along these directions were ancient operations of the sea, at the rising and filling of the level of the land, and other operations, sometimes very ancient, but often still in force, depending on atmospheric vicissitudes. In reference to the latter, the author gave proof, from the upper part of Leck Beck, that the narrow rocky limestone glen which runs up toward the 'County-stone' is nothing else than a line of ancient subterranean caverns, of which the roofs have fallen in; and that this process is still in progress, the water being received in 'swallows' at higher levels on the slope of the moors, and employed in dissolving the calcareous rocks on its passage. Thus the valley in question, and many others similarly situated, were not excavated from the surface, but, after long ages of underground action of water, were formed by the falling in of the unsupported roofs. After this had occurred, the usual surface-action of running water had modified the sides and the slopes.

On the Thermal Waters of Bath.* By Dr. Daubeny, F.R.S., F.G.S., Professor of Botany, Oxford.

After alluding very briefly to the mineral constitution of the Bath Waters as affording no adequate explanation of the medicinal virtues ascribed to them, the author proceeded to one point of scientific interest connected with their appearance—namely, the large volume of gas which they have gone on constantly disengaging, apparently from time immemorial. The nature and amount of this were made the subject of the author's examination, in the year 1832, during an entire month; and the result arrived at was that the gas consisted mainly of nitrogen, which is present, indeed, in most other thermal waters, but in none so copiously as at Bath. Judging from the circumstance that the majority of these springs are associated with volcanos, and likewise that the same gas is freely evolved from the latter both in an active and in a more dormant condition, we may fairly infer that the evolution of nitrogen at Bath is in some manner or other connected with the same widely spreading and deep-

* Read before the Chemical Section. 'The Reader,' Oct. 1, 1864.

seated cause. And, if this be the case, the phenomenon in question acquires an additional interest, as affording a possible clue to the true nature of the processes which give rise to volcanos as well as to thermal springs. Now this evolution of nitrogen seems best to admit of explanation by supposing a process of combustion to be going on in the interior of the globe by which oxygen may be abstracted from the common air which penetrates to these depths, whilst the residuary nitrogen is evolved. What may be the nature of the bodies by which this process of combustion is maintained must, from the depth at which the latter is carried on, be ever shrouded in mystery ; but it is at least certain that, whilst they cannot belong to the category of those which supply fuel for the ordinary processes of combustion of which we are ourselves eye-witnesses, there is nothing in the nature of the products resulting from volcanic action inconsistent with the idea that metals possessing a strong affinity for oxygen, but not already combined with it, might, if they existed in the interior of the earth, be instrumental in producing the supposed combustion. And, if we indulge in speculation, it may be maintained, with some show of probability, that the bases of the earths and alkalies which constitute the present crust of the globe would have existed originally uncombined with oxygen, and therefore must at one time have been subjected to that very process of oxidation and combustion which we imagine to be at the present time continued. The author therefore suggested that volcanic action may be owing to certain chemical reactions proceeding in the interior of the globe between the constituents of air and water, on the one hand, and the metallic bases of the earths and alkalies on the other. After developing this theory, the paper concluded with pointing out a practical use to which the waste waters of the thermal springs of Bath might be applied after they had fed the several baths ; suggesting that, if, instead of being at once discharged into the river, they were first conveyed through underground pipes a few feet beneath the surface within a given area, the warmth imparted to the soil would prove highly favourable to the culture of tender exotics, and that, if the ground were further protected from cold by a glass roof, a winter-garden might be obtained with scarcely any further expense beyond that of the original outlay.

On the Cause of the Extrication of Carbonic-Acid from the Interior of the Earth, and its Chemical Action upon the Constituents of Felspathic Rocks. By Dr. Daubeny, F.R.S., F.G.S., &c.

THE author made some comments upon a theory advanced by Professor Bischoff, of Bonn, in his work entitled 'Elements of Chemical and Physical Geology,' in which the elevation and dislocation of certain rocks were attributed to the decomposition of felspar, through the agency of carbonic-acid, disengaged from the interior of the earth, seeing that the products of the decomposition of granite are found to possess a lower specific gravity, and therefore occupy more space than the original materials of the rock.

Such a change would doubtless occur in granite and trap, if acted upon by carbonic-acid at temperatures below 212°; but above that point the very opposite would be obtained, inasmuch as silica would then take the place of carbonic-acid, and, consequently, if brought into contact with earthy or alkaline carbonates in the interior of the earth, would produce silicates and expel carbonic-acid; as, indeed, was long ago pointed out by the author of this paper, in his work on volcanos, and is insisted upon by Professor Bischoff himself, in other parts of his volume. It seems difficult, therefore, to attach much importance to the cause assigned by Professor Bischoff for the elevation of strata; especially considering that the loss of substance incurred through the removal of its alkali by the agency of carbonic-acid, would go far towards counterbalancing any expansion due to the lower specific gravity of the kaolin resulting, and moreover recollecting that no theory which professes to account for the elevation of certain portions of the earth's surface ought to be accepted, if it does not embrace likewise the corresponding phenomenon of the sinking or depression of others.

In a note ON THE OCCURRENCE OF THE SAME FOSSIL PLANTS IN THE PERMIAN ROCKS OF WESTMORELAND AND DURHAM, Sir R. I. MURCHISON stated that certain forms of fossil plants not previously known in the Permian Rocks of the NE. of England have been found by Mr. Lyall in the Marl-slate under the Magnesian Limestone of Westhoe, Durham. These, one of which is a well-known species (*Ullmannia selaginoides*), were all identical with those found by Professor Harkness in the plant-bearing shales of the Permian rocks of Westmoreland (see Journ. Geol. Soc., vol. xx. p. 154). Sir Roderick further remarked, that, by the occurrence of these plant-beds, the sandstones and conglomerates of Westmoreland have been shown to be the true equivalents of the calcareous Permian rocks in Durham.

ON THE RELATIONS OF THE SILURIAN SCHISTS WITH THE QUARTZOSE ROCKS OF SOUTH AFRICA. By R. N. RUBIDGE, B.M. Lond.

THE quartzose sandstones of Table Mountain rest unconformably on slates and schists, and are continuous with ranges of like lithological character in the Eastern Province, where, however, they are interstratified with schists. This diversity of relation had led former geologists to separate the clay-slate of Cape Town from the schists of the East and the Interior; but the author had conjectured some years ago that the schists and slates throughout the Colony belonged to one great formation. Evidence had been brought forward before to show that this was probably the case; but only now was it clearly established by the production of Devonian fossils from many localities both in the Eastern and Western divisions of the Colony; and a species of *Knorria* from Swellendam, closely resembling one from the Kowie Mouth, proved the identity of the schists of those two localities. A map was exhibited, which showed the changes necessitated by these discoveries in the geological map of the Colony. Yet Dr. Rubidge considered this correction of slight importance in comparison with the principle which led him to establish it as a truth. This principle was the change of rocks of different ages into continuous quartzites. This change, he gave reasons for thinking, was due to molecular action with the aid of water, and was chiefly superficial.

ON THE GEOLOGY OF THE PROVINCE OF OTAGO, NEW ZEALAND. By DR. JAMES HECTOR, F.G.S.

IN a letter to Sir R. Murchison, with maps, sections, and photographs of fossils, Dr. Hector briefly described the geology of the Province of Otago. On the west rise mountains of metamorphic rocks, cut into by fiords at the coast, and furrowed by long, deep lakes on their eastern ranges. The base rocks are foliated and twisted gneiss, granite, syenite, and diorite (*m*, *l*, *k*); and are flanked by hornblendic slates, micaceous and hornblendic gneiss, clay-slate, and quartzite, with felstone-dykes, serpentine, and marble (*h*), which support sandstones, slate, and porphyritic conglomerates (*g*), possibly of Lower Mesozoic age. Further to the east, beyond a great valley, grey and blue gold-bearing schists (*i*) form a wide flattened boss, and are seen to throw off the hornblendic slates (*h*) and sandstones (*g*) to the west, and only *g* to the east. These old slaty rocks (*i*), often micaceous, quartzose, or chloritic, were described in some detail, as forming a triple series; they bear ancient lake-deposits (*d*), with brown-coal, and the great gold-drift, as shewn by special maps and sections. East of the schistose country are—1. inclined sandstones with estuarine shells and excellent brown-coal (*e*); 2. marine clays with septaria (*c*); and 3. the white crag (*b*)—'Ototara limestone' of Mantell. Some marine beds, possibly contemporaneous with *d*, also occur near the coast. The carbonaceous beds *e* may possibly be Upper Mesozoic, the others (*d*–*b*) are Tertiary. There are also extensive alluvial deposits. Volcanic rocks occur at Otago Harbour and elsewhere near the eastern coast, and are of late Tertiary age. The author thinks that the country was higher, and glacial action greater, in Post-tertiary times than now, but that no great or general submergence has taken place since.

ON THE COAL-MEASURES OF NEW SOUTH WALES, WITH *SPIRIFER*, *GLOSSOPTERIS*, AND *LEPIDODENDRON*. By WILLIAM KEENE, Esq., Examiner of Coal-fields and Keeper of Mining Records, New South Wales.

A GEOLOGICAL map of the country as far as examined by the author, and a generalized section, illustrated this paper, which referred, firstly, to the existence of *Belemnites* (indicating Secondary rocks) near the River Belliando, in Queensland; 2nd, the siliceous fern-shales with dicotyledonous leaves, from the southern part of N. S. Wales, which the author thinks to be older than the Coal-measures; 3rd, the 'false coal-measures' or 'Wyanamatta Shales,' in the upper part of the 'Sydney sandstone;' 4th, the existence of eleven workable seams of coal in the true Coal-measures of N. S. Wales, and the occurrence of *Vertebraria* and *Glossopteris* throughout the entire series. *Pachydomus* and *Bellerophon* (abundant) and *Spirifer* (rare) are found towards the lowest seams; and here, as well as lower down, *Spirifer*, *Fenestella*, and *Orthoceras* abound. A Heterocercal Fish has also been found in the shale above the 'Yard Seam.' Siliceous grits underneath the lowest seam contain *Lepidodendron* (*Pachyphlœus*); 5th, the author alluded to the volcanic phenomena of the Peale Ranges, which have been upheaved since the Coal-period; indeed, in some of the lavas Mr. Keene found a fresh-water mussel of a probably existing species; 6th, referring to the auriferous quartz-rocks, shales, and fossiliferous limestones, on which the Coal-measures lie unconformably, the author stated that he believed these older rocks were mutually connected, and belonged to one and the same system of strata; and that, besides gold, the quartz was rich with copper- and iron-ores. An illustrative series of specimens accompanied the paper; and the author referred to a still finer collection deposited in the Bath Museum in 1862.

In a letter addressed to Sir Roderick Murchison, Mr. J. Mackenzie indicated that a coal-seam thirty-eight feet thick, and of good quality, had lately been discovered in New South Wales, thirty miles distant from any known coal, and that it belonged to the true Carboniferous age.

A Brief Explanation of a Geological Map of the Neighbourhood of Bristol and Bath, by W. Sanders, Esq., F.R.S., F.G.S., was a very clear and concise description of his large map of the district, prepared by reducing 220 parish-maps to the scale of 4 inches to the mile, or 20 chains to the inch, with the colouring in accordance with that used by the Government Geological Survey. The area represented is 36 miles long from N. to S., and 30 miles wide from E. to W., including the Tortworth, Clevedon, Wraxall, Mendip, and Cotswold Hills; and presents the general features of a disturbed coal-basin, with its boundaries well defined on all sides except the eastern. Some tracts of limestone project from its western border. Nearly the whole of its interior is occupied by strata of Mesozoic age. Exterior to its northern boundary, Silurian strata appear. On the east and south the country is covered by strata of the lower and middle divisions of the Mesozoic or Secondary system. On the extreme south-eastern corner a small tract of the Greensand formation is seen, Thus, the map comprises a large portion of the geological series, ranging from the Lower Silurian up to the lower division of the Cretaceous system. The author then proceeded to point out the position of each geological formation, and their relations with the hill-ranges and valley-systems. The Coal-measures, opened up by the Kingswood, Nailsea, and Radstock pits, were especially mentioned, as being 5000 feet thick, and divisible into lower and upper series, separated by the Pennant Grit, and containing about 90 feet of coal-seams, of which the half is more or less workable. Only one half of the Coal-beds of the northern part of the basin, and less than a tenth of the southern portion, come to the surface. The absence of the Permian Beds, and the unconformability of the New Red Sandstone were also duly noticed; as well as the distribution of the Penarth Beds (formerly thought to be part of the Lower Lias). The superficial alluvium, with peat, was alluded to; and, lastly, a brief mention of the greenstone and vesicular trap-rock traversing the Lower Silurian strata and the Carboniferous Limestone at eight spots, concluded this geological history of the prominent features of the country.

On the Geology of the South-West of England.* By C. Moore, Esq., F.G.S.

THE author pointed out certain physical features which led him to the conclusion that the Mendip Hills had performed an important part in modifying the physical geology of the West of England, and that it was probable that that range of hills had proved a barrier to the incursion of the Secondary seas which washed their southern slopes. He then observed that, whilst the Secondary rocks outside the coal-basin were generally deposited conformably, those on the outer edge, and within the Somersetshire coal-basin, afforded evidences of general unconformability, and were found under very abnormal conditions; his view being, that the Mendips were at times only so far depressed as to admit of occasional irruptions of the sea within the coal-basin; the deposits of the New Red Sandstone and the Rhætic and Liassic seas being very thinly represented therein.

The Rhætic beds are a group of strata intermediate between the Trias and the Lias. Though thinly represented in this country, as compared with the Continental beds, they were shown to be of great interest in a palæontological point of view. Mr. Moore described the contents of three cartloads of deposit of this age, that he had found washed into a fissure of Carboniferous Limestone near Frome. From this he exhibited twenty-nine teeth of the oldest Mammals, three only having been previously found; together with relics of nine genera of Reptiles, most of them new to this country, and fifteen genera of Fishes. Mr. Moore produced to the meeting 70,000 teeth of the *Lophodus* alone as the result of his labour, and stated that the three loads of clay had yielded him probably one million specimens.

He then referred to the ironstone of the Middle Lias in the North of England, and remarked that one land-proprietor alone possessed there a quantity which, it had been calculated, when converted into iron, and sold at the present price of iron, would bring in money enough to pay off the national debt. The same beds, he remarked, occurred around Bath and in the West of England; but, from their not containing quite so much iron, and from their being thinner, the Fair City of the West would be spared the mortification of finding blast-furnaces springing up around. Passing to the Upper Lias, Mr. Moore described a very remarkable bed containing remains of Insects,

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* 'The Reader,' Oct. 1, 1864.

Fruits, Crustaceans, Fishes, and Reptiles. In doing this he produced a number of nodular stones, and riveted the attention of the audience by affirming that he was enabled to say that one contained the tail of a *Pachycormus*, that a second contained a head of a similar Fish, a third a perfect Fish, whilst another held in its stony embrace a Cuttle-fish, which, it was prophesied, would contain the cuttle-bone and ink-bag. Hammer in hand, Mr. Moore proceeded to open them, when, to the great amusement and delight of the Section, the fish he had previously indicated was discovered; and the most interesting specimen was that which contained the Cuttle-fish. When Mr. Moore broke open the stone, not only was the Cuttle-fish visible, but the dried inky fluid—the sepia—was discovered, as in a Cuttle-fish of the same kind that might be taken out of the sea at the present day. There was as much of it as would fill an ordinary ink-bottle. He then produced some very perfect specimens of *Ichthyosauri* found in the neighbourhood of Bath, and a specimen of a fish, about the size of a salmon of six or seven pounds weight, and so perfect in its form and appearance and shape that, but for its colour, as Mr. Moore said, it might be handed by mistake to the cook to dress; and yet millions and millions of years must have elapsed since this fish lived and moved about in the water. In the Mammaliferous Drift, which covers the Bath basin, and passes into the adjoining valleys, the remains of extinct Mammalia are abundant, and Mr. Moore exhibited many specimens.

On the Foraminifera of the Upper and Middle Lias. By H. B. Brady, F.L.S.

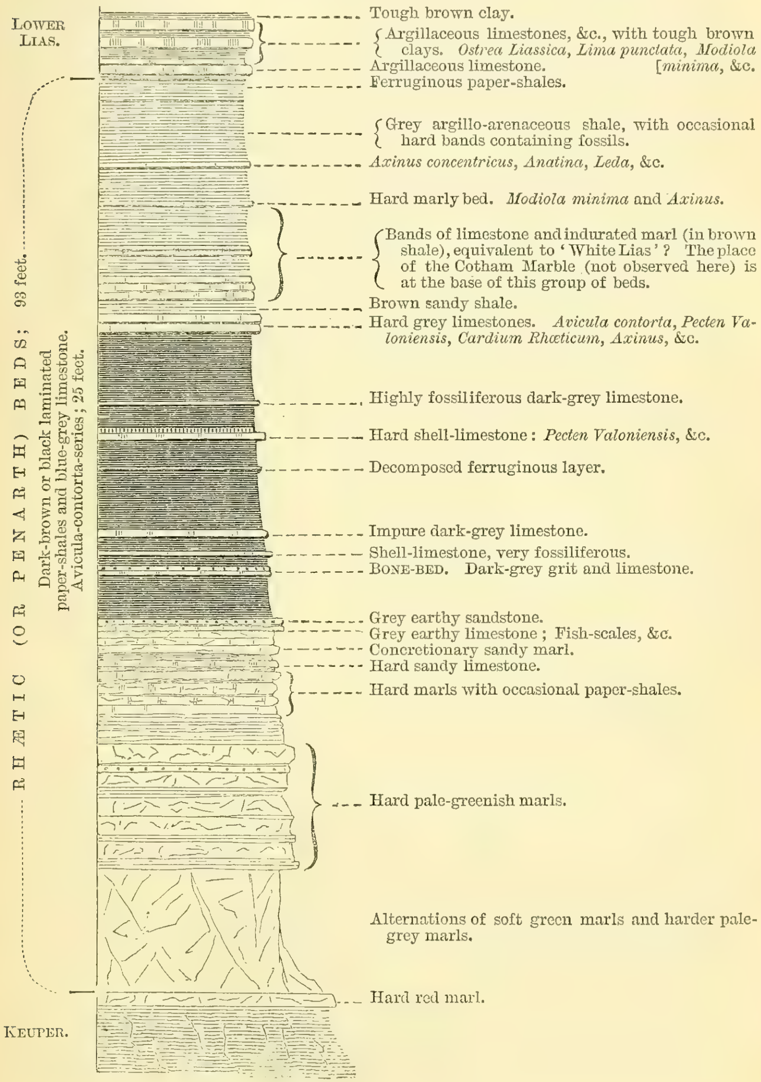
THE author stated that for some time past he had had Mr. Charles Moore's beautiful collection of Lias Foraminifera in his hands to work out, and that he had been requested to give some account of them to the Section as supplementary to Mr. Moore's paper on the Geology of the District, which had just been read. After enumerating the few scattered memoirs which form the scanty literature of the subject, a brief outline was given of the great Nodosarian group, to which almost all the Rhizopods of the Upper and Middle Lias belong. Passing allusion was also made to the so-called 'Nummulite' of the Lias (*Involutina*), of which a notice appears in our present Number. The author further stated that he was at present engaged upon the Liassic Foraminifera generally, and exhibited a series of drawings of the species occurring in the upper and middle portion of the series.

On the Rhætic or Penarth Beds of the neighbourhood of Bristol and the South-west of England. By W. H. Bristow, Esq., F.R.S., F.G.S., of the Geological Survey of Great Britain.

IN this paper Mr. Bristow stated that, the Directors of the Geological Survey being desirous of learning how far the Rhætic strata were capable of being represented by means of a separate colour on the Survey-map, he visited some of the localities in the West of England where the beds in question were best displayed; and, in company with his colleague Mr. Etheridge, he measured sections of them at Saltford, Uphill, Aust, Garden-Cliff, Watchet, Penarth, and other places.

The general section of these beds in the neighbourhood of Bristol was then described, and illustrated by means of diagrams. The

Section of the Rhætic (or Penarth) Beds
(measured at Penarth by Messrs. Bristow and Etheridge, in June, 1864).



middle part was shown to be a mass of black paper-shales containing *Avicula contorta*, a shell eminently characteristic of the formation, and thin beds of a tough bluish-grey limestone, coarsely fissile, and containing great numbers of another characteristic shell, *Pecten Valoniensis*, as well as *Cardium Rhæticum*, &c. These black paper-shales, with their thin included bands of even-bedded, tough, blue-grey, fossiliferous limestone, are well shown in the railway-cuttings at Patchway, opposite to and on either side of the Station. It is towards the lower part of these paper-shales that the bed so well known to collectors by the name of the 'Aust Bone-bed' is met with at Aust Passage, at Garden-Cliff near Westbury-on-Severn, at Penarth, and in other localities in the West of England. In those localities, as well as at the Patchway Cutting of the South-Wales Union Railway, this curious bed contains immense numbers of the bones, teeth, and scales of Fishes and Saurians, together with their fossil excrement (coprolites)—becoming in places a true bone-breccia, and very commonly highly pyritiferous.

The lower portion of the Rhætic strata consists of alternations of hard and soft marls, passing gradually into the red and green marls of the Keuper formation, upon which they are based.

The junction with the overlying Lias is of a more decided nature, and is denoted by the presence of *Ostrea liassica*, *Modiola minima*, and *Ammonites planorbis* in the lowest Lias; the two former shells being especially abundant and well preserved at Penarth, and the last in the shales at Watchet.

The upper subdivision of the Rhætic beds consists, for the most part, of alternations of limestones, marls, and clays, and includes certain beds which are commonly known as 'White Lias,' from the occurrence amongst them of a smooth-grained compact limestone (resembling the lithographic limestone of Solenhofen in texture and general appearance), to which the name 'White Lias' is usually given by some of the quarrymen of the West of England. The well-known 'Cotham marble,' or 'Landscape-stone' of the dealers in polished rocks at Bristol, is almost universally met with in the lower part of the White Lias series of the neighbourhood of Bristol, and in Dorsetshire; and thus affords an easily recognized horizon of great value in defining the upper boundary of the Rhætic series.

In conclusion, Mr. Bristow directed attention to the circumstance, that, it being desirable that a name borrowed from a British locality should be used on the Map of the Geological Survey to denote the Rhætic Beds, he was induced to recommend, at the suggestion of the Director-General, that the term 'Penarth Beds' should be adopted for that purpose. That name was selected by Sir Roderick Murchison, partly because none of the other places where sections of the beds under notice are displayed are of sufficient importance in themselves, or afford names sufficiently distinctive for the purpose in view; but chiefly because the docks and other great works now in course of construction by the Marquis of Bute, and the vast numbers of ships which make use of the Penarth Roads, confer additional importance on a locality where the beds are highly developed and well displayed—where they may be recognized from far out at sea, in the cliffs and bold headland forming the coast—resting on the red marls of the Keuper and overlain by the pale-coloured Liassic strata, in which the fossils are altogether different.

On Two Outliers of Lias and Rhætic Beds at Knowle and near Wootton Wawen in South Warwickshire. By the Rev. P. B. Brodie, F.G.S.

THE chief object of the author in this paper was to describe the Liassic Outlier at Copt Heath, where the limestones were formerly worked by a shaft long since abandoned. These apparently belong to the 'Saurian beds,' and the associated shales contain well-preserved specimens of *Ammonites planorbis*. Near this spot, on the canal-bank, in a very obscure section, some black shales may be seen overlying the Red Marl, on the top of which are small detached masses of thin-bedded sandstone, of a brown and yellow colour, in which impressions of *Pullastra arenicòla* were abundant—a shell which always occurs low down in the series, in connection with the 'bone-bed,' and seems to have a very limited range. These representatives of the Rhætic beds had not been previously noticed in Warwickshire, and this is their extreme northern limit in that county; but they have been detected further north in Staffordshire, by Mr. Howell of the Geological Survey. The paper also gave an account of some other outliers in Warwickshire, where the lowest beds of the Lias are exposed, including the 'Insect-beds,' with numerous remains of Insects, and lower strata containing the characteristic *Estheria* and *Pecten Valoniensis*. In all these cases, they can be readily identified with the basement-beds (Rhætic) overlying the Red Marl in Gloucestershire, though much reduced in thickness; and, though no actual bone-bed has as yet been seen *in sitû*, it may possibly be present in some places which have escaped a close examination.

On the Eurypteridæ, with Descriptions of some New Genera and Species. By H. Woodward, Esq., F.Z.S., F.G.S.

THE Palæozoic Crustacea included in this family have already formed the subject of papers read before the Association by Messrs. Page and Salter, and were first discovered in America by De Kay in 1826. The only separate memoir, however, is that in the Geological Survey Memoirs, 1859, by Messrs. Huxley and Salter. Other descriptions are to be found in the Quart. Journ. Geol. Soc., Hall's Palæontology of New York, &c. During the past five years numerous additional specimens have been discovered, better illustrating those already partially known, and affording many new forms. The author proposed the following classification of the genera and species, and gave descriptions and figures of the principal British forms:—

1. Eurypterus, De Kay.

Eurypterus Scouleri, *Hibbert*; Lower Carboniferous Rocks, Fifeshire.
E. mammatus, *Salter*; Coal-measures, Manchester.
Arthropleura (Eurypterus) ferox, *Salter*; Coal-measures, Coalbrook-dale.

Eurypterus acuminatus, *Salter*; Old Red Sandstone, Ludlow.
E. Brewsteri, *H. Woodw.* (sp. nov.); Old Red Sandstone, Forfarshire.
E. pygmæus, *Salter*; Upper Ludlow Rock, Kington, and Old Red Sandstone, Forfarshire.
E. lanceolatus, *Salter*; Upper Ludlow Rock, Lanarkshire.
E. linearis, *Salter*; Upper Ludlow Rock, &c., Kington.
E. abbreviatus, *Salter*; Upper Ludlow Rock, Kington.
E. chartarius, *Salter*; Upper Ludlow Rock, Lanarkshire.

2. Pterygotus, Agassiz.

Pterygotus Anglicus, *Ag.*; Old Red Sandstone, Forfarshire, &c.
Pt. minor, *H. Woodw.* (sp. nov.); Old Red Sandstone, Forfarshire.
Pt. Ludensis, *Salter*; Old Red Sandstone, Ludlow.
Pt. problematicus, *Salter*; Old Red Sandstone and Upper Ludlow Rock, Ludlow, &c.
Pt. stylops, *Salter*; Upper Ludlow Rock, Herefordshire.
Pt. Banksii, *Salter*; Upper Ludlow Rock, Herefordshire.
Pt. gigas, *Salter*; Upper Ludlow Rock, Herefordshire.
Pt. perornatus, *Salter*; Upper Ludlow Rock, Lanarkshire.
Pt. bilobus, *Salter*; Upper Ludlow Rock, Lanarkshire.
Pt. arcuatus, *Salter*, Lower Ludlow Rock, Leintwardine.

3. Slimonia, Page.

Slimonia acuminata, *Salter*, sp.; Upper Ludlow Rock, Lanarkshire.
Sl. (Pterygotus) punctata, *Salter*, sp.; Upper and Lower Ludlow Rocks, Westmoreland and Shropshire.
Sl. scorpioides, *Salter*, MS.; Upper Ludlow Rock, Lanarkshire.

4. Stylonurus, Page.

Stylonurus Powriei, *Page*; Old Red Sandstone, Forfarshire.
St. Scoticus, *H. Woodw.* (sp. nov.); Old Red Sandstone, Forfarshire.
St. ensiformis, *H. Woodw.* (sp. nov.); Old Red Sandstone, Forfarshire.
St. (Eurypterus) Symondsii, *Salter*, sp.; Old Red Sandstone, Herefordshire.
St. (Eurypterus) megalops, *Salter*, sp.; Old Red Sandstone and Upper Ludlow Rock, Ludlow.
St. Logani, *H. Woodw.* (sp. nov.); Upper Ludlow Rock, Lanarkshire.

5. Hemiaspis, H. Woodw. (genus nov.).

Hemiaspis limuloides, *Salter*, MS. H. tuberculata, *Salter*, MS. H. optata, *Salter*, MS. H. sperata, *Salter*, MS.	} Lower Ludlow Rock, Leintwardine.

Descriptions of some of the new forms will be found in the present Number of this Magazine; and the whole will be embodied in a Monograph for the Palæontographical Society.

On the Conclusion to be deduced from the Physical Structure of some Meteorites. By H. C. Sorby, F.R.S., F.G.S.

The microscopical study of thin sections of meteorites had led the author to conclude that their earliest condition of which we have evidence was that of igneous fusion, as indicated by the crystals of olivine containing 'glass-cavities,' like those characteristic of the minerals in terrestrial volcanic rocks. (See Quart. Jour. Geol. Soc., vol. xiv. p. 453; and Proceed. Roy. Soc., vol. xiii. p. 333.) There are, however, some meteorites, of which the 'Pallas Iron' may be taken as the type, consisting of a mixture of iron and olivine; and, if these were melted artificially, there can be no doubt, that, the iron being so much more dense would almost immediately sink to the bottom, and the olivine would rise to the top, like the slag in an iron-furnace. This at first sight appears to be strongly opposed to the supposition of igneous fusion; but the author contended that, since the force which would tend to separate the iron and olivine would vary with the force of gravitation, whilst the resistance to separation would be chiefly cohesion almost independent of it, if the fusion had taken place where the force of gravitation was very small, the iron and olivine might have remained fused and mixed together long enough to allow of slow crystallization. Hence he argued that such meteorites furnish us with physical evidence of having been formed where the force of gravitation was much smaller than on our globe, either near the surface of a very small planetary body, or towards the centre of a larger, which has since been broken into fragments.

NOTICES OF RECENT DISCOVERIES.

Discovery of a Cranium of *Elephas primigenius* at Ilford in Essex.

Of all fossils that are found, few at the present time excite more interest than the remains of the great extinct Pachyderms, such as the 'Mammoth' (*Elephas primigenius*), the Tichorhine Rhinoceros, and others. Not only have these animals been met with in a frozen state in Siberia, and have there been disinterred with all their soft parts preserved, but their remains are distributed in the superficial gravels, sands, and peat-deposits throughout Europe, Asia, and North America. They are still more important as 'time-marks,' from the fact that they occur both in this country and in France associated with flint implements,—the earliest indications of pre-historic man. Since British Geologists have more carefully examined the latest alluvial deposits of our lakes, rivers, and estuaries, numerous new or long-neglected localities where remains of the Mammoth occur, usually with many other Mammals, have of late been indicated. Among these we may mention Fisherton, near Salisbury, where flint implements also have been found with them by Dr. H. P. Blackmore, in high-level gravel; and these implements were described by Mr. John Evans, F.S.A., F.G.S., in the Quart. Journ. Geol. Soc. vol. xx. p. 188;—the Valley of the Ouse, near Bedford, where also they are associated with flint implements (see a paper by Mr. James Wyatt, *Op. cit.* p. 183),—Lexden, near Colchester, in peat beneath brick-earth (the Rev. O. Fisher, F.G.S., *Op. cit.* vol. xix. p. 393). They have been found also in the Hyæna-den near Wells, Somersetshire, by Mr. W. B. Dawkins, F.G.S. (*Op. cit.* vol. xix. p. 260); in a brick-pit at Churchbridge, Oldbury, near Birmingham (Geological Magazine, No. 1, p. 46); in one of the sand-banks of the Bridgewater Level, and along the coast, in a submerged forest, at St. Audries, Somersetshire (Quart. Journ. Geol. Soc. vol. xx p. 120); in gravel between Thame and Oxford; at Swathling, near Southampton; at Ilford and Ballingdon, in Essex; at Bridlington, in Yorkshire; at Leighton Buzzard, in Bedfordshire; in brick-earth, beneath gravel, near Newport, Isle of Wight; in a turbary at Holyhead Harbour; at Crayford, Erith, and Aylesford, in Kent; in an excavation in the Old Kent Road: they have been dredged up by fishermen off Dungeness, Kent, and off Hasboro' on the Norfolk coast; they are also met with at Bracklesham Bay, near Selsey, and in the Forest-bed at Mundesley, Bacton, and Cromer, in Norfolk.* In all these localities detached remains of the Mammoth have been found, consisting of the more solid portions of the skeleton, such as the lower jaw, and the upper and lower molars, the tusks, the vertebræ, and the leg-bones. Many such examples are to be seen in the extensive collection of Elephant-remains in the British Museum.

But though more or less fragmentary relics are thus met with, it is only within the past month that a nearly perfect cranium, with the tusks, has been for the first time obtained in this country.

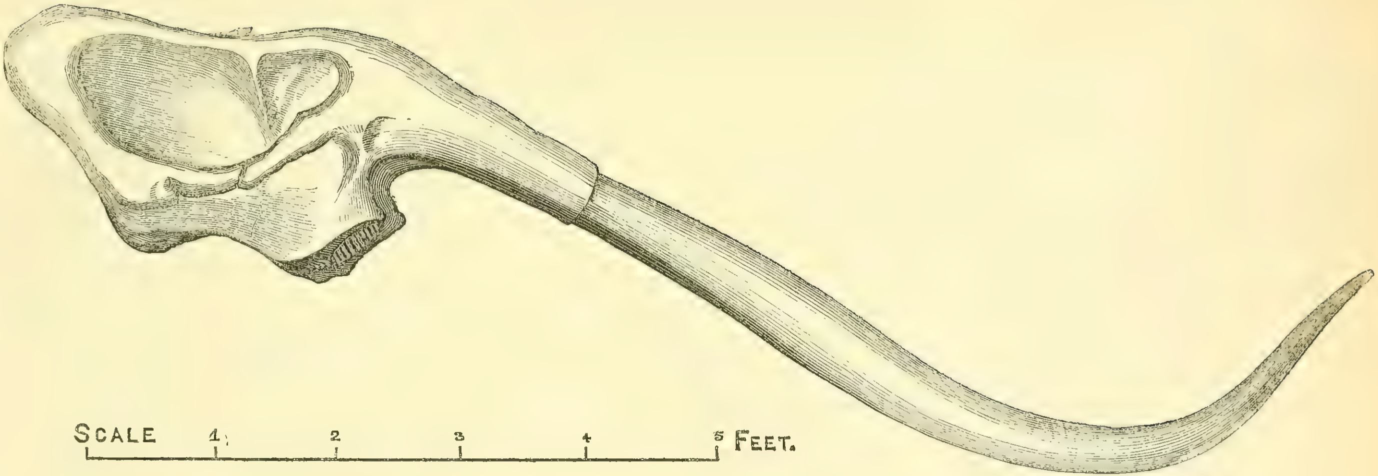
The 'Athenæum' of the 15th October, in referring to the discovery, remarks—'No such perfect skull of the true Mammoth has ever been found in England, nor anything comparable with this important example, so far as we are aware, except it may be the fine fossil Elephant in the Chichester Museum, a specimen of which we have heard, but have not seen.' My colleague, Mr. W. H. Coxe of the Department of Antiquities, having lately visited Chichester, obligingly informs me that this specimen was obtained from near Selsey, and consists of—one tusk 9 feet in length, a detached molar, the upper molars *in sitû*, with remains of the cranium much broken; also portions of the pelvis, scapula, and femur, *probably* belonging to the same individual. The remains are labelled *Elephas antiquus* † (an older species); and, as we have no positive evidence to the contrary, we may still consider our Ilford specimen unique.

The Museum authorities are indebted to Antonio Brady, Esq., for the first information of this discovery, and to William Hill, Esq., the proprietor of the Uphall Brickfield, who very liberally allowed them to take possession of it. I had, in company with Mr. W. Davies, of the Geological Department, the opportunity of seeing it *in sitû*; and it was entirely owing to his skill and judgment that it was removed from the matrix entire and brought away in safety. The specimen was discovered by the workmen at 15 feet beneath the surface, associated with remains of *Bos primigenius* (?), *Rhinoceros tichorhinus*, and numerous shells of *Cyrena fluminalis* and *Anodon*.

It is evident that the skull belonged to an aged individual, by its having cut its last pair of molars, and by these having been considerably worn. Of the upper molars 18 laminæ remain, 11 of which have been used; several of the front laminæ have been worn entirely away. The entire right tusk had been detached, with a portion of the socket, before it was finally enveloped in the sands and brick-

* See scattered notices in the 'Geologist' and other periodicals.

† See Geological Magazine, No. 3, p. 140.



Side-view of the Cranium of 'Mammoth' (*Elephas primigenius*). From the Brick-earth at Ilford, Essex.

earth; for it was found upon the same level in the pit, but nearly 20 feet from the cranium to which it belongs.

The cranium itself is nearly entire, the upper portion only of the left side having received an injury from the stroke of a pick or spade when the workmen first came near it.

The tusks measure 8 feet 8 inches from the point to the insertion into the socket (on the outside curve); the length concealed within the socket being more than 18 inches. The flexure of the tusks is very remarkable; but it is impossible in a single representation to convey anything more than a very faint conception of their actual contour. An examination, however, of the specimens from Eschscholtz Bay, upon the top of the wall-case in the VIth Room of the Geological Gallery, may help to elucidate this remarkable feature in the Mammoth.

It will take some months to saturate the entire cranium in gelatine, and much careful work to repair all the tiny loose fragments and complete the development of the specimen.

The measurements we have taken are as follows:—

From the top of the cranium to the end of the socket of the tusk	4 feet.
From the frontal bone to the occipital . . .	18 inches.
Breadth at the orbital bones	23 inches.
Breadth at the condyles, upper end of the zygomatic arch	22 inches.
Length of the zygomatic arch	10 inches.
Length of the socket of tusk	18 inches.
From the occipital condyles to the front of the palate	21 inches.
Length of the grinding surface of the upper molars	$6\frac{1}{2}$ inches.
From the occipital to the top of the cranium .	20 inches.
Length of tusk from the point to the alveolus (outer curve)	8 feet 8 inches.
Circumference at 1 foot from the socket . .	26 inches.
Length of the detached tusk (including 1 foot 10 inches which would have been enclosed in the bony socket)	10 feet 6 inches.

A tusk belonging to a very young Elephant was found in the same pit by one of the men; it measures 9 inches in length, and is perfect!

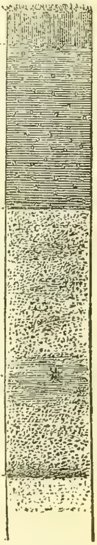
Mr. Prestwich, who visited the spot with me, has kindly added a Note upon the geological position of these remains.

British Museum. Henry Woodward.

The Brick-earth with Elephant Remains at Ilford.

THE brick pits of Ilford have been long celebrated for their Mammalian remains. The one best known is about a quarter of a mile beyond Ilford, on the left-hand side of the high-road from London to Ipswich. It was in this pit that the nearly entire skeleton of an Elephant was found half a century ago. Another pit, now closed, was formerly worked on the left-hand side near the top of the lane leading to Barking. The pit in which the skull of the Mammoth has now been found is situated on the right-hand side, a short distance farther down the same lane. The ground forms a low terrace, bordering the small river Roding, on the one side, and on the other it slopes gradually down to the Thames. The height of the surface of the ground at the pit is about 28 feet above the Thames. (T. H. W. M.)

The lower part of the section at this pit consists of marl and light yellow sands, interstratified with a few thin seams of gravel, the whole resting on London clay. Land and fresh-water Shells are common in places, and include several species of *Unio*, *Anodon*, *Limnea*, *Helix*, &c.; but the species which particularly abound in this pit are *Cyrena fluminalis* and *Helix nemoralis*, the latter often showing its colour-bands. The Mammalian remains are dispersed chiefly in the sand and thin patches of gravel lying on the bottom marl. They are generally very friable, and often very ferruginous. Fine fragments of the antlers of the large variety of *Cervus elaphus* have often been found, together with numerous molars of the narrow-tooth variety of *Elephas primigenius*, and bones and teeth of *Rhinoceros*, *Bos*, *Equus*, &c. Last year the tusk of an Elephant, 4 ft. 11 in. long, was found within a few yards of where the skull has since been discovered.

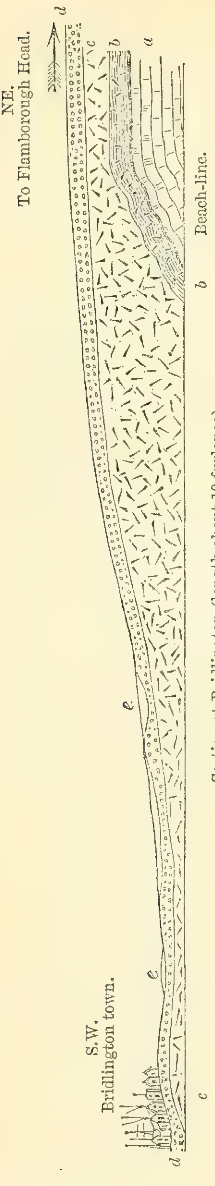


Section at the Uphall Brickfield, Ilford, Essex.

This series of fossiliferous sands, clays, and gravels belongs to the Quaternary low-level valley-gravels of the Thames Valley, and is of late Post-pliocene age. It is here overlain by a variable and irregular bed of non-fossiliferous brown clay, mixed with more or less gravel, and not stratified. This is the character the 'Loess' puts on at this spot, where it is formed of reconstructed London Clay and of gravel derived partly from the Boulder-clay. Farther on to the eastward of Ilford the Loess assumes its finer and better known aspect, and is largely worked as a brick-earth. There a few Shells (chiefly *Succinea*) are found in it, here none.

I do not go into fuller details, as I shall have occasion to give these various sections when treating of the Quaternary beds of the Thames Valley. I trust, however, that the above short notice will suffice to show the geological position of the fine specimen so successfully secured for the British Museum. JOSEPH PRESTWICH.

10, KENT TERRACE, N.W.: *Oct.* 18, 1864.



Section at Bridlington (length about 10 furlongs).

a. Chalk. *b.* Base of Boulder-clay, consisting of a black clay, with abundant small chalk-detritus; 10 feet.
c. Purplish black clay, with occasional stones, being the ordinary Boulder-clay of the coast of South Yorkshire; 30 feet where thickest in section.
d. Ferruginous gravel; from 6 to 15 feet. *e.* White chalky marl, in deep indentations in *d.*

CORRESPONDENCE.

THE BRIDLINGTON CRAG.

To the Editors of the GEOLOGICAL MAGAZINE.

As your correspondents from Bridlington have not furnished you with any explanation of the geological position of the so-called 'Crag' of that place,* I send you a section, taken by me during the early part of the present summer. It will be seen that about a mile north of the town, the base of the Boulder-clay (or Upper Drift) is brought up by an abrupt upheaval of the Chalk, upon which the clay rests. This clay (forming, with its capping deposits, the whole of the Holderness country) dips towards Bridlington Harbour; and there the gravel and overlying marl come down to the beach. The base of the Boulder-clay, where brought up, consists of a bed of dark clay, abounding in small chalk-detritus; but, so far as I could detect, it yields no fossils, and has nothing whatever like 'Crag,' or any sandy bed, underlying it. The section is interesting in many respects; amongst others, in showing the disturbances on this part of the Yorkshire coast to have begun subsequently to the deposition of the Boulder-clay (*c*), and prior to the overspread of the gravel (*d*); and to have been renewed after the deposition of the white marl (*e*), resting upon it, a deposit probably identical with those described by Phillips as yielding fresh-water remains at various points on this coast. A sand or gravel is shown by borings to be present under the clay further to the south, extending from Hull eastwards along the Hull and Withernsea Railway to the sea. That bed, however, I regard as indicating the occurrence, at this part of Yorkshire, of the upper series of the Lower Drift, which covers

* See GEOLOGICAL MAGAZINE, No. 2.

great part of Norfolk, Suffolk, and Essex. It is certainly possible that this bed might reach to Bridlington, and be abruptly overlapped by the clay, between the harbour and the place where the Chalk is forced up north of it, as the Lower Drift is undoubtedly overlapped by the Boulder-clay at various places along its inland border, in the more southern counties; but the dip of the Boulder-clay towards the harbour militates against the Lower Drift, even if present under the clay, coming up at that place. On the whole, I can see no other tenable conclusion than that the so-called 'Bridlington Crag' is, either a fossiliferous bed of the Boulder-clay (or Upper Drift), or else the base of the gravel that rests upon the clay, and extends inland to the foot of the Wolds, round by Beverley to the Humber, and is fossiliferous at Paull's Cliff, where I collected a few of the existing Bridlington shells.

The bed of cretaceous flint gravel referred to in Young and Bird's 'Geol. Surv. Yorksh. Coast' I take to be the stratum *b* in the annexed woodcut, although that bed is not really gravel.

Mr. S. P. Woodward, in his list of 'Shells from the Newer Pliocene or Norwich Crag,'* includes, not only Mollusca from the Bridlington bed, but also from Chillesford, and from Weybourne, Cromer, and Mundesley, the marine beds of all of which, I think, can be shown to be in no way connected (in structure) with the Norwich Crag, but to form horizons in the Lower Drift; while the Bridlington bed, assuming it at the lowest—namely, the base of the Boulder-clay, is separated from the Norwich Crag by the Lower Drift deposits, possessing, where they occur, an aggregate thickness of not less than 250 feet.—Your obedient servant, SEARLES V. WOOD, Junr.

MISCELLANEOUS.

HONOURS CONFERRED ON MEN OF SCIENCE.—H. M. the Emperor of Austria has been pleased to confer the Knighthood of his Order of St. Leopold on W. K. Haidinger, M. & Ph. D., &c., Director of the Geological Survey of Austria and of the Imp. Roy. Geological Institute of Vienna, 'in acknowledgment of his distinguished scientific exertions and his successful superintendence of the Imp. Geol. Institute.' The same distinction has been conferred on Professor Martius, of Munich, and on Professor Noeggerath, of Bonn, on the occasion of the celebration of their semi-centenary scientific careers. The Knighthood of the Imperial Order of Francis-Joseph had been conferred (on the 6th of last August) on Director Hohenegger, since deceased.—COUNT M.

M. L. HOHENEGGER, born at Meunningen (Bavaria) in 1807, died, after a short illness, on August 25 this year. Having filled sub-

* A Sketch of the Geology of Norfolk, by the Rev. J. Gunn, F.G.S. (Reprinted from White's County Directory, 1864, pp. 13, &c.)

altern mining offices in Moravia and on the Rhine, he superintended the Wolfsberg Iron-works (Carinthia) in 1837, and in 1839 was intrusted with the Archducal mining and metallurgical establishments in Austrian Silesia, which he advanced by new works and improvements. By his own exertions, assisted by some of his subalterns, to whom he imparted sound geological notions and a taste for scientific pursuits, he threw much light, by descriptions, maps, and collections, on the geology of the Sudetian Mountains of Silesia, the North-west Carpathians, and the territory of Cracovia. (From an obituary notice, by Baron Hingenau, Proceed. Imp. Geol. Instit. Vienna, Sept. 13, 1864.)—COUNT M.

AMONGST the many indications of the spread of Geological knowledge and its increased culture, we notice the establishment of a new local Society having that aim,—namely, 'The Sunderland Geological Society,' numbering as yet about thirty members, who intend to have, besides Ordinary Evening-meetings, four Field-meetings during the summer months at some of the many points of Geological interest to be found throughout the Northumberland and Durham district. The objects of the Society being to collect and diffuse information on the Science of Geology, the formation of a Museum and Library is also contemplated.

THE Palæontological Collection of the British Museum has lately been enriched by some fine remains of Thecodont Reptiles from the Upper Keuper Sandstone near Stuttgart, consisting of a cranium, a lower jaw, several vertebræ, dermal scutes, and limb-bones of *Belodon Kapffi*, von Meyer. These specimens are remarkably perfect, and have been extracted with great skill from their coarse and brittle matrix by Dr. Kapff, of Stuttgart. The lower jaw measures 2 feet 3 inches in length; both rami are perfect, and have nearly their whole series of teeth *in situ*. There are also portions of the upper jaw and an entire right ramus of the lower jaw of *Belodon Plieningeri*, von Meyer; with several detached teeth and bones of this and other like reptiles from the same locality.—W. D.

THE SKIN OF REPTILES PRESERVED IN A FOSSIL STATE.—There has lately been obtained, for the British Museum, from Barrow-on-Soar, Leicestershire, a specimen of *Ichthyosaurus tenuirostris*, showing a large extension of the dermal covering upon the surface of the slab. It seems to indicate, from the outline, that these Reptiles had a prominent ridge upon the dorsal surface, similar in appearance to that which the males of the Pond-newt (*Triton cristatus*) present in spring. A specimen with a considerable portion of skin attached, also from Barrow, came into the possession of the late Dr. Mantell, who, unfortunately not recognizing its real nature, chiselled it nearly all away in developing the bones. Some fragments of the skin may, however, still be observed upon the specimen, which is now in the Museum.—W. D.

THE

GEOLOGICAL MAGAZINE.

No. VI.—DECEMBER 1864.

ORIGINAL ARTICLES.

I. Notes on Brachiopoda from the Pebble-bed of the Lower Greensand of Surrey; with Descriptions of the New Species, and Remarks on the Correlation of the Greensand Beds of Kent, Surrey, and Berks, and of the Farringdon Sponge-gravel, and the Tourtia of Belgium.

By C. J. A. Meÿer, Esq.

[Plates XI. and XII.]

THE pebble-bed of the Lower Greensand of Godalming has been already referred to (‘Geologist,’ vol. vi. pp. 53,54) as a singular deposit, underlying the Bargate-stone series of that neighbourhood, remarkable alike on account of its peculiar organisms and its (probable) relation to other distant, though somewhat similar, beds; its position in the Greensand is fortunately well-marked, being immediately at the base of Fitton's ‘Upper or Ferruginous division;’ or, following the nomenclature of the Geological Survey, at the base of the ‘Folkestone Beds.’ In composition, it may be roughly described as a mixture of sand and small subangular pebbles, either loosely bedded or variously concreted. Its thickness at Godalming varies considerably, thinning out rapidly to the south of the town, but increasing on the north, in approaching the Hogsback, to a thickness of 8 or 10 feet; occasionally passing into, and alternating with, the lower layers of the Bargate-stone.

Hidden, for the most part, at its outcrop by surface-soil, or by the débris of the upper deposits, the pebble-bed around Godalming is but rarely to be seen unless by chance cut through in some quarry or lane-section. It is in this manner exposed in an old quarry or sand-pit on the side of a lane at Tewsley, to the south of Godalming, where it occurs as a band of brownish sand and pebbles, varying from 8 inches to 2 feet in thickness. This bed has, by careful search, afforded me a singular series of organisms, amongst which fragments of the casts of *Ammonites* (Oolitic) are the most abundant; casts of small Univalve and Bivalve Shells, teeth of Saurians, teeth and scales of Fishes—*Lepidotus*, *Gyrodus*, *Hybodus*, *Acrodus*, and *Lamna* (?), occurring less frequently, and rarely indeed teeth of *Saurichthys*. It is not, however, to the occurrence of derivative fossils in the pebble-bed that I would now refer; but to that of such fossils as, by their appearance and state of preservation, are evidently proper to the bed in question. These consist of twelve or more species of *Brachiopoda*, three or four small forms of *Exogyra*, *Pecten orbicularis*, a *Pecten* in markings most nearly resembling *P. Raulinianus*, D'Orb., *Avicula pectinata*, *Serpulæ*, and fragments of *Bryozoa*. I propose on the present occasion to confine my observations to the *Brachiopoda*.

The Brachiopod most frequently to be met with in the pebble-bed of Godalming is a species of *Terebratella*, which, in some of its variations, might be mistaken for a small variety of *Terebratula oblonga*, Sow. (M. C. pl. 535, figs. 4–6); and such indeed I had long considered it to be; but, after meeting with specimens of *T. oblonga* in the same deposit, in its ordinary form, I began to doubt the identification of the smaller species; and a closer examination of the pebble-bed shell tended to convince me that it was not only distinct from Sowerby's *T. oblonga*, but also from two other (foreign) Cretaceous species which it somewhat nearly resembles, namely *T. semistriata*, Defr. (D'Orb. Ter. Crét., iv. pl. 508, figs. 1–11), and *T. Beaumonti*, D'Arch. (Mém. S. G. Fr., 2 sér. pl. 21, figs. 12–14). I am still, however, in doubt whether the imperfect specimen figured and described in Dr. Fitton's Memoir 'On the Strata below the Chalk' (Geol. Trans. 2nd ser. vol. iv. pl. 14, fig. 9), under the name of *T. quadrata* is not the same as this Godalming shell. Yet, while considering the present species as specifically distinct from *T. oblonga*, it seems unadvisable to retain for it a name by which it would still be confounded with that species. I propose therefore to describe the pebble-bed shell under the specific name of *Fittoni*, in honour of one who, if not the original discoverer of the species, has done so much for our Cretaceous geology.

1. Terebratella Fittoni. Spec. nov. Pl. XI., figs. 1 to 10.
Terebratula quadrata (?), Sow. in Fitton, Geol. Trans., 2 ser. vol. iv. p. 338, pl. 14, fig. 9.

Shell ovate or irregularly pentagonal, its greatest width and thickness occurring usually near the middle of the shell. Beak rather obtusely pointed or rounded in outline, and more or less recurved; beak-ridges sharply defined, with a flattened, slightly concave, false area between them and the hinge-line. Foramen small, entire; rounded above, pointed below where completed by the deltidial plates, which it indents. Deltidium shallow, broadly triangular, in two pieces, and bordered at the sides by a narrow depressed line.

Valves unequally convex; the larger or dental valve much the deepest, the smaller valve being usually somewhat flattened towards the front. Socket-valve in young shells sometimes wider than long, in old specimens irregularly oval; surface of the valves ornamented by a variable number of plaits, rounded in outline, either simple or bifurcated, the central plaits conspicuously larger; the number on each valve varying from 7 to 15, usually 11. In old specimens the two or three central plaits on the dorsal valve are elevated into a mesial fold (see Pl. XI., fig. 1). The spaces between the ribs often exceed the width of the ribs themselves; which appears to be rarely the case in *T. oblonga.* Lines of growth, in well-preserved specimens, numerous and prominent. Margins of the shell slightly curved at the sides, and more or less *elevated* in front. Loop of moderate length (extending nearly two-thirds the length of the shell), doubly attached, first to the hinge-plate, and then to lateral processes, which are given off at right angles by the moderately elevated mesial septum; the base and, from the continual growth of the shell, the disused portions of these processes may be seen extending as a curved rib down the sides of the septum to its commencement beneath the hinge-plate. Shell-structure largely punctuated. Dimensions variable:—

Length $7\frac{1}{2}$, width 5, depth 4 lines; largest of 50 specimens.
„ 6, „ $4\frac{1}{2}$, „ $3\frac{1}{2}$ lines; average size.

Localities.—This species occurs abundantly in the pebble-bed at Tewsley and a few other places around Godalming. In the British Museum there are three specimens of this shell from Dorking.

Terebratella Fittoni may be most readily distinguished from *Terebratula oblonga,* Sow, by its diminutive size, and by the smaller number and inequality of the plaits on either valve; it differs also from *T. oblonga* in the ventral valve being less pointed towards the beak, and in the beak itself being more strongly recurved. In *T. semistriata,* Defr., the foramen is rounder and of larger size, and the beak is more abruptly truncated. In *T. Beaumonti,* D'Arch., the beak is shorter and also more abruptly truncated, while the smaller valve is more inflated near the hinge-line. So much for external differences; it remains yet to be decided, however, whether the loop in either of these species was doubly attached as in *T. Fittoni.*

2. Waldheimia Moutoniana, D'Orb., Pl. XII., figs. 12–14.

Associated with the foregoing species there occurs a shell which, from its outward form and elongated internal loop, can be no other than a variety of *Terebratula Moutoniana*, D'Orb., a species which has been recently added to our list of Cretaceous Brachiopoda by Mr. E. R. Lankester ('Geologist,' vol. vi. p. 314). The lowest layers of the pebble-bed at Tewsley also afford examples of two elongated species of Brachiopoda, one of which is an undescribed form of *Terebratula*, for which, for want of a better designation, I propose the name of *T. extensa*; the other I am inclined to consider as probably identical with *T. Boubei*, D'Arch. (Mém. S. G. Fr. ii., pl. 19, fig. 11. The first of these species requires a short description.

3. TEREBRATULA EXTENSA, Spec. nov. Pl. XII., figs. 1–4.

Shell unequally oblong-ovate, square in front, somewhat pointed towards the beak. Valves unequally convex, smooth, without either mesial fold or sinus; showing only a few, concentric lines of growth. Ventral valve much the deepest and curved upwards in front. Dorsal valve flattened and slightly elevated in front, much depressed at the sides, and inflated near the hinge-line. Most of my specimens show also on the dorsal valve a central, longitudinal depression (see Pl. XII., fig. 3), which, commencing near the hinge, extends to about the centre of the valve.* Beak short, very slightly recurved, and abruptly truncated by a large circular foramen, which is formed chiefly from the beak, and completed by the deltidial plates. Deltidium in two pieces, wide, but extremely shallow (see Pl. XII., fig. 4), and almost hidden by the (apparent) encroachment of the smaller valve upon the hinge-area; beak-ridges but little defined; margin of the valves flexuous. Shell-structure minutely punctuate. Loop short and simple.

Dimensions.—The two largest of my specimens measure:—

Length 13, width 7, depth 6 lines.
,, 11, ,, 7, ,, $5\frac{1}{2}$ lines.

Approaching to *T. prælonga*, Sow., in its elongated form, and in its large and circular foramen, *T. extensa* differs from that species in the shortness of its beak, the greater comparative breadth of the dorsal valve near the hinge-line, and in the absence of biplication in front.

4. Of the shell which resembles *Terebratula Boubei*, D'Arch., I have obtained many single valves from the pebble-bed around Godalming, about a dozen specimens (from a similar position in the series) from the Lower Greensand between Folkestone and Sandgate, and a few single valves from the Sponge-gravel of Farringdon. See Pl. XII., figs. 5–7. The specimens from these three localities have a general outward resemblance to each other, and appear to be all equally distinct from *T. Celtica*, Morris, and *T. prælonga*, Sow., to both of

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* A somewhat similar depression may be occasionally seen in specimens of *Waldheimia Celtica*, and would usually perhaps afford evidence of an internal septum; this species, however, as is proved by casts and single valves in my collection, had no trace of an internal septum.

which species this form somewhat nearly approaches; I am not, however, prepared to say that they are specifically identical with *T. Boubei*, D'Archiac, and must therefore be content, for the present, merely to notice their occurrence in our Lower Greensand.

Some uncertainty appears to exist with regard to the specific value of the two or more forms of *Terebratula* which, under the name of *T. Tornacensis* and varieties, are so abundant at Farringdon; for I find that M. D'Orbigny (Prodrome de Paléontologie, vol. ii. p. 172) includes the following—*TT. Tornacensis, Bouei, crassa, Robertoni, crassificata, rustica, Boubei, Virleti, revoluta, subpectoralis*, and *Keyserlingii*, of D'Archiac, amongst the varieties of *T. biplicata*, Brocchi; while Mr. Davidson (Monogr. Cretac. Brachiop. pt. 2), on the contrary, appears to consider *T. Tornacensis*, D'Arch., to be a well established species, perfectly distinct from *T. biplicata*, and of which the following—*TT. Roemeri, Bouei, rustica, crassa, crassificata*, and *Murchisoni*, are varieties; admitting *T. Robertoni, T. subpectoralis*, and perhaps *T. Virleti* and *T. revoluta*, to be specifically distinct from *T. Tornacensis*. Whether owing to distorted growth in certain individuals, or to any other cause, it is certain that the forms attributed to *T. biplicata* and *T. Tornacensis*, in the Farringdon Sponge-gravels, vary greatly in size, form, and general outward appearance; so much so indeed as to render it difficult, amongst a large number of specimens, to determine whether there are two, or four, or more species present; and, as in these specimens the loop is never (?) or very rarely preserved, it is the more to be regretted that so little dependence can be placed on those surface-markings of the shell ('striés d'acroissement') by which M. D'Archiac has distinguished several of his (Tourtia) species,—among others *T. Boubei*, but which, in the Farringdon specimens, appear to be of too fleeting and variable a character to be of any appreciable value. That Mr. Davidson is right in distinguishing *T. Tornacensis* from *T. biplicata* there can be little doubt; the former being even more closely allied to *Terebratula sella*. Some examples of this last species, indeed, in the form which prevails in the upper beds of the Lower Greensand at Shanklin are scarcely to be distinguished from M. D'Archiac's figures of *T. Tornacensis* (Mém. S. G. Fr., 2nd. sér. ii. pl. 18, fig. 3). Whether or not *T. Boubei* should therefore be regarded as a distinct species, or included among the varieties of *T. Tornacensis*, future researches must decide.

In addition to those already mentioned the pebble-bed has afforded me more or less perfect examples of the following species:—

Terebratella Menardi, *Lam.*—A few single valves from the pebble-bed, and from the Bargate-stone near Guildford.

Terebratulina striata, *Wahl.*—Several specimens from the pebble-bed at Tewsley and Hurtmore; it occurs more frequently in the Bargate-stone near Guildford. *T. striata* does not appear to have been heretofore met with below the Gault.

Terebratula oblonga, *Sow.**—Occurring sparingly in the pebble-bed, but more frequently in the Bargate-stone near Guildford, in the form represented Pl. XI. figs. 12–14.

T. Tornacensis, var. Roemeri, *D'Archiac.*—A few single valves from the pebble-bed near Guildford.

T. Robertoni (?) *D'Archiac.*—Several imperfect specimens, answering most nearly to the description of *T. Robertoni*, have been met with in the pebble-bed at Hurtmore near Godalming, and also near Guildford. See Pl. XII. figs. 10, 11.

T. depressa (?), *Lam.*—Fragments of a large *Terebratula*, which may possibly represent *T. depressa*, have been obtained from the pebble-bed near Godalming. The specimen represented on Pl. XII. figs. 15*a*, *b*. is from the Lower Greensand of Shanklin.

Waldheimia tamarindus, *Sow.*—Occurring sparingly at Tewsley. At Hurtmore, SW. of Godalming, it occurs in the sand immediately beneath the pebble-bed.

Rhynchonella latissima, *Sow.*—Single valves only, from the pebble-bed near Guildford ; rare.

Rh. depressa (?), *Sow.*—Single valves only, Godalming and Guildford ; rare.

Rh. Gibbsiana, *Sow.*, var.—Single valves, Tewsley and Hurtmore, &c. ; rare.

Figures of several of the above-mentioned species are given in the accompanying Plates XI. and XII., in consequence of the infrequency of their occurrence in beds of undoubted Lower Greensand.

In the May Number of the 'Geologist' (vol. vii. No. 77, p. 166), there was given a description of a new species of *Terebratella* from the Bargate-stone, under the name of *T. trifida*, drawings of which were to have appeared in the following Number ; but, in consequence of the somewhat sudden discontinuance of that periodical, they were inadvertently omitted : these figures are therefore introduced on the present occasion. See Pl. XI. figs. 17–23.

In the foregoing remarks mention has been made more especially of the pebble-bed of Godalming as a local deposit; yet, though in one sense local, it should not properly be so considered; the same band of pebbly strata being more or less traceable in the Greensand along the whole of the North Downs,—as at Guildford, Dorking, Nutfield, and Sevenoaks; it may also be observed at Folkestone and Shanklin; in all these places holding exactly the same position in the series. So that, although perhaps in part a local, as well as a littoral,

* I regret that I am unable, partly for want of space, to enter into a minute comparison of the varieties of *T. oblonga*, some of which, as is shown by Mr. Davidson (Mon. Cret. Brach., pt. 2, pl. 2. figs. 29–32), and still more by M. D'Orbigny, differ widely from the typical form; yet all, if I mistake not, within such limits as completely to separate them from *Terebratella Fittoni* described above.

deposit, its presence should rather be regarded as affording evidence of some slight elevation or depression of the sea-bed or adjacent land-surface at a particular period, affecting more or less the whole of our Greensand area.* Viewed thus, the pebble-bed becomes at once serviceable as marking a distinct horizon or boundary-line in the Cretaceous series, and one which might possibly be found to afford a more correct boundary between the faunas of the Lower and Upper Greensand formations than the Gault itself; few of the characteristic fossils of the Lower Greensand passing above this line, while it is the starting-point of many of the common forms of *Testacea* which range upwards through the Gault and Upper Greensand.

In the present state of our knowledge, however, it is still difficult to determine the exact relation of the pebble-beds of Kent and Surrey to those somewhat similar deposits to the west of the Wealden area, namely the Sponge-gravels of Farringdon, &c., excepting upon palæontological evidence; and even this admits of much difference of opinion. Thus we find, for instance, that those species of *Brachiopoda* which are common at Farringdon (*T. Tornacensis*, var., *T. depressa*, &c.), are of such rare occurrence within the Wealden area as to have been overlooked by nearly all collectors; and their supposed absence in typical Lower Greensand deposits has led many Geologists to consider the Farringdon Sponge-gravels as wholly distinct in age from the Lower Greensand. It is a question, however, how far the abundance of a particular species in one locality and its scarceness in some other should be admitted as a proof of difference in the age of the deposits in which such species occurs; for one cannot but notice in the case of living *Mollusca* how much irregularity exists in the range and abundance of almost every known species.

The occurrence, then, though ever so rarely, in a well defined position in the Lower Greensand of such forms as *Terebratella Menardi* and *Terebratula Tornacensis*, at Godalming, or *T. depressa* at Shanklin,—species which may be regarded as highly characteristic of the Farringdon Sponge-gravels, is very interesting; and the more so as tending to confirm the opinion now generally entertained with regard to the age of these last-mentioned deposits; an opinion which the natural distribution of our British Cretaceous Brachiopoda surely tends to uphold. For in granting the Sponge-gravels to be of Lower Greensand age we restore and restrict to that formation such characteristic

* Possibly the commencement of the Wealden axis of elevation; for there it evidence at Godalming, and I imagine also at Folkestone, of slight unconformity between the lower and the upper beds of the Lower Greensand.

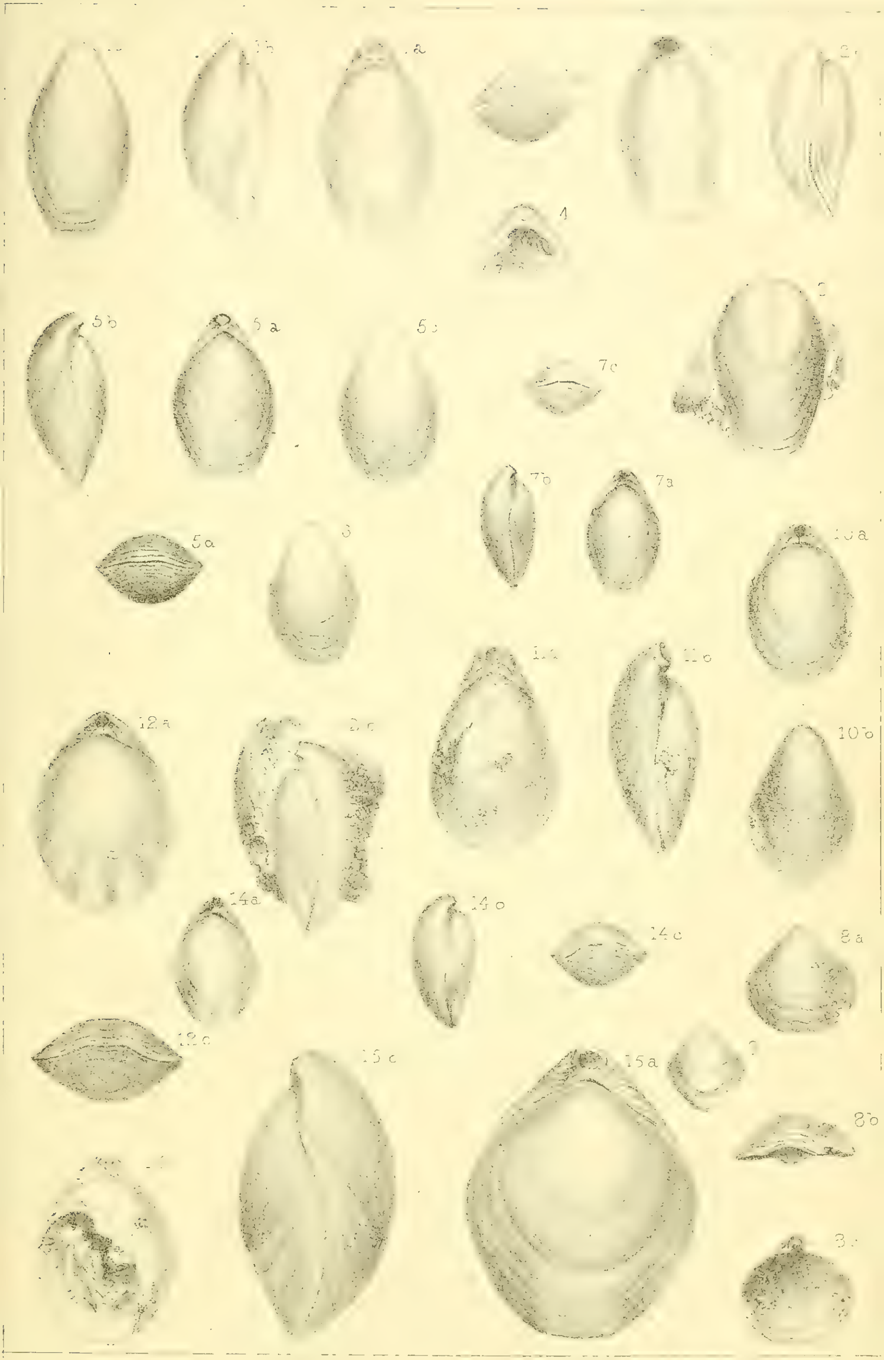
species as *Terebratula oblonga, T. tamarindus* and *Lingula truncata*; and, at the same time, limit those of the Upper Greensand, with the single exception of *T. capillata*, D'Archiac, to such species as are common to Warminster, to Cambridge, and a few other typical Upper Greensand localities.

Is then the evidence so fully conclusive with respect to the 'Tourtia' (the supposed foreign equivalent of our Farringdon Sponge-gravels), as to leave no doubt as to its position in the Cretaceous series? Are we to regard that also as possibly a Lower Greensand deposit? or may the presence of Lower Greensand species in that bed be accounted for by the known, but scarcely recognized, difference between the lateral extension of species and their vertical range?

EXPLANATION OF PLATES XI. AND XII.

Plate XI.

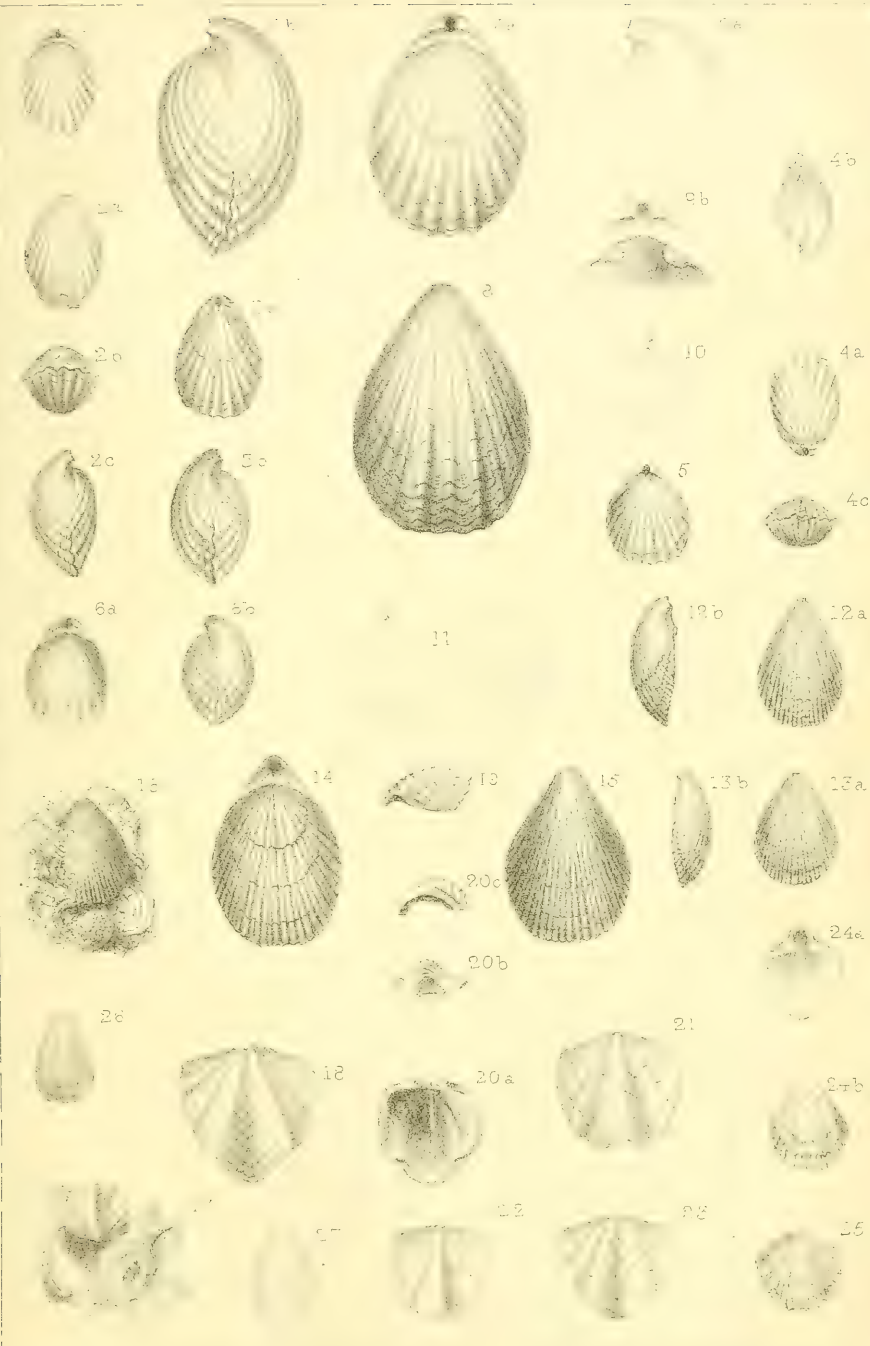
Fig. 1. *Terebratella Fittoni*, sp. nov. An adult specimen, of the most usual form and size; from the pebble-bed at Tewsley, near Godalming.
2 *a, b, c.* *T. Fittoni.* Another specimen, with lines of growth strongly marked.
3 *a, b.* *T. Fittoni.* A fine specimen, from Hurtmore, W. of Godalming; the largest in my collection.
4 *a, b, c.* *T. Fittoni.* A specimen of the form that approaches to *T. Beaumonti*, D'Archiac.
5 & 6 *a, b.* *T. Fittoni.* Specimens with few ribs; greatly resembling *T. quadrata*, Sow.
7 *a, b*, 8 & 9 *a, b.* *T. Fittoni.* Enlarged figures, to show the style of marking and other features.
10. *T. Fittoni.* Internal cast.
11. *Terebratula quadrata*, Sow. Outlines of the original figures, introduced for comparison with the above.
12 *a, b.* *T. oblonga*, Sow. Ventral valve, from the pebble-bed.
13 *a, b.* *T. oblonga.* Ventral valve, from the Bargate-stone; a young shell.
14. *T. oblonga.* A specimen from the pebble-bed, enlarged.
15. *T. oblonga.* Ventral valve, from the Kentish Rag of Maidstone; of the natural size.
16. *T. oblonga.* A specimen from the Red Sponge-gravel of Badbury Hill, near Farringdon, accompanied by *T. Tornacensis*, var., and *T. Menardi.*
17. *Terebratella* (?) *trifida*, sp. n. (Described in the 'Geologist' for May, 1864.) Dorsal valve, on a fragment of Bargate-stone, together with a single valve of *Terebratulina striata.*
18. *T.* (?) *trifida.* Exterior of a *ventral* valve, enlarged.
19. *T.* (?) *trifida.* Side-view of the same, slightly enlarged.
20 *a.* *T.* (?) *trifida.* Interior of a *dorsal* valve, enlarged, showing the medial septum.
20 *b.* *T.* (?) *trifida.* Front view.
20 *c.* *T.* (?) *trifida.* Side view.
21, 22. *T.* (?) *trifida.* Exteriors of *dorsal* valves, enlarged.
23. *T.* (?) *trifida.* Ventral valve, enlarged.



C. J. A. Meyer del. & lith.

M. & N. Hanhart imp.

BRACHIOPODA FROM THE LOWER GREENSAND OF SURREY & HANTS.



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BRACHIOPODA FROM THE LOWER GREENSAND OF SURREY.

Fig. 24 *a, b. T. Menardi*, Lam. A *ventral* valve, from the pebble-bed of Godalming.
25. *T. Menardi.* Dorsal valve, from the Bargate-stone of Guildford.
26, 27. *Terebratulina striata*, Wahl. Single valves, from the pebble-bed of Godalming.
(The vertical lines indicate the length of the specimens.)

Plate XII.

(All the figures in this Plate are represented of the natural size.)

Figs. 1 *a, b, c, d*, & 2 *a, b. Terebratula extensa*, sp. nov. Specimens from the pebble-bed at Tewsley, near Godalming.
Fig. 3. *T. extensa.* A *dorsal* valve, on which the central, longitudinal depression is strongly marked.
4. *T. extensa.* Portion of a *ventral* valve, showing the form of beak and its deltidium.
5 *a, b, c, d. T. Boubei* (?), D'Archiac. A specimen from Folkestone.
6. *T. Boubei* (?). From the Sponge-gravel of Farringdon.
7 *a, b, c. T. Boubei* (?). From the pebble-bed at Tewsley, near Godalming.
8 *a, b, c. T. Tornacensis*, D'Archiac, var. Dorsal valve, from the pebble-bed near Guildford.
9. *T. Tornacensis.* Ventral valve from Godalming.
10 *a, b. T. Robertoni* (?), D'Archiac. From the pebble-bed at Hurtmore, near Godalming.
11 *a, b. T. Robertoni* (?). From the pebble-bed near Guildford.
12 *a, b, c. Waldheimia Moutoniana*, D'Orb. A specimen from the pebble-bed at Shanklin, Isle of Wight.
13. *W. Moutoniana.* A specimen from Shanklin, with part of the dorsal valve removed, showing a portion of the elongated loop.
14 *a, b, c. W. Moutoniana.* From the pebble-bed of Godalming.
15 *a, b. Terebratula depressa*, Lam. A fine specimen from the Lower Greensand of Shanklin, Isle of Wight.

II. Outline of the Rhætic Formation in West and Central Somerset. By W. Boyd Dawkins, B.A. Oxon., F.G.S.; of the Geological Survey of Great Britain.

Contents:—I. Introduction; II. White Lias, or Upper Rhætic; III. Avicula-contorta-series, or Middle Rhætic; IV. Lower Rhætic (Marls).

I. The identification of the Rhætic Formation in Britain, previously discovered to be intercalated between the Keuper Marls and Lower Lias Shales in Germany, we owe to the labours of Dr. Wright, F.G.S., and Mr. Charles Moore, F.G.S., In the year 1860, the former published an account of the strata beneath the Lias, characterized by the occurrence of *Avicula contorta*; the latter, in the following year, showing in a most valuable paper the true relation of the sandstones, shales, and limestones to the White Lias above and the Keuper below, added upwards of twenty-eight new species to the list of British Fossils. The White Lias, which Dr. Wright incorporated with the group of beds characterized by *Ammonites planorbis*, Mr. Moore considered to belong to, and to constitute an upper member of, the Rhætic Formation. Lastly, in 1861, after a careful examination of these beds in the West of England, I was able to trace the downward extension of the formation into the Grey Marls, until that time classed with the Keuper. My reason for treating, in the pages of this Magazine, of subject-matter that has already been embodied in a paper just published in the Quart. Journ. Geological Society, vol. xx. p. 396, is that new evidence has been adduced since the latter was written, inclining me to modify some of the views therein expressed. I purpose, therefore, to treat of the beds in question in three groups:—first, the White Lias or Upper Rhætic; secondly, the Avicula-contorta-series or Middle Rhætic; and lastly, the Grey and Black Marls and Marlstones up to the present time classed with the Keuper Marls, or the Lower Rhætic.

II. *The White Lias.*—Immediately underlying the dark-blue shales and thinly bedded limestones of the Ammonites-planorbis-zone, which in the Poulden Hills, and near the villages of Butleigh, Kingweston, Charlton-Adam, Kingsdon, Long-Sutton, and West Hatch are characterized by *Myacites unionoides*, occurs the White Lias, composed of a series of earthy limestones, thinly bedded, and separated from each other by loose earthy marl. Sometimes the limestones are very hard, and of a pinkish tinge, as at West Hatch, where also some of the layers are very much water-worn, and bored by *Pholades*. More generally, however, the beds vary from a milk-white to a dark grey colour. The following section of the White Lias at Long-Sutton is a fair example of the beds and their fossils in the West of England, and is important as showing the total thickness of the White Lias, from the Ammonites-planorbis-shales above, to the Avicula-contorta-series below:—

7	inch.	Soft grey Lias, earthy.
13	,,	White marly earth.
28	,,	Soft grey earthy Lias: *Modiola minima*, *Lima pectinoides*.
16	,,	Two layers of earthy grey Lias.
4	,,	Grey shale.
9	,,	Hard grey Lias.
24	,,	Six layers of earthy marly Lias.
12	,,	Hard grey Lias: casts of Corals, *Cladyophyllia* (?).
18	,,	Six layers of soft earthy Lias: *Modiola minima*, *Lima punctata*.
4	,,	Hard grey Lias, with worn surface; evidently an old sea-bottom. It burns into 'White Lime.'
5	,,	Earthy grey Marl: *Cardium Rhæticum*, *Modiola minima*, *Pleurophorus*.
56	,,	Five layers of earthy grey Lias, without shale. It burns into good lime.

In thickness the White Lias varies considerably, even over small areas, measuring 9 feet at Beer-Crowcombe, and 32 feet at Saltford, near Bath. Its average thickness in West and Central Somerset is 15 feet.

Palæontologically, it is remarkable for the rarity of specific forms; and, so far as I know, it does not possess any one species peculiar to itself, excepting, perhaps, a small Coral (*Cladyophyllia*?) found at Long-Sutton (see preceding section), and also near Theale. In the absence of Ammonites, it contrasts with the beds above; in the absence of Vertebrates, with those above and below. In the paper before alluded to, I was inclined to consider it the passage-beds of the Lower Lias, its fossils, so far as they had at that time been made out, being as much Liassic as Rhætic; for if *Monotis decussata*, *Cardium Rhæticum*, *Pleurophorus* (sp.), and *Ostrea interstriata* bound it to the latter formation, so also did *Modiola Hillana*, *Pecten textorius*, *Pholadomya glabra*, and *Lima punctata* bind it to the former. In the conflicting palæontological evidence, therefore, as to true classification, I appealed to its lithology; and, as it contrasts strongly with the beds below in the absence of arenaceous deposits, and was akin to those above in the large development of the calcareous element, I classed it with the latter. Since that time, however, additional palæontological evidence has been adduced, that turns the scale the other way. Mr. R. Tate, F.G.S., in a list of fossils from the White Lias of the neighbourhood of Belfast (Quart. Journ. Geol. Soc. vol. xx. p. 109), adds to its fauna *Axinus cloacinus*, Quensted, *A. concentricus* (?), Moore, and an *Arca* closely allied to *A. Lycetti*, all of which, up to that time, had been found only in the Avicula-contorta-series below. It is therefore evident, that, while these beds, by the presence of a mixed molluscan fauna are passage-beds, they are more akin to the Rhætic formation than to the Liassic; the lithological characteristics derived from varying depth of sea, proximity to land, and the like, being of far less value in classification than the evidence afforded by palæontology. It is for this reason, therefore, that I consider the White Lias to constitute the Upper Rhætic group. The great breaks in the succession of life, both above and below, prove that great intervals elapsed between the deposition of the Avicula-contorta-series, below, and the White Lias, as also between the latter and the Ammonites-planorbis-zone.

III. *Avicula-contorta-group, or Middle Rhætic.*—This is composed of a series of dark and grey marls, thinly bedded, micaceous, and pyritous sandstones, and dark-grey or blue limestones. Sometimes there is a layer of conglomerate, as in a section near Frome, described by Mr. C. Moore, F.G.S. (Quart. Journ. Geol. Soc., vol. xvii. p. 497). Very generally the beds are charged with a fibrous carbonate of lime, strongly resembling gypsum, and are more or less micaceous. Throughout the series, traces of animal life are remarkably abundant; and usually at the base there is a *Bone-bed*, made up of the remains of Fishes and Saurians, and more or less conglomeratic. This bed, at Diegerloch, near Stuttgart, yielded teeth of *Microlestes* to Professor Plieninger. From this also, or from the dark shale above, which contains similar organic remains, the mammalian teeth found by the industry of Mr. C. Moore, in a fissure of the Carboniferous Limestone, near Frome, were probably derived, the stratum in which they were originally deposited having been broken up and washed into the fissure, together with the débris of other and younger rocks.

Besides the Bone-bed universally present at the base of the Avicula-contorta-series, there are two more, on the Watchet shore, in the middle and upper parts. Two or three beds of dark impure limestone, charged with fibrous carbonate of lime, and composed in great part of crushed *Pecten Valoniensis*, Defrance, appearing at Uphill, Watchet, and Stoke-Courcy, characterize the upper portion of the series. The fact, that the pebbles included in the conglomeratic bone-bed at the base are rounded fragments of the subjacent rock, intimates an interval of greater or less length, during which the subjacent sands became indurated into sandstone, and so elevated as to be exposed to the violence of the waves. Quartzose pebbles also prove that the Mid-Rhætic sea beat against cliffs of Devonian age. In thickness the Avicula-contorta-series varies from eleven feet, at Beer-Crowcombe, to twenty-five feet at Saltford. Its sandstones, shales, and earthy limestones prove it to have been deposited in comparatively shallow water, and not very far from land.

IV. *The Lower Rhætic Marls and Marlstones.*—These are generally unfossiliferous; and, from their conformity with, and gradual passage into the Red Marls of the Keuper, were formerly considered to belong to the latter. The Marlstones are hard, grey, and slightly calcareous; and are at some places intercalated with a coal-black shale, as on the Watchet shore. The upper Marlstones are laminated, ripple-marked, and traversed by the borings of Annelids. Sometimes both marls and marlstones are highly gypseous. I have included both in the Rhætic Formation on the evidence of the fossils found some 10 feet below the Bone-bed to the west of Watchet. They consist of *Modiola minima*, *Myacites striato-granulata*, *Gervillia precursor*, *Pecten Valoniensis*, *Pullastra arenicola*, *Cardium Rhæticum*, *Saurichthys apicalis*, *Gyrolepis Alberti*, *G. tenuistriatus*, *Acrodus minimus*, and *Sargodon Tomicus*, besides many forms too fragmentary to be identified. Here I obtained also a tooth of the oldest British mammal yet found in a stratified deposit. It is allied to the Kangaroo-rat, and is described in the paper before alluded to, under the provisional name of *Hypsiprymnopsis Rhæticus*. This assemblage of species proves beyond all doubt the Rhætic age of the rocks in which they occur; and, as the latter differ in no respect from the grey unfossiliferous marls and marlstones lying beneath, save in the accidental preservation of the fossils, it is a fair inference that both fossiliferous and unfossiliferous belong to the same group. Lithologically, in colour and texture, and in the arenaceous conditions of deposit, they are identical. Considering, therefore, the preservation or non-preservation of the fossils a mere accident, I propose to include the grey marls, marlstones, and black shales, down to the point where the Red Marls begin to appear, in the Rhætic Formation, whether they be fossiliferous or not. The thickness of the rocks so defined, from the Bone-bed above downwards to the first layer of Red Marl, on the east side of Watchet harbour, is 53 feet, and at Saltford 30 feet. Further down, beneath alternations of Red and Grey Marls and Marlstones, that prove the gradual passage of the Keuper into the Lower Rhætic series, is the deep-red marl so characteristic of the former.

A tabular list of Rhætic fossils is given at p. 406 of the paper alluded to above.

ABSTRACTS OF FOREIGN MEMOIRS.

BEOBACHTUNGEN IM MITTLEREN JURA DES BADISCHEN OBERLANDES, von F. SANDBERGER. pp. 22. (From the Würzburger naturwissenschaftl. Zeitschrift, vol. v.) [Observations on the Middle Jura of the Upland of the Duchy of Baden.]

THE Chain of the Jura, broken asunder at right angles to admit the passage of the Rhine, is continued towards the north-east into the Duchy of Baden, but the typical Jurassic rocks are somewhat changed. Fromherz in 1838, and afterwards in 1853, gave a correct outline of the strata, and their relations with their Swabian and Swiss analogues. The author of the present memoir in 1856 had occasion to go over the ground again, and found a Nerinæa-bed above the so-called Great Oolite. He was thus enabled to correct the nomenclature, and adapt it to the modern state of science. He has since pursued his investigations, and now gives the following as the series, in descending order. No representatives of the Kimmeridge beds have been detected.

11.	Coral-limestone of Istein, Kleinkems, &c. (Coral-rag) *Corallien* of D'Orbigny.		MIDDLE OOLITE.
10.	Marl, with *Ammonites cordatus.* (Oxford Clay.)	*Callovien,* D'Orb.	
9?	Grey clay, with pyritous nodules; at Müllheim.		
8.	Ferruginous marl, with *Ammonites macrocephalus.*		
7.	Cornbrash.	*Bathonien,* D'Orb. LOWER OOLITE, Upper Division.	
6.	Marly oolite, with *Ammonites ferrugineus.*	*Bajocien,* D'Orb. LOWER OOLITE, Lower Division.	
5.	Large-grained oolite, with *Nerinæa Bruckneri.*		
4.	White small-grained oolite, with *Ostrea acuminata* and *Echinobrissus Renggeri.*		
3.	Limestone, with *Ammonites Humphriesianus.*		
2.	Sandstone and ferruginous limestone, with *Am. Murchisonæ.*		
1.	Clay, with *Am. opalinus.*		

Carefully prepared tables of the fossils, and a description of some new species, add to the value of this memoir. The following are the names of the new species :—*Waldheimia bicincta, Rhynchonella semiglobosa, Opis calva, Pleurotomaria disparitexta.*—D. T. A.

UEBER ORGANISCHE UEBERRESTE IN DEM DACHSCHIEFER VON WURZBACH BEI LOBENSTEIN. [On Fossils in the Roofing-slate of Wurzbach, near Lobenstein, Thüringerwald.] By Dr. GEINITZ. 9 pages, with 2 plates. (From the Neues Jahrbuch, 1864. Heft 1.)

THIS paper treats of some few fossils found in the Wurzbach Slate by Bergmeister Hartung, of Lobenstein (Duchy of Reuss), by which the author determines that this slate or schist is of Silurian and not Devonian age. Most of these fossils are such as have been usually referred to the trails of Annelids and to the gallery-tracks of Crustaceans. 1. *Gordia marina,* Emmons, found also in the 'Taconic' schists of North America. 2. A riband-shaped worm-like fossil, figured in pl. 1, fig. 1 and 1A. 3. *Crassopodia Thuringiaca,* Gein., pl. 1, fig. 2. 4. A worm-like body (pl. 2, fig. 3) similar to *Nereites lanceolata*, Emmons. 5. *Nereograpsus Jacksoni*, Emmons, sp. This is figured in pl. 2, fig. 4. 6. *Lophoctenium Hartungi*, Gein. (pl. 2, fig. 5), differing somewhat from *L. Richteri*, which occurs in the Silurian rocks at Saalfeld, together with *Nereograpsus Cambrensis* and *N. pugnus*. 7. Crinoidal remains (indeterminable). 8. *Sagenaria* ? (pl. 1, fig. 6), a fragment of stem, 28 centim. long, and referable either to *Sagenaria*, or *Lycopodites*, or some other Lycopodiaceous form. Two Graptolites (*Monograpsus priodon* and *M. peregrinus*) also have been found in these Wurzbach slates; thus eliminating from the indefinite 'Grauwacké' of Central Germany another patch of Silurian strata. Professor Geinitz, in describing the above-mentioned fossils, states that he is confirmed in his views of the relationship of *Nereograpsus* to the Graptolite family, with *Funiculina cylindrica*, Blainville, as its analogue; and of *Lophoctenium* to *Sertularidæ*.—T. R. J.

Ueber ein neues Erdharz, Euosmit, aus einem Braunkohlen-Lager bei Thumsenreuth in der Bayer. Oberpfalz. Von Herrn Dr. C. W. Gümbel. [On a new Fossil Resin (Euosmite) from a bed of Brown-coal near Thumsenreuth, in the Upper Palatinate, Bavaria. By Dr. C. W. Gümbel.] (Neues Jahrbuch für Min., Geol., &c. Jahrg. 1864. Heft 1. pp. 10—14.)

In small isolated troughs upon the basalt which extends from Bohemia westwards, between the Fichtelgebirge and the Oberpfälzer-Wald, there occurs a Browncoal-formation, in contact with other Tertiary deposits, which is easily distinguished from others by scarcity of animal remains both in the Browncoal itself and the associated beds, and especially by the entire absence of Shells. In the bituminous shale of the Clausen, however, near Leussen, not far from Redwitz, there are not unfrequently found Fishes (*Leuciscus papyraceus* and *Lebias gobio*), Dragon-flies, Beetles (*Bruchus, Buprestis, Nemotæles*), and other organisms. Plant-remains, on the other hand, are everywhere abundant, and are often very well preserved, in consequence of having undergone a kind of silicification. Beds of *Diatomaceæ* of a considerable thickness also occur. Usually the beds of Browncoal are overlain by a deposit of bog-iron-ore; and in some places earthy phosphorite occurs in the associated strata.

Respecting the Browncoal itself, Dr. Gümbel observes that it is composed partly of soft, earthy, nearly useless coaly masses, and partly of very good lignite. In it are found, besides numerous stems, *Glyptostrophus Europæus*, *Acer tricuspidatus*, *Juglans rostrata*, *J. ventricosa*, and in extraordinary numbers the little fruit, *Folliculites Kaltenhordheimensis*.

It was in a Browncoal-formation at the Baiershof, near Thumsenreuth, not far from Erbendorf, in the Oberpfalz, having these general characters, that the fossil resin was found, of which Dr. Gümbel, after describing in detail the strata of that locality, next proceeds to give the characters.

Most Browncoal-formations have yielded fossil resins; but that of Thumsenreuth is easily distinguished from them, by a very strong and peculiar smell, which caused the miners to give it the name of 'Kampferharz,' the odour being very similar to that of Camphor, and at the same time resembling that of Rosemary. It occurs either in brownish-yellow, almost pulverulent masses, or in nearly firm pieces, of the colour of cherrytree-gum, and looking like ordinary pitch; in both states it has the same pleasant odour. It is brittle, translucent in thin films, becomes strongly electric when rubbed, and has a conchoidal fracture. Its hardness is 1·5, and its specific gravity 1·2 – 1·5. Its composition, excluding 0·84 per cent. of ash, is, according to Dr. Wittstein, as follows:—Carbon 81·89; Hydrogen 11·73; Oxygen 6·38=100·00. This corresponds to the formula $C_{34}H_{29}O_2$, and shows the resin to be most nearly related to that from Giron in New Granada, which was analyzed by Boussingault;* but it is distinguished from that species by its aromatic smell, and its being very easily soluble, without leaving any residue, both in alcohol and ether. The author then proceeds to give in more detail the effect of chemical reagents and solvents upon the resin, and states that, as he cannot reconcile its behaviour under their action, nor its peculiar smell, with the characters of any known species, he ventures to bestow upon it the name of *Euosmite.*

Euosmite is generally found filling up clefts and rents in the lignite, in such a manner as to leave litle doubt that the wood forming the lignite belonged to the tree which produced the resin. A microscopic examination of these pieces of lignite has shown that it consists of coniferous wood very similar to that of *Cupressinoxylon subæquale*, Goeppert, and doubtless belonging to a closely allied species, with the characters of which Dr. Gümbel concludes his paper.—H. M. J.

LEONHARD UND GEINITZ'S NEUES JAHRBUCH FÜR MINERALOGIE, GEOLOGIE, UND PALÆONTOLOGIE. Jahrgang 1864. Heft 5.

THIS number of the Jahrbuch contains six original memoirs, besides the usual miscellaneous matter. The first two papers are by Dr. Geinitz, forming additional contributions towards a complete history of the Permian fauna and flora; they are:—

1. '*Palæosiren Beinerti*, Gein., Ein neues Reptil aus der unteren Dyas von Oelberg bei Braunau' (*Palæosiren Beinerti*, Gein., a new Reptile from the Lower Dyas of Oelberg near Braunau). 2. 'Zwei Arten von *Spongillopsis*, Gein.' (Two species of *Spongillopsis*, Gein.) These papers necessarily consist almost entirely of detailed descriptions of the fossils; it will therefore be sufficient to state that *Palæosiren Beinerti* is considered by Dr. Geinitz to be most nearly allied to the existing Salamander—*Siren lacertina*, L., and the two species of *Spongillopsis* (*S. dyadica* and *S. carbonica*) to the living *Spongilla fluviatilis*, Blainv.

The remaining papers are the following:—

3. 'Ueber die Stellung des "Terrain à Chailles" in der Schichtenfolge der Juraformation' (On the stratigraphical position of the 'Terrain à Chailles' in the Jurassic Formation), by M. Peter Merian.

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* Journ. für prakt. Chem. vol. xxviii. p. 380.

The 'Terrain à Chailles' (so named by Thurmann on account of its containing siliceous particles, which are locally termed 'Chailles') is one of the inconstant minor subdivisions of the Middle or Upper Jura, and occurs in the Cantons of Basel, Solothurn, and Berne, as well as in the neighbouring French Jurassic area. It is rich in well-preserved fossil remains, more especially of Corals, besides Crinoids and Echinoderms, but Cephalopods are rare; the whole assemblage constitutes, however, a peculiar and very distinct fauna. Of the Echinoderms, the most important being *Cidaris Blumenbachii*, Ag. (*C. florigemma*, Phill.), *C. cervicalis*, Ag., *Hemicidaris crenularis*, Ag., and *Glypticus hieroglyphicus*, Ag., scarcely a single species is known to the author to occur on any other horizon. For this and other reasons, which are given by M. Merian in detail, he considers the 'Terrain à Chailles' to be the equivalent of the Crenularis-beds (so-named by Herr Mösch, from the occurrence in them of the *Hemicidaris crenularis*, Ag.) of the 'White Jura' of the Canton Aargau, the above-named characteristic species of that formation occurring therein in company with *Stomechinus perlatus*, Desm., and *Diplopodia Annonii*, Des.

The position of the Crenularis-beds is shown in the following table of the Aargau Jura, the beds being given in descending order: —

	Proximate thickness. feet.
11. Cidaris-beds	80
10. Passage-beds (Grenzregion)	9
9. Baden beds	45
8. Letzi beds	32
7. Concretionary bed	1 to 9
6. White Limestone	10 to 12
5. Caprimontana-beds	20
4. CRENULARIS-BEDS	12 to 15
3. Geissberg beds	100 to 110
2. Effing beds	300
1. Birmensdorf beds	18
Maximum total	650 feet.

The Birmensdorf beds, forming the lowest member of the series, repose immediately on the Ornatus-clay,—the 'Terrain Callovien' of D'Orbigny.

4. 'Ueber den Zwillingsbau des Quarzes' (On Twin-crystals of Quartz), by Dr. Friedrich Scharff. With two Plates. In this paper the author discusses, at great length, the question whether twin-crystals of Quartz are really known to exist, and he comes to the conclusion that, while certain crystals, obtained from Flöha and from Munzig, appear to establish the fact of the existence of such formations; yet there is sufficient evidence to cast doubt on the supposed twin-character of certain other double crystals of that mineral; and he further remarks that the statement of Weiss, to the effect that Quartz is but rarely disposed to form twin-crystals, has received confirmation on all sides.

5. 'Ein Beitrag zur Kenntniss des Versteinerungs-Zustandes der

Crinoideenreste' (A contribution to the knowledge of the fossil state of Crinoid-remains), by Herr A. W. Stelzner. With one Plate. This paper is a contribution to our knowledge of the microscopic structure of Crinoidal remains, and of the causes which produce the peculiar crystallization that has for so long been known to characterize Echinoderms. The author first gives a critical notice of the various essays on the subject, which have appeared since that of Hessel* in 1826, and then describes in detail the appearances under the microscope presented by prepared longitudinal and transverse sections of the stems and arms of several species of Crinoids. The conclusion to which the author arrives is identical with that enunciated by Dr. Carpenter in 'The Microscope and its Revelations' (p. 345), and quoted in a postscript by Herr Stelzner, who, it appears, was not aware that so much had been done in this direction until after his paper was written; this conclusion may be thus stated: In the cylindrical stems of Encrinites the calcareous network is uniform throughout, or very nearly so; but in the five-sided Pentacrinites a determinate pattern is formed, through a difference of texture in various parts of the cross-section, and these patterns, although always belonging to one general type, are nevertheless sufficiently different to be recognized apart on an examination of the transverse sections of different stem-joints.

6. 'Ueber die Entstehung des Travertins in den Wasserfällen von Tivoli' (On the Origin of the Travertin in the Cascades of Tivoli), by Dr. Ferdinand Cohn. The Travertin of the neighbourhood of Tivoli comprises four varieties, and in this paper the author discusses at length the origin of two of them, namely, the 'Shaly Travertin,' and the 'Confetto,' giving merely a sketch of the characters of the other two—the 'Thick Travertin' or the Travertin of architecture, and the so-called 'Alabaster' of the Roman artists.

The 'shaly' variety consists of a succession of beds of more or less earthy carbonate of lime, and composed of a great number of cylinders of travertin, each of which has been formed in concentric layers round a vegetable nucleus. The author is of opinion that the plants are the primary cause of the deposition of the carbonate of lime, but that the subsequent stages in the formation of the deposit are altogether unconnected with organic laws. In support of this opinion he observes that, if the cause of the deposition of carbonate of lime were merely the exposure of the water to the atmosphere, the deposit would first appear upon the surface as a film,—which is not the fact in this case, although it is so at the thermal springs of Karlsbad, &c.

Respecting the second variety of Travertin, Dr. Cohn strives to show that its deposition is not owing to the sulphurous acid which emanates from the Solfatara of Tivoli, in which it is formed, as on analysis he found it to contain no sulphides, but only carbonates.

H. M. J.

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* Einfluss des organischen Körpers auf den unorganischen, nachgewiesen an Enkriniten, Pentakriniten und anderen Thierversteinerungen. Marburg, 1826.

REVIEWS.

A GUIDE TO GEOLOGY. By JOHN PHILLIPS, M.A., &c. 5th ed. 12mo. LONGMANS, 1864.

THIRTY years ago Professor Phillips published a neat little volume, small enough to go into a schoolboy's pocket, for it contained only 139 duodecimo pages and two outline diagrammatic plates. Yet it professed to be a 'Guide to Geology,' and dealt, in that small space, with the great problems of the mineral composition of the globe, its temperature, physical geography, the arrangement and origin of rock-masses, and the distribution of life; and gave a description of all the formations which aqueous and igneous forces have manufactured or moulded into shape. The author was not yet a Professor, but he was Secretary of the British Association, and a Fellow of the Royal Society. His love of tables and calculations was shown as strongly in this early performance as in all his subsequent writings; and the methodical division of his subject might have served as a model for his competitors. Each series of strata had a separate heading for its thickness, mineral character, stratification, cleavage, sub-divisions, physical geography and topography, organic remains, and bibliography.

In 1838 a third edition of the 'Guide' appeared, with 186 pages of letter-press and four plates, the frontispiece being an admirable little bird's-eye-view of the Isle of Wight; and the small geological map of England was now shaded with engraved lines, to show the extent of the principal strata. These editions were dedicated to the Yorkshire Philosophic Society; those which succeeded are inscribed to the University of Oxford.

In the edition of 1854 the text was increased to 211 pp., and the little map of England converted into a yet smaller map of the British Isles. And in the new version, which has just appeared, there are 314 pages; the little geological sections are remodelled, though essentially the same as before, and 53 woodcuts, or 'diagrams,' are added to the text. Although thus grown to more than twice its original bulk, Professor Phillips' 'Guide' is still the most portable of text-books; and it has this great and distinctive recommendation —that it is the work of one who has himself seen and understood the things about which he writes; and, when we remember that there are eminent professional geologists who are neither engineers, mathematicians, chemists, mineralogists, nor palæontologists, we cannot sufficiently admire the amount of severe study and self-discipline implied in every aspect of Professor Phillips' 'many-sided' mind.

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(1) THE ABBEVILLE JAW; AN EPISODE IN A GREAT CONTROVERSY, BEING A PAPER READ BEFORE THE HULL LITERARY AND PHILOSOPHICAL SOCIETY, March 15, 1864. By J. L. ROME, F.G.S. 8vo. London: LONGMANS, pp. 88.

(2) NOTES ON A RAMBLE THROUGH WALES. A LECTURE DELIVERED TO THE WORCESTER NATURAL HISTORY SOCIETY, February, 1864. By W. S. SYMONDS, Rector of Pendock. London: R. HARDWICKE, pp. 20. 8vo. 1864.

(3) NOTES ON THE DRIFT-DEPOSITS OF THE VALLEY OF THE SEVERN, IN THE NEIGHBOURHOOD OF COALBROOK-DALE AND BRIDGNORTH. By GEORGE MAW, F.S.A., F.L.S. 8vo. pp. 14, 1864. (From the Quarterly Journal Geol. Soc.)

(4) ADDRESS OF PRINCIPAL DAWSON, President of the Natural History Society of Montreal, read at the ANNUAL MEETING, May, 1864. 8vo. pp. 12. (From the Canadian Naturalist.)

THE first of these works is a somewhat heavy pamphlet on a subject that was very recently of considerable interest. Were it not for the exceedingly bad taste displayed in a profusion of indifferent jokes, personalities, and heavy banter, and the want of thorough appreciation of the whole question involved, we should be inclined to speak of this work as a fair popular account of the Abbeville discussion. As, however, that particular matter has been somewhat forgotten in the rapid accumulation of other and better evidence from the Bruniquel and Gibraltar caves and elsewhere, and as the subject is really not one to joke about, we can hardly recommend our readers to avail themselves of Mr. Rome's labours. In his second chapter he endeavours to show that, although the Mammoth, the Reindeer, the Rhinoceros, and other locally extinct species may have lived in Europe contemporaneously with man, this does not necessarily involve a very great antiquity for either. The actual determination of how many thousands or tens of thousands of years a given geological event may have required has always seemed to us as unimportant as it is impossible. That all recent discovery points to the existence of races of men living in Europe very much longer ago than the traditional 6000 years is certain. Granted this, 'the antiquity of man' is established in Sir C. Lyell's sense, and the very great changes in physical outline and climate that have taken place since the Rhinoceros bones were buried with human implements are certainly sufficient to require a great and probably an incalculable age.

The Rev. Mr. SYMONDS' lecture, though containing nothing new to geologists, is a convenient *résumé* of some of the chief points known concerning the Glacial Period as represented in North Wales, and a careful study of it might do much to convince Mr. Rome that the time needed by the changes there to be traced can hardly be measured by centuries.

The Drift-beds of the Severn-valley, carefully described by Mr. MAW, afford additional evidence of the gradual nature of the latest changes, and the variety of movements needed to account for the present condition of things. It is by such estimates only, and by the knowledge obtained by studying the recent deposits carefully in various parts of England and Europe, that the student of geology acquires the knowledge required to speak with authority on the subject of time. It is one that needs all the care and caution of the sage, as well as the boldness and vigour of a fresh intellect.

The Address of Dr. DAWSON is also chiefly devoted to the subject of Boulder-drift, and the conditions of its deposit in Canada; but it does not relate to the vexed question of the Antiquity of Man. Dr. Dawson urges the extreme improbability that, under any conceivable physical conditions, there should have been land-glaciers sufficient to account for the phenomena of Boulder-drift in Canada.

Glacial Action in Northumberland and Durham.

AN interesting paper on the Glaciation of the Counties of Durham and Northumberland, by Mr. R. Howse, has recently appeared in the 'Proceedings of the North of England Institute of Mining Engineers' (May 1864). In it the author observes that fine examples of glaciated rock-surface have been brought to light in baring the Magnesian Limestone for quarrying near South Shields. In other localities the surface of this limestone has also been found more or less polished and scored. The harder sandstones also of the Coal-measures, and the Mountain-limestone, which crop out to the north and west of the former rock, both show the same phenomena. The direction of the grooves and scratches varies in different localities, and even in the same locality; it being sometimes to the N., sometimes to NE., and sometimes due E., within an area of a few acres. Resting on glaciated as well as on non-glaciated rock-surfaces is a deposit of brown, reddish, grey, or bluish clay, full of rock-fragments, varying in size from the smallest grain to blocks of five and six tons weight. Some are angular, but most of them are more or less worn. Many, both large and small, are very much glaciated; and some are not unfrequently scratched and ground in different directions on their different surfaces, and sometimes on the same surface; it is indeed the exception to meet with glaciated fragments scored and scratched in straight and parallel lines.

The materials composing the deposit—both clay and boulders—are largely composed of the rocks on which it immediately rests, or which underlie it to the west. Thus, in the north-eastern district of Durham, where Mr. Howse seems to have pursued his investigations in most detail, the deposit is chiefly composed of débris from the Coal-measures and Magnesian Limestone; the remainder has come from the Millstone-grit, Mountain-limestone (including the associated basalts), Old Red conglomerate, the porphyry of Cheviot, and the granites of Criffle and Shap-fell. The deposit is pretty generally distributed over the district; but is thickest towards the sea-board and in the valleys. Where thickest, it is 60, 100, and sometimes nearly 150 feet; but from 20 to 50 feet is its most usual thickness. It usually shows no trace of stratification, the materials having been thrown together without the least assortment; but frequently a more regular structural arrangement obtains. Until recently it was supposed to be devoid of fossils; fragments of *Cyprina Islandica*, have, however, lately been found in it.

Above this Boulder-clay either resting on it, or forming its uppermost portion, there is occasionally found a purer deposit of tenacious clay, containing fewer fragments of rock, but charged with numerous angular pieces of Chalk-flints. This clay does not appear to be more than five or six feet thick; and is supposed by Mr. Howse, from the Chalk-flints included in it, to be an extension of the great Scandinavian Drift.

Mr. Howse next proceeds to notice, under the designation of 'Raised Beaches,' some beds of gravel, clay, and sand, with coal-drift, which are found on the flanks of some of the Magnesian Limestone hills, and on the top of the sea-cliffs between Sunderland and Hartlepool. These beds are principally composed of materials washed out of the Boulder-clay, &c. and Magnesian Limestone, and contain fragments of *Cyprina Islandica* in some places, and the remains of land animals occasionally in others. Other superficial deposits are alluded to by the author. The whole he tabulates as follows (p. 170):—

'1. Beds of peat, and submarine forests, with fossil remains of oak, alder, mountain-birch, and hazel, horns of *Cervus alces* and *Cervus elaphus*, *Bos primigenius*, &c.
2. Rubble, transported from moraine-heaps of upper valleys.
3. Gravel-beds, forming remains of ancient raised beaches.
4. Sand, forming elevated mounds along the courses of valleys.
5. Brick-clay, with intercalations of laminated clay, sand, and peat-bed, containing skeleton of *Megaceros Hibernicus* and stems of *Calluna vulgaris*.
6. Scandinavian drift (?), containing angular flints, and small fragments of rock, probably derived from the Boulder-clay.
7. Boulder-clay, or drifted glacier-moraine, containing fragments of *Cyprina Islandica*.
8. Ancient gravel-bed, resting on rock-surface.'

Mr. Howse thinks that, at the period of glaciation of the rock-surface, most of the North of England was much higher above the sea than now—that the climate and physical conditions were similar to those which now obtain in Greenland and Spitzbergen—that glaciers filled all the present river-valleys—and that the whole of the surface of the land was more or less covered with snow and ice for nearly all the year. The great depth of the Tyne Valley and its tributaries below the level of the sea, and the prevalence of glaciated rock-surfaces, are the grounds on which he bases these opinions. As to the origin of the Boulder-clay, the views of the author are not quite so clearly expressed. To quote his own words:—

'It therefore appeared certain, from these facts, that the moving ice, bearing these special boulders, which can be traced to their original beds up the Tyne, must have travelled from the west, from the higher ground towards the coast; and that the hypothesis of continental or land-ice, involving, as it did, the subsidence of nearly the whole island, and afterwards an immense change of climatal conditions to those at present existing, seemed more in accordance with the facts registered on these rocks, and absolutely necessary to explain the appearances of the glaciated surface, and the formation and deposition of the Boulder-clay, than the vague and merely conjectural theory of the stranding of icebergs drifting southwards from some unknown northern locality.' (p. 170.)

Further on (p. 182) we find the following passage :—

'For it is necessary, in order to account for the deposition of the Boulder-clay, and the beds of clay, sand, and gravel which occur all over these counties, to assume that the whole, or nearly so, of the entire island was submerged beneath the sea. It was during this period of submergence that the Boulder-clay was deposited . . . . Can we doubt, when we look at the surface of the country, that the numerous isolated hills formed at this period numerous small islands, which were in their turn submerged, and covered with deposits still brought down from the west on *floating masses of ice* detached from the glacier-face of the upper valley?'

Again, at p. 184 :—

'The theory of stranded icebergs, and masses of floating ice drifting along the coast-line, is quite insufficient, and entirely inadequate to produce the appearances above enumerated; for it is pretty clear that these rocks were glaciated and covered with a thick deposit of Boulder-clay before the land was submerged deep enough for icebergs to pass over them.'

The subject itself is undoubtedly one of great difficulty; and only continued steady examination of ice-worn and drift-laden districts, with a clear comprehension of the meaning of the phenomena, elucidated by our slowly advancing knowledge of ice-action under manifold conditions, can be expected to make us masters in this branch of geology.

On the Conformation of the Alps. By John Tyndall, F.R.S., &c. (Phil. Mag., October, 1864, pp. 255–271.)

On the Erosion of Valleys and Lakes; a Reply to Sir Roderick Murchison's Anniversary Address to the Geographical Society. By A. C. Ramsay, F.R.S. (Phil. Mag., October, 1864, pp. 293–311.)

THERE is no question at present under discussion among geologists so important as that relating to the value of existing causes of change; and one branch of this subject is treated in the two able and interesting articles now before us. They both treat, though in a different way, of the action of water—liquid and solid, as an agent in the production of the surface-phenomena of the globe. They both support the view that to the slow, but long enduring, mechanical power of water, rather than to any convulsive throes or violent disruptions, are due those grand, striking, and exceptional phenomena seen in perfection in the Western Alps. They refer to erosion as the one great cause of the most picturesque features of that noble mountain-chain,—its deep and narrow gorges, its mountain-valleys, and even its large and beautiful lakes. They communicate the experience of men, one an accomplished student of the physical sciences, who is exceedingly familiar with ice and its results,—the other an experienced practical geologist, who has observed much in his own country, and who is not without a personal knowledge of Switzerland. The questions they discuss are rendered yet more interesting at the present moment, because the veteran champion of the opposite school of geology,—that which assumes periodical convulsions on a grand scale to have been concerned in the elevation of mountains and the formation of valleys, has recently, from the Chair of the Geographical Society, repeating his firm conviction that his own views are correct, protested against the more modern theory.*

Professor Tyndall's paper is, like others by him on the same and similar subjects, clear, definite, and positive. It brings forward his experience of the present year, and points out its bearing on what he has before seen and described. Two very remarkable longitudinal and transverse valleys, the gorge of Pfäffers and the celebrated Via Mala of the Splügen Pass, both quoted by the advocates of the Fissure-theory in their own favour, were visited by him for the express purpose of testing the Erosion-theory. Certainly there are few phenomena of the kind in Europe more striking. In the Via Mala the road is an artificial ledge on one of the vertical walls of a deep cleft. One looks up to a narrow strip of sky overhead, and down on a roaring torrent, scarcely heard in the far depth. In the gorge of Pfäffers the scene is, if possible, more striking; the rocks meet, or seem to meet overhead, and the valley is still narrower. Yet it is certain that on the walls of these two valleys, from bottom to top, there are unmistakable marks of erosion. Whatever may have been the cause of the cleft the water has always been there to take advantage of each widening of the split. Water has been present too at the top to act at the first commencement, and rush into the opening formed. The two valleys are (if we remember right) nearly at right angles, and open into the valley of the Rhine near Coire.

Professor Tyndall points out that such narrow gorges are chiefly confined to limestone. They are certainly not always so, though in limestone they are common. Limestone is a rock that has a special tendency to crack systematically, and its joints facilitate greatly the action of water. We know of similar crevices in granite, and in that rock it is generally the existence of veins of softer mineral that determine the action of water. It may be so in limestones and elsewhere; but in most of these cases there is a certain amount of undermining that rapidly increases the depth, but also widens the crevice. It is not necessary, however, that there should be a crack of any importance produced during elevation or by disturbance to determine the commencement of a deep valley, for the remarkable *Cañons* on the Colorado River (described by Dr. Newberry) are clearly the result of erosion in horizontal strata; and something of the same kind on a smaller scale is common in the South of Spain.

Mr. Tyndall points out that the cracks, if the result of dislocation, ought to extend through the *cols*, which are generally very different from the throat or gorge that the name implies. There is almost always a flat space at the top of a deep gorge, such as the Via Mala runs through, and on the other side a corresponding deep

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* See Geological Magazine, No. 3, p. 127.

valley. This is remarkably the case on the Italian side of the Splügen Pass; and we are surprised that Professor Tyndall has not alluded to it. We can assure him that it fully supports his argument.

After pointing out that, in the elevation necessary to bring the Alps into their present state, the area of the fissures produced by the cracking of the rocks would be very much smaller than the areas of the existing valleys, and that the character of the valleys is not such as would be produced by elevation and cracking, Professor Tyndall proceeds to consider the mechanical effect of glaciers. That the principal crushing and grinding effect of a glacier must be under the middle part, where the motion is most rapid, is certain: that the walls of a valley are really torn by a glacier passing down between them, and that obstacles to downward progress, when it can be traced, are rapidly and effectually removed, are matters of observation; and these points are sometimes well seen in the valleys from which the smaller glaciers retire during summer. Thus in the valley near Engelberg, towards the Surenen Pass, we have noticed these results; and indeed every one who has been among the ice in the higher valleys is familiar with numerous such instances. That in former times, during the Glacial Period, the ice was more abundant and more efficacious is only another way of saying that there was a Glacial Period. The Erosion-theory evokes, therefore, as Professor Tyndall observes, nothing but true and known causes; while the Fracture-theory cannot of itself explain the phenomena. Professor Tyndall believes that the fissures formed during elevation were insufficient to determine the conformation of the Alps; but this is a conclusion concerning which we feel inclined to think that much remains to be said.

Professor Ramsay, in the article bearing his name, replies to Sir R. Murchison's recent attack on the Erosion-theory. Sir Roderick, as our readers are aware, and as is well expressed in the article before us, believes that 'mountain-valleys lie in lines of curvature, dislocation, and fracture; and that the mountains on each side of them are mountains far less because of denudation than by reason of operations of fracture and dislocation.'

Professor Ramsay asks for the proof of such faults and dislocations in the Alps. He believes that, when accurate geological sections (on the true scale) shall have been made through Switzerland and the adjoining mountain-tracts, there will be ample proof of enormous denudation previous to the conformation of the existing valleys, and that these have necessarily been formed long since the latest important disturbances of the strata took place.

Referring to the argument so much insisted on, that the opinion of 'the vast majority of practical geologists' is worthy of some respect, our author refers to the writings of Hutton and Playfair, quoting the former to show that the modern view of the overwhelming importance of water-action is really a very old one, and the latter to the effect that 'the sharp peaks of the granite mountains but mark so many epochs in the progress of decay,' and that 'the great chains of mountains which traverse the surface of the globe are cut out of masses vastly greater and more lofty than anything that now remains.'

The great and long continued operations of nature which are concerned in the production of scenery Professor Ramsay considers may be resolved into three series, that may be arranged in any possible combination. They are in brief:—

(1) Oscillation, with respect to the sea-level, of all rocks in all stages of contortion and metamorphosis, alternating with longer or shorter periods of repose.

(2) Great plains of marine denudation, which are inclined at a very low angle if formed during slow depression.

(3) Subaërial denudation, of all kinds, wearing away of sea-coasts, and disintegration, decomposition, and erosion by all causes; all these being modified by the conditions of the surface.

Mountain-chains are characterized by contortion and metamorphism; and it may be that they are high or low according to the antiquity of the disturbances. Sometimes the protuberances are planed altogether away.

The third class of causes may be assumed to cut out all mountain-peaks, not volcanic, and the valleys of the second class, but not the wider and more open valleys.

Fractures and volcanos are subordinate accidents, modifying denudations and forming hills or mountains independent of the mountain-chains.

Having enunciated these canons, Professor Ramsay proceeds to the subject of the value of ice as a medium in forming such lakes as are true rock-basins; meeting *seriatim* the objections raised by Sir R. Murchison. Of these, the first is the position of the Lake of Geneva, which trends from E. to W., whilst the detritus marking the direction of the old glacier of the Rhone is N. and NNW. The same argument applies to the Lake of Constance and the Rhine. In answer to the former objection, it is assumed that a great tributary glacier came in formerly from the valley of Chamouni, and others from the mountains on the southern side of the lake; and that, when the ice abutted against the Jura, it was there checked and turned towards the north, forming also the Lake of Neuchâtel. The case of the old Rhine glacier has already been disposed of by the researches of M. Escher.

The objection that ice has no excavating power is answered by referring to many well-known facts. The rivers flowing from glaciers are all muddy. The *loess* of the Rhine is believed to be a mud-deposit from the glaciers: the striation and deep grooving, the mammillation and the glassy polish of Alpine rocks are all illustrations of the mechanical power of moving ice. Bosses and islands, standing out from a moraine or in the midst of valleys, are no more proofs of the absence of the moving power of ice than the existence of Goat Island in Niagara, and of the Needles off the Isle of Wight, is proof that the river and the sea have not produced the gorges that there exist.

The plasticity of ice is the great cause of the difference of its mode of action from that of water. Still water cannot excavate, and in the depths of a lake water is still; but glacier-ice, moulded to the inequalities of the land, can rise over obstacles, and mountain acclivities, grinding as it goes. Nor is the fact that some glaciers ride over their moraines an objection to this. They do so now, but they may not have done so when larger. That glaciers touch the bottom, and grind the rocks they touch, is certain, even if water is usually present at the contact of ice and earth. The quantity and weight of the column of ice are amply sufficient to prove this.

'If then,' Professor Ramsay asks, 'glaciers can waste rocks and deepen valleys, is it possible (? impossible) that the great old glaciers under favourable circumstances have excavated lake-basins, when rocks of unequal hardness came in their course, or when, from special causes, the pressure of ice was unusually great on certain areas?'

The course of ice in a flat-bottomed part of a valley or in a plain at the base of a mountain-range must be different from its course on a slope. The ice can select soft places; and, if from any cause, the weight is greater at any point, the excavating effect must have been so also, and must have resulted in the formation of rock-bound hollows. The case of Ivrea, quoted as adverse to this view, is not really so when fairly examined, and only time and the extension of the glaciers are needed to account for everything.

It is objected that ice cannot flow up an inclined plane. This is contradicted. The great old glacier of the Aar, and the fact of the existence of *Stoss-Seiten* and their upward striations, are proofs to the contrary. The slopes also are really very small. In the Lago Maggiore the slope from the deepest part (2600 feet) to the outflow of the lake is not more than 2° 21′ in twelve miles,—a slope hardly perceptible. In the Lake of Geneva, from the point where the depth is about 1000 feet to the end of the Lake at Geneva, the average slope is only 25′. The question therefore is whether ice could have been forced forwards for a number of miles up such slight slopes as these. Further, would not advancing glaciers travel over the ice in the plains and hollows without moving the lower strata, and therefore without erosion of the bottom? Professor Ramsay gives several reasons why it should not. A glacier moves not only by gravity but by pressure from behind, as is seen in the Rhone Glacier; and any heavy body passing across any other body whose particles are movable will drag along the lower mass and make it move also. This is too familiar to need proof. But do these lakes lie in fractures? As a matter of fact, those on the north side of the Alps, in the region of the Miocene strata, do not; for, if they did, the strata would be crumpled up in zigzag lines across the average line of strike, which we know is not the case. Or if the fractures were mere narrow cracks, the denudation must have been so large as to involve a practical admission of the Erosion-theory. The case of North America and its great lakes is in contradiction to the Fracture-theory. The Silurian strata amid which the lakes lie are almost horizontal and undisturbed. One of the lakes (Ontario) lies in a low anticlinal bend of soft strata, and Lake Superior on a faint synclinal curve.

Professor Ramsay concludes with an inquiry—why it is 'that not only drift- and moraine-dammed lakes, but striated rock-basins, of all sizes, occur in such prodigious numbers in America, Scandinavia, the Highlands, and in all other rocky temperate regions, high and low, that have been glaciated, while in tropical and subtropical regions they are so rare as to be quite exceptional elsewhere than in mountain-areas that now or once maintained their glaciers?'

A Sketch of the Geology of Norfolk. By the Rev. John Gunn, F.G.S. Reprinted from White's History and Directory of the County. Sheffield: W. White, 1864. 8vo. pp. 27.

In this unpretending pamplet, which is of a class that might with advantage be more common, the author follows the usual arrangement, beginning with an account of the geography, especially of the rivers, followed by a list of the geological formations of the County, ranging from the Kimmeridge Clay to the peat and other recent deposits; and he names the chief books and papers that have treated of Norfolk geologically.

Norfolk affords examples of those 'gaps' to which Dr. Bigsby has lately drawn attention;* thus the Lower Greensand rests at once on the Kimmeridge Clay, the higher Oolitic and the Wealden formations being absent; and the Norwich Crag lies upon London Clay. In parts also the Chalk is but barely separated from the Lower Greensand, the thin bed of so-called 'Red Chalk' being all that comes between those formations at Hunstanton. This 'Red Chalk' Mr. Gunn seems to look upon, with Professor Sedgwick, as the representative of the Gault (p. 7), although he allows (p. 8) that Mr. Seeley had good reason for taking it to be the Upper Greensand: may it not represent both those formations, as we believe the Rev. T. Wiltshire has suggested? It would perhaps have been better to have treated of the Red Chalk under a separate heading. Strange to say, fragments of so thin and local a bed have been found in the Drift just north of London, a very long way from any spot where it occurs in place.

We must demur to the remark made at p. 7 as to 'fossil contents' being 'the only dependable basis' on which one can trust to 'establish identity' of beds. Were this the case, we fear there would soon be an end to field-geology (a branch of the science, by the way, not so well understood as it should be); fossils not being so ever-present as is often thought, and the lithological nature and relative position of beds being often of, at least, equal importance. What this doctrine of the all-powerfulness of fossils leads to may be seen at p. 8, where we are told that 'it may be inferred that the Gault is principally represented in the Lower Greensand, and the Upper Greensand in the red lime-

* Journ. Geol. Soc., vol. xx. p. 198.

stone' (which has been classed with the Gault just before)! In this particular case there is no doubt about the lithological division, the white Chalk, the red 'Hunstanton limestone,' and the brown ironsand of the Lower Greensand contrasting very strongly.*

We are glad to see that Mr. Gunn treats of the Chalk in different divisions, which we should like to hear more about. This formation will almost everywhere bear more notice than has been given to it. As to its being 'composed of a soft white mud, which has passed through the bodies of Worms and the intestines of Fishes,' surely other classes of animals had something to do with the matter!

In speaking of the Lower Eocenes, Mr. Gunn is not quite clear, for he says that the London Clay 'with the Woolwich and Reading Series overlies the Chalk;' as if the first two were parts of one formation. The absence of the Thanet Sand might have been noted.

The account of the Norwich Crag of course takes up some space, and a full list† of fossils (172 species) from that bed is given. It has been thought that the Red Crag and the Norwich Crag are the same; partly because they never occur together. Mr. Gunn thinks that 'they are one continuous formation, occupying a long period of time, during which the land has been gradually rising; and that in the process of upheaval, they may possibly bear to each other the same relation as the upper valley-gravels bear to the lower.' The remark is to the point, but the tenses are bewildering. The overlying fluvio-marine 'Forest-bed,' with its many remains of Elephant and Deer, next claims attention; and is succeeded by the 'Laminated Beds,' a sort of 'warp.'

The Glacial Drifts are divided into: (1) Lower Boulder-clay, or Till, 'mostly (of) a greyish blue, but occasionally of a reddish tinge,' and containing ice-scratched boulders of many kinds of rocks; (2) stratified Clays, with Sands and Gravel, which 'lie upon the denuded surface of the Till, generally with a thin layer of beach-shingle intervening,' and are often much contorted; (3) Upper Boulder-clay, with scratched boulders, chiefly Oolitic, flint, and Chalk. The Mundesley fluvio-lacustrine bed, filling an old valley cut through the Boulder-clay to the Forest-bed, is also here classed with the Glacial Series; but strictly this is hardly right. The same may be said of the Valley-formations, in the account of which Mr. Gunn has availed himself of Mr. Prestwich's late researches. It is to be noted that Norfolk is one of the 'flint-implement' counties.

The author concludes with an interesting account of the growth of peat, the incursions of the sea, and the formation of sand-dunes.

In the hope that this useful little work may reach a second edition, we suggest, besides the few points already noticed, that a small geological map would be a great improvement; that the list of

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* A marked case of the result of trying to classify a set of beds by fossils *alone* occurs in a late number of the Journ. Geol. Soc. (vol. xx. p. 99), where, in a classification of the English Tertiaries, the Upper and the Lower Bagshot Beds are missed out, we suppose because they do not yield fossils, and therefore, though sometimes 200 and 600 feet thick respectively, are not worth taking into account!

† Prepared by Mr. S. P. Woodward.

works on the geology of the county should be made fuller; and that some transverse sections, to show the general arrangement of the beds, would be a good addition. Lists of fossils from other formations than the Norwich Crag might also be given; and we advise a more careful correction of the press, as there are not a few printer's mistakes.

PALÆONTOGRAPHICAL SOCIETY'S MONOGRAPHS. VOL. XVI. ISSUED FOR 1864. London. 1864.

THIS fasciculus contains the following Monographs:—

I. *British Cretaceous Echinodermata*, Vol. I., Part 1. By T. Wright, M.D., F.R.S.E., F.G.S. With 11 plates. The author supplies an epitomized outline of the Cretaceous group of strata in England, noticing some of the chief fossils, especially Echinoderms, found in them, and indicating the equivalent strata on the Continent. There is also a chapter on the classification of the *Echinodermata*, and on the structure, terminology, and classification of the *Echinoidea*. Of the genus *Cidaris* there are here figured and described, from the Gault, 1 species; Upper Greensand, 1; Grey Chalk, 4; and White Chalk, 7. These have all been previously described; and *C. Merceyi*, Cotteau, is the only addition to our lists.

II. *Trilobites of the Silurian, Devonian, &c., Formations.* By J. W. Salter, F.G.S., A.L.S. With 6 plates. A short summary of the history of Trilobites, with a provisional classification, is given, followed by some account of their vertical range, and of their structure and habits. Forty species are here figured and described:—Family, *Phacopidæ*: Genus, *Phacops*:—Subgenera; *Trimerocephalus*, 2 species, Upper Devonian; *Phacops*, 5, Middle Silurian to Upper Devonian; *Acaste*, 7, Lower and Upper Silurian; *Chasmops*, 6, Caradoc Beds; *Odontochile*, 6, Lower and Upper Silurian; *Cryphæus*, 1, Lower and Middle Devonian. Family, *Cheiruridæ*: Genus, *Cheirurus*:—Subgenera; *Crotalocephalus*, 2 species, Upper Silurian and Devonian; *Eccoptochile*, 2, Lower Silurian; *Actinopeltis*, 2, Caradoc Beds; *Cheirurus*, 2, Caradoc Beds: Genus, *Sphærexochus*, 2, Lower and Upper Silurian: Genus, *Amphion*, 3, Caradoc Beds.

III. *British Devonian Brachiopoda*, Part VI. First Portion. By T. Davidson, F.R.S., F.G.S., &c. With 9 plates. An introduction contains some remarks upon the stratigraphical relations of the so-called Devonian rocks of the South-west of England, embodying the observations of Messrs. Ramsay, De Koninck, Jukes, Salter, and Pengelly. There are fully described 4 species (one new) of *Terebratula*, 1 of *Rensselæria*, 1 of *Stringocephalus*, 4 (two new) of *Athyris*, 1 of *Merista*, 1 of *Uncites*, 14 (one new) of *Spirifera*, 2 of *Spiriferina*, 3 of *Cyrtina*, and 3 of *Atrypa*. Of the above, there are the following important new, or well-known foreign, Devonian species, for the first time added to our British lists:—*Uncites gryphus*, *Atrypa lepida*, *Rensselæria stringiceps*, *Spirifera subcuspidata*, *Sp. cultrijugata*, *Sp. undifera*, and *Sp. curvata*.

Mr. Davidson purposes to reserve until a future occasion any remarks upon the local and general distribution of the British Devonian *Brachiopoda.* No Devonian Brachiopods have been found in Scotland; the Dron Shales, which contain *Rhynchonella pleurodon* (?), are regarded as Lower Carboniferous. The Devonian formation is largely represented in Ireland; but, with the exception of a few localities, wherein plants, fish-scales, and *Anodon Jukesii* have been found, it is non-fossiliferous (foot-note, p. 3).

IV. *Eocene Mollusca*, Part IV., No. 2, Bivalves (continued). By S. V. Wood, F.G.S. With 7 plates. This contains descriptions and figures of—*Modiola*, 5 species; *Arca*, 18; *Cucullæa*, 1; *Pectunculus*, 10; *Limopsis*, 2; *Trigonocœlia*, 2; *Nucula*, 23; *Leda*, 9; and *Unio*, 7. Nearly one-half are new species.

V. *Reptilia of the Cretaceous and Wealden Formations* (*Supplements*), By Professor Owen, F.R.S., F.L.S., F.G.S., &c. With 10 plates. Supplement No. II. contains descriptions, and additional particulars, of Cretaceous *Sauropterygia*:—*Plesiosaurus planus*, sp. n.; *Pl. Neocomiensis*, Campiche, and *Pl. Bernardi*,* Owen, from the Phosphatic Greensand near Cambridge; and of *Pl. latispinus*, Owen, from the Lower Greensand near Maidstone. The subject of Supplement No. III. is the half of a lower jaw of a young *Iguanodon*, from the Wealden near Brixton, Isle of Wight.

The Quarterly Journal of Science continues to fulfil its office of supplying both special and general information to the scientific public, and to those who, enjoying the advantages of the widened limits of modern education, can follow the steps of the advancing Naturalist and Physicist, or at least intelligently appreciate the results of scientific research. Geological readers will find in No. 4 of this Journal, for October, much to interest them in several of the papers and notices—such as Th. Lacaze Duthiers' illustrated account of *Corallium rubrum*; H. Seeley's clever and suggestive remarks on the probable relation of the *septa* of Cephalopod shells to the periodic loss of bulk in the collapsing ovaries; the Rev. C. W. Kett's translation of Cæsar's account of the Gallic Reindeer (?) and Aurochs; H. C. Sorby's notes on meteorites and on the photography of the structure of metals; Dr. Turner's comparison (illustrated) of the Neanderthal skull with one from an old cemetery at Aberdeen; but more especially in the 'Chronicles of Geology and Palæontology,' and the Progress of the Geological Survey of the United Kingdom, written *con amore.* Dr. Dawson's 'Flora of the Carboniferous Epoch of Nova Scotia' is noticed; and his memoir on the 'Air-breathers of the Coal-period;' also Geinitz's revision of his 'Dalmanites Kablikæ' (really *Placoparia ziphei*), and 'K. dyadica' (*K. Silurica*), in the 'Dresden Isis.' Mineralogy, Mining, and Metallurgy have also due attention. A good index completes the first volume.

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* Professor Owen has received bones of this species from the Lower Cretaceous beds near Moscow.

Bericht über die bisherige Wirksamkeit des Vereingten Comités für die naturwissenschaftliche Durchforschung von Böhmen. (Notice of the results obtained up to the present date by the united committees for investigating the Natural History of Bohemia.) Sheet. 1864.

THIS brief notice of the progress of investigation into the Natural History of Bohemia we owe to our correspondent Dr. Anton Fritsch, Keeper of the Museum at Prague. Bohemia is a country so centrally placed in Europe, so rich in all departments of natural history, and one in which enquiry of this kind was so much needed, that we welcome the present investigation as in every sense desirable. The labours of the committees involve:—(1) A complete orographic investigation of the country; and (2) a geologico-agronomic investigation. Taking the map of the Geological Survey of the Austrian Empire as a basis, it is proposed to describe (1) the various members of the formations in detail, geologically and palæontologically; (2) the diluvial and alluvial deposits in reference to the culture of the land; and (3) all varieties of minerals and rocks found in each district. A complete account of the botany, zoology, and meteorology are also to be included.

What seems most astonishing is the extraordinary economy with which this work is proposed to be carried on. Dr. Fritsch, in conjunction with Professor Krejci, undertakes to conduct the geological part of the work for a yearly allowance of 600 fl. (about £60).

REPORTS AND PROCEEDINGS.

The Members of the Exeter Naturalists' Club, on September 24, went to Exmouth, on their fifth and last excursion this summer, and were disappointed, by the rain, in their intention of visiting Littleham Cove. After tea (A. H. A. Hamilton, Esq., president, in the chair), three new members were balloted for. Mr. Ellis then read the minutes of the last meeting, and some letters he had received in reference to an Ornithological paper recently brought before the Club by Dr. Scott.

Mr. Pycroft, of Kenton, then read a paper on 'The Waters under the Earth.' He explained the sinking of the rain into the earth,—its settling down into sandy or other porous strata, its forming underground streams and watercourses, the boring of artesian wells, and the facts learnt from their formation, viz., that the rain-water will penetrate to very great depths, and that during the process of boring sheets of water and streams of considerable size are sometimes passed through; that these streams are not caused directly by rain, but have in many cases communication with lakes and river-beds on the surface, as is proved by the fact that stems and roots of fresh-water plants, seeds, fresh-water shells, and even living fish similar to those of neighbouring rivers, have been thrown up from artesian wells of great depth. He pointed out that this fact should make us cautious how we draw conclusions from the presence of a single fossil in a stratum. He stated that there were two small crustaceans, *Niphargus fontanus* and *Crangonyx subterraneus*, found in the wells of Wiltshire, Berkshire, Hampshire, and Devonshire. These animals were both colourless and blind, showing how dark had been their dwelling-place. Mr. Pycroft next entered into the subject of limestone-caverns, observing that they are or have been the natural drainage-channels of the earth's crust, and that they exhibit the phenomena of underground rivers on the grandest scale. Among other points he particularly discussed, was the frequency and violence of floods in these chasms. He stated that when a traveller visits one of these caves, such as the Peak Cavern, he cannot bring his mind to believe that all this grand vault has been excavated by so insignificant a small stream as that now running through it. But we must remember that it is with these natural drainage-channels as it is with the London sewers: one leads into another; and in the season of winter-storms, the 'main' in one case and the cavern in the other is not more than large enough to carry off the torrent. In the case of the limestone-caverns, the torrent is furious indeed, from the varying size of the channel, the cascades, the generally inclined form of the floor, and the frequent turns. He discussed at some length the bearing which the study of these phenomena had upon the unravelling of the mystery of bone-caverns, and said that bones washed or fallen into a fissure in a limestone-country might in process of time be discovered in caverns many miles distant. Mr. Pycroft next described the animals inhabiting these dark rivers—the blind and almost colourless *Proteus*, and the blind Crustacea and Fishes of the Adelsberg, with blind Spiders, Beetles, Crickets, and Rats. He next entered into the subject of the enormous caverns, hundreds of miles in extent, known to exist in the neighbourhood of volcanos — of their having communication by open channels with the waters of the ocean, and with those of fresh-water lakes and rivers. The ashes which overwhelmed Pompeii were proved by the microscope to be in great part composed of the siliceous diatoms which once lived in the neighbouring streams; and Humboldt states that he has seen the little fish *Pimelodus Cyclopum* thrown from apertures on the sides of the mountains of Quito living, though ejected with scalding water.

Having shown that the rain, the rivers, and the seas all have communication with the interior of the earth, he next proceeded to discuss the use to which this free supply is put in the economy of nature. He showed that in crystallization, in chemical decomposition, and in all the chemical processes the earth's crust undergoes, water is absolutely necsseary; that it is the bond of union between geological formations, without which each would be isolated and unconnected with all others not in immediate contact; that water will penetrate to any depth, even until it reaches a level, the temperature of which is so high that the expansive power of the heat counterbalances the gravitating power of the water; that there is at this level a zone in the crust of the earth, probably not of a very high temperature, where the sedimentary rocks are 'steam-baked' (as Beete Jukes calls it) into crystalline, and all those metamorphoses take place of which so much has lately been written. That this is in all probability a general phenomenon, is clear from the fact that in all parts of the world wherever an artesian well has been sunk or a shaft driven, there is found a regular increase of heat as we descend downwards : and that there does not appear any necessity for a very high temperature, is shown by the fact that we have pretty good proof that the temperature of boiling water continued to a long period is sufficient to produce very great change in the structure of rocks. The hot springs far from volcanic regions, as those of Bath and the Clifford Lode in Cornwall, probably take their rise from this level; and when we consider that the waters in the earth have a never-ceasing circulation, that they are all in turn exposed to the oxygenation of the air to fit them for the purposes of circulation, that they are the agents by which oxygen is carried through every square foot of the earth's crust, that by their means all the chemical changes are carried on, that by them the particles of one rock are distributed to others, that by their means fresh growths on the coral islands are formed,—when we reflect that enormous quantities of nitrogen and carbonic acid are given off with them in the gaseous form, that their chemical power is assisted by an internal heat, it is impossible to resist the conviction that the analogy between the waters under the earth and the life-blood of animals is very strong. He believed that this analogy had been pointed out by Professor Ansted. Lastly, he concluded by observing, that if we look at the rain as intended solely to fertilize the earth and supply the wants of animals, we take a very imperfect view of the case ; we so look at it because we are not as yet able to grasp the whole plan of creation ; and when farmer John calls at the vicarage hoping that 'Master will be so well pleased as to pray for rain,' he little thinks he is asking that the beautiful harmony of those laws designed for the benefit of all should be broken through for his supposed benefit—he knows not what he asks.

Mr. Parfitt submitted some questions relative to the wearing away of the sandstone cliffs just at the highwater line.

Mr. D'Urban read 'Some Notes on Land-Shells,' suggesting that possibly the Fluke or *Distoma* in Sheep may be derived from the internal parasites of *Helix virgata*, which sheep greedily eat on some pastures. Mr. D'Urban also alluded to the occurrence of *Cyclostoma elegans*, *Helix Ericetorum*, and other *Helices*, in a semi-fossilized condition at the base of clay and chalk cliffs in Devonshire.

Natural History Society of Glasgow.—The ordinary evening meeting of this Society was held on Oct. 25, in the library of Anderson's University, Dr. John Scouler in the chair. Mr. David Robertson exhibited a specimen of *Porcellidium fimbriatum*, of Claus, an Entomostracan new to Britain, and a number of specimens of *Cuma Robertsoni*, a species recently named by the Rev.

A. M. Norman in honour of its discoverer. These were taken at Cumbrae.

Mr. John Young having then taken the chair, Dr. Scouler introduced to the notice of the meeting two casts of the ancient crania found at Engis, in Belgium, and Neanderthal, in Germany. These crania are interesting on account of the antiquity assigned to them, as well as from their remarkable conformation. Omitting, however, the question of their antiquity, he confined himself to instituting a comparison between them and an extensive series of crania which he had on the table. The peculiarities of the Neanderthal cranium were shown to exist in other crania, although not to the same degree; and there was no ground for admitting that it was anything but a genuine human cranium. With respect to the degree of intellect which the owner of this peculiar skull possessed, nothing could be inferred, as classification of the brains and nervous system of animals would never give a scale of intelligence. Dr. Scouler likewise exhibited a very interesting collection of fossil bones from Gibraltar.

Glasgow Geological Society.—1. The Introductory Lecture of the Winter Session of this Society was delivered October 27, in the Hall of the Andersonian University, by Mr. Archibald Geikie, F.R.S.E., F.G.S., the subject being, 'The Origin of the present Scenery of Scotland.' Mr. Geikie stated that his object was to analyse the scenery of the country and to trace its various features to their original cause. The chief bulk of the country, mountain and valley, excepting some volcanic rocks here and there, has been formed of strata deposited in the sea, raised up as dry land, and subsequently furrowed with greater and less channels of drainage, the regularity of which suggests that some general uniform agent has been at work, moulding the surface, and producing its present configuration; and they bear no evidence of violent cataclasms, either referable to the ups and downs of upheaval, or connected with fissures and dislocations of the rocky mass. The mountain-gorges among the peaks and precipices of the Highlands are but parts of a harmonious and uniform drainage-system, and, though occasionally, do not necessarily coincide with 'faults;' neither are the mountain-ridges themselves broken through where these ravines cut into their sides, as they would be if the gorges were due to cracks; nor can any drainage-system be supposed to be due to a system of fissures, any more than the runlets of retiring tide-water on harbour-mud. Again 'faults' occur in numbers without the least relation to ravines and valleys which cross them at every angle, though sometimes valley and fissures coincide, as in the great Glen of Scotland. Water can excavate deep ravines in Boulder-clay in a short time; and in hard rocks in longer time; and it is not by great convulsions, but by the slow working of the forces still operating around us, that the superficial changes of the earth have taken place. The great hydrographical basins, with their independent systems of drainage, can only have been brought about by running water: an idea as old as the time of Hutton and Playfair, but lost sight of until lately. The operations of the sea and rivers—the first producing planes of denudation, the latter removing material along their channels from the higher levels, with the concurring agencies of frost, ice, rain, and springs, were alluded to; and as great agencies of waste, they were applied in the consideration of the three kinds of scenery in Scotland;—that of the Highlands, that of the Southern Uplands, and that of the great Central Valley. Mr. Geikie explained that the Highlands have been at one time covered by a great sheet of Old Red Sandstone conglomerate, which has been worn into, and even penetrated by, furrows and hollows, often down to the massive schists beneath, which come out in enormous undulations and rugged outcrops, often forcibly but wrongly suggesting themselves as the original features of the country. The wonderfully uniform level of the mountain-tops refers to a great plain of marine denudation subsequent to the formation of the Lower Old Red Sandstone, coincident with a sinking of the land, and followed by upheaval and denudation by running water and by great glaciers or an ice-sheet, during incalculably long periods of time. In the Southern Uplands the Upper Old Red Sandstone had been horizontally planed by the sea during either a rising or sinking of the land, and subsequently furrowed by drainage-systems of running water and glaciation. In the Central Valley the hard rock-masses of igneous origin have resisted to a great extent the denuding agencies, and thus modified what would otherwise have been conditions very similar to those seen in the scenery of the other districts.

2. At the monthly meeting of the Society, on November 10th, the Rev. H. W. Crosskey in the chair, Mr. Wunsch moved 'That a standing committee be appointed to collect information as to the relative level of the glacial shell-beds and the present sea-level; also, to concert measures for placing marks on various portions of the seashore and in river-beds, for the purpose of ascertaining whether any variations in the present relative level of sea and land are taking place, and also for the purpose of ascertaining at what rate seashores are eroded and river-beds worn down; and to take any other measures they may deem expedient for collecting data to serve as a basis for future inquiries into recent geology.' This was agreed to.

Messrs. John Young and James Thomson exhibited plates of three species of *Chiton* from the Carboniferous Limestone of Western Scotland. Mr. Young pointed out the characters of each species, and stated that two of them appear to be undescribed, and the other agrees very closely in the form of the plate, and its granulated marking, with *Chiton gemmatus* (De Koninck). He further stated that the remains of Chitons are very rare in British Carboniferous strata, having been detected in England only within the last few years, and that the three species then exhibited were the first that have been recorded from Scotland, their localities being Craigen Glen, Campsie, Robroyston, near Glasgow, and the banks of the Avon near Strathaven. Mr. Thomson also exhibited specimens of *Camarophoria globulina*, *Lingula Thomsoni*, and several species of *Entomostraca* from the Campbeltown Carboniferous Limestones, including examples of the genera *Leperditia*, *Kirkbya*, and *Cythere*.

Mr. James Russell, of Chapelhall, near Airdrie, forwarded a set of specimens of the lately discovered Coal Reptiles from the Airdrie Blackbands, including *Anthracosaurus Russelli* (Huxley), and one or two jaws with teeth, not yet described.

The Chairman congratulated the Society on the interest and value of the specimens exhibited. The discovery of *Camarophoria globulina* by Mr. Thomson is of importance as a connecting link between the Carboniferous and Permian strata. The existence of Chitons in palæozoic strata a few years ago was dogmatically denied; the discovery of at least three species in the Scotch Coal-field is a rebuke to all dogmatic limitation of the range of special forms. More remarkable still are the wonderful discoveries of Reptilian remains in Carboniferous strata, and especially those made by Mr. Russell. The Reptiles of that age now known were not poor, small, feebly developed creatures, but powerful and highly organized. Within a few years the range in time of Reptiles has thus been extended from the Permian downwards—a lesson to geologists that they are only opening the first page of the book of nature; and that it is impossible to generalize, with negative evidence, upon the range in time of any class of Vertebrata.

The Chairman exhibited some flint implements, found on the Chalk Downs of Sussex, and a suite of Liassic fossils from Skye, containing thirteen species not given in previous lists,* namely :—

Serpula, sp.
Terebratula numismalis.
Rhynchonella variabilis.
Spiriferina Walcottii.
Pecten acuticosta.
P. corneus.
P. sublævis.
Pteroperna Pabbaensis, *Wright, MS.*
Cardinia Listeri.
Pleurotomaria acuticosta.
Belemnites clavatus.
Ammonites semicostatus.
Am. multicostatus.

A paper was read by Dr. Bryce, 'On the Age of Certain Trap-rocks in the Neighbourhood of Glasgow.' After some introductory observations on the relative and absolute age of rocks, and the few points of contact yet obtained between geology and human history, the mode of determining the age of any bed in relation to those adjoining was pointed out, both in the case of the Sedimentary and the Igneous formations, and the sources of error to students briefly indicated. The paper now submitted had chiefly in view the age of the trap-rocks of the Campsie district. Dr. Bryce had long regarded these as having been erupted after the Coal-period, and had described them as of that age. His attention was lately recalled to the subject by finding that the Geologists of the Survey had laid these rocks down upon their maps as of Devonian age,—as erupted and spread over the Old Red Sandstone of the Campsie Fells, before the deposit of the Coal-series against their southern sides. The arguments were then brought forward on which this view is controverted. It was shown that igneous rocks covering the beds known as the Ballagan series, which are of intermediate age, extend continuously in un-

* Quart. Journ. Geol. Soc., vol. xiv. p. 26.

broken sheets and streams over the Old Red Sandstone, on one side, and the Coal-series on the other,—that immense coulées of basaltic rock, connected with the trap-masses of the hills, cut right into the Coal-measures, altering in a remarkable way all the beds along the places of contact, converting coal into coke, sandstones and shale into quartz-rock, opal, jasper, or hornstone. Such a stream occurs in Corrie Glen, near Kilsyth; another crosses the west part of Craigmaddie Moor, throwing up the Coal-measures out of their usual position; a third is that through which the great tunnel of the Waterworks was carried, near Milngavie. Besides, the members of the Coal-series about Lennoxtown include conglomerates in which pebbles and lumps of the Old Red Sandstone occur,—in fact, this conglomerate was derived from the waste mainly of the Old Red Sandstone formation; and it is hardly conceivable that if trap-rock had covered the Old Red *then* as *now*, fragments of them should not be found in those conglomerates, whereas no such trap-fragments have ever been found. Dr. Bryce then adduced cases of the same kind from the opposite side of the district. On the Gleniffer Braes, about Johnstone and Kilbarchan, and round by Houston and Bishopton, igneous intrusive masses alter and upturn the coal, inverting the dip, and towards the borders run in upon the Old Red Sandstone, while streams and sheets of trap, descending from the Old Red hills of the coast-range, cross the frontier-line of the new formation, and pass on to cover the outcrops of the Carboniferous strata. These facts making a clear case in favour of the view that all the trap-rocks of the district in question are of one age—an age *posterior* to the complete development of the Coal-series, Dr. Bryce expressed a hope that the Geologists of the Survey would reconsider their opinion, and pronounce in accordance with this evidence. He said the question was certainly not one of any practical value; but it had an important bearing on physical geology. In conclusion, Dr. Bryce mentioned several illustrative cases, one of which was especially in point. In the great promontory of Ben-More, opposite to the Mull of Cantyre, a vast range of columnar greenstone rests on the Coal-formation, altering the upper beds, and at the southern end of the precipice abuts at the same level against strata of white Chalk, which is altered to the state of a flaky saccharoid limestone, closely resembling Carrara marble, and showing no trace whatever of any fossil. Had it not been for the character of its contact with the Chalk, the trap would have been regarded as of a much greater age than really belongs to it.

In a paper on a section near Inch-na-damff (Sutherland), the Chairman gave a general sketch of the Assynt district, with its succession of Fundamental Gneiss, Cambrian sandstone, and Lower Silurian quartz-rocks and limestones. The particular section described involved a point in dispute between Sir R. Murchison and Professor Nicol, of Aberdeen, relating to the existence of an upper quartzite on the limestone. Mr. Crosskey's observations confirmed the view taken by Sir R. Murchison. The paper concluded with a reference to the discovery of forms of animal life in the lower half of the Laurentian Gneiss of Canada. The oldest rock known in the British Islands is the Gneiss of Sutherland, and this is the equivalent of the Laurentian Gneiss of Canada. It follows, therefore, that the period of life commenced previous to the metamorphism of the whole of the Highland schists. The Chairman urged a renewed search for fossils in all the limestones connected with the schists of the West Highlands, and felt assured that, if found, they would prove to be Silurian.—J. F.

Halifax Literary and Philosophical Society.—The annual report was presented on the 31st October. In the Geological department considerable interest continues to be taken by the members. The Museum of the Society contains an excellent and well arranged geological collection. That portion of it which illustrates the geology of the district is (as all local collections should be) especially rich and valuable, and is rapidly increasing in extent, owing to the interest which is taken by the members in the cultivation of this branch of scientific enquiry. During the past year several sections have been cut of the fossil found in the neighbourhood, hitherto named *Goniatites Inglisi*, but which is now proved to be a *Nautilus*.—J. W. W.

Liverpool Geological Society.—The last meeting of this Society was hold on the 8th of November, the President, Henry Duckworth, F.G.S., F.L.S., in the chair. After some preliminary business, the President, elected at the previous meeting, delivered his opening address. He reviewed the progress of the Society during the last session, and referred at length to several valuable communications that had been printed in the Report of the Society's proceedings. In a general review of the state of geological science, he referred to the origin of granite, and more particularly to the breaks in the series of stratified rocks, both of which are subjects of great interest at the present time.

The paper of the evening was then read by Mr. G. S. Worthy, 'On the Section along the course of the Avon at Clifton,' illustrated by diagrams, and a numerous series of specimens of rocks and fossils, lucidly explained by the author, who resided several years at Bristol.—G. H. M.

Geological Society of London.—The following communications were read on November 9th:—1. 'Notes on the Geology of Jamaica; with Descriptions of new Species of Cretaceous, Eocene, and Miocene Corals.' By P. Martin Duncan, M.B., Sec.G.S., and G. P. Wall, Esq., F.G.S. The authors first referred to the Miocene age of the Corals that have hitherto been described from the West Indies, and then stated that in this paper conclusive evidence was brought forward, for the first time, of the existence of an Eocene formation in Jamaica. They next noticed successively the lithological characters of the different members of the Jamaican fossiliferous rocks, and then described two new species of Corals from the Lower Cretaceous beds, and six from the Miocene, besides giving notices of additional known forms from all the strata; and the conclusion was drawn, that the *facies* of these Cretaceous Corals was suggestive of a close alliance having existed between this fauna and that of Gosau in the Eastern Alps. The question of the existence of Lower Cretaceous strata in other West Indian Islands having been discussed, attention was drawn to the character of the Eocene Corals, as being confirmatory of the late Mr. Barrett's views on the existence of that formation in the island; and the paper was concluded by some additional remarks on the Miocene beds, and their probable correlation with those of Trinidad, Antigua, &c.

2. 'On the Correlation of the Irish Cretaceous Strata.' By Ralph Tate, Esq., F.G.S. The non-existence in Ireland of the formations between the Lower Lias and the Upper Greensand having been stated, Mr. Tate first showed that the Cretaceous formations occurring near Belfast are referable to the so-called Upper Greensand ('Hibernian Greensand' of the author) and to the Upper Chalk, the latter consisting chiefly of a 'White Limestone' with flints, and containing species known to occur in the Upper Chalk of Norwich and Meudon, with others allied to Maestricht forms. The basement-beds, forming lithologically a passage from the 'Hibernian Greensand,' are (1) chloritic limestone with Sponge-remains belonging to about thirty species, and (2) a calcareo-chloritic sandstone with three species of Echinoderms, the dominant form being *Ananchytes gibbus.* These passage-beds are only locally developed; and when they are absent the junction of the Greensand and the White Limestone is very abrupt. The Hibernian Greensand was considered by Mr. Tate to represent the Upper Greensand, the Chalk-marl, and the lower part of the Lower Chalk of England, and to be the miniature counterpart of D'Orbigny's Étage Cénomanien. It nowhere exceeds 55 feet in thickness; but it nevertheless contains the following beds:—(1) Chloritic sands and sandstones of Colin Glen, or the Zone of *Exogyra columba*; (2) Chloritic sandstones of Woodburn, or the Zone of *Inoceramus Crispi*?: (3) Yellow-sandstones and Marls with Chert, or the Zone of *Ostrea carinata*; and (4) Glauconitic sands, or the Zone of *Exogyra conica.* The author concluded by giving descriptions of several new species of fossils, chiefly from the 'White Limestone' and the Sponge-bearing-zone.

3. 'On the Recent Earthquake at St. Helena.' By Governor Sir C. Elliot, K.C.B. Communicated by the Colonial Secretary through Sir C. Lyell, Bart., F.R.S., F.G.S. This earthquake, which is stated to be the fourth that has occurred during the two centuries that we have been in the occupation of the Island, occurred at about 4^{h} 10^{m} on July 15th, and in this paper Sir C. Elliot described the nature of the shock attending it.—H. M. J.

Notices of Geological Papers read before the British Association—*continued.*

On the Lower Silurians of the South-east of Cumberland and the North-east of Westmorland. By Professor Harkness, F.R.S., F.G.S.

THE area occupied by rocks appertaining to the Lower Silurian extends in a NNW. and SSE. course along the western margin of the Pennine chain for about fourteen miles. On their eastern side these rocks are flanked by the upper beds of the Old Red Sandstone and the Lower Carboniferous rocks; and on their western margin they have usually the Pennine Fault bringing against them the Upper Permian strata. The greatest breadth of the Lower Silurian rocks, as exposed in the NE. of Westmorland and the SE. of Cumberland, does not exceed $1\frac{1}{2}$ miles.

The contour of the country occupied by rocks of this age presents a strong contrast with the areas where the newer palæozoic rocks occur, being composed of hills possessing a conical outline, of which the Pikes, Knock, Dufton, and Murton, are fine examples; whilst the newer palæozoic strata present a regular outline as seen in the Pennine Chain, or an undulating aspect as exhibited by the Permian group.

The Lower Silurian rocks of this part of the North of England have an ENE. and WSW. strike; and their prevailing dips are towards the SSE. In their more northerly extension, these rocks show strata belonging to the Skiddaw Slates; and several bands of rocks of this age are exposed by flexures and denudations in this Lower Silurian area. These Skiddaw Slates have the mineral nature and characteristic fossils of this series as represented in the Lake-country.

To these succeed a thick mass, composed of greenstones, porphyries, and ash-beds, which have also their equivalents in the rocks overlying the Skiddaw Slates, and which are known as the greenstones, porphyries, and ashes of the typical Lake-country. They are well seen in the NE. of Westmorland, in Knock and Dufton Pikes. Immediately south of Dufton Pike a totally different group of rocks makes its appearance. This consists of black flaggy shales full of fossils; and these flaggy shales are of such a nature as to mark them as the equivalents of rocks of the same nature, which are seen interbedded between porphyries and greenstones in the Arens and Arenigs in Wales, and also in the Snowdonian group. Upon these fossiliferous black shales, greenstones, porphyries, and ashes are also seen; and to the latter there succeeds a mass of dark-coloured limestone, which is worked at Keisley. The Keisley limestones are also fossiliferous; and their position and fossil contents show their analogy to the Bala or Coniston Limestone.

Immediately S. of the limestone at Keisley, the Skiddaw Slates are again seen, dipping NNW. or directly opposite to the Keisley limestone. They here form Murton Pike. The occurrence of a great W. and E. fault, probably of 10,000 feet throw, brings these lower rocks against the Coniston Limestones here.

Another fault, having a NNW. and SSE. direction, also intersects the Lower Silurian of this part of the North of England, throwing them down towards the W. This, however, is comparatively slight; but it detaches a small area of Carboniferous strata, which in one locality lie on the west side of the older palæozoic series from the great mass of limestone of the Pennine escarpment.

On some New Forms of Olenoid Trilobites from the Lower Fossiliferous Rocks of Wales. By J. W. Salter, Esq., A.L.S., F.G.S.

The grey rocks and black shales at the base of the Lower Lingula-flags, in which Mr. Salter discovered, two years ago, the great *Paradoxides Davidis*, are being fully explored (with the aid of a grant from the British Association), by Mr. Henry Hicks. His energetic work has already brought to light more than thirty species of fossils, most of them Trilobites. Some of these are quasi-embryonic forms, such as *Microdiscus*, which, like *Agnostus*, is a blind Trilobite without facial sutures ; but it has four body-rings, instead of two. There are also species of *Conocoryphe* and *Agnostus*, both of them well-known genera, and others allied to *Arionellus* of Barrande ; all of them have a 'primordial' aspect. Among the new discoveries is a new genus, named *Anopolenus* ; a remarkable form, which at first seemed to have the head devoid of eyes and of any facial suture. Later observations, however, have discerned the cheeks, eyes, and head-spines in a most abnormal position,—placed far forward on the head, and so easily separable as to justify the previous belief in their entire absence. In order to find a parallel for this bizarre form, the author was obliged to describe a new *Olenus*, or rather *Sphærophthalmus*, found by Mr. Turner, of Pauntley, in the Black Shales of Malvern. In this fossil the characters so much exaggerated in *Anopolenus* are less strongly pronounced ; and the new genus is thus connected with the older and better known forms of the *Olenidæ* (the most ancient Trilobite family, if we except *Agnostus* and its allies, which were probably coeval with them). It is worthy of remark, that in this earliest family (*Olenidæ*) the largest size attained by the group of Trilobites is reached ; the great *Paradoxides Harlani* being nearly 22 inches long.

In reply to a question put by Mr. Pengelly, Mr. Salter stated that the exceptional blind species found in the latest formations known to contain Trilobites are degraded forms of the highest groups, namely, *Phacops* and *Phillipsia*, and that there is good evidence of a progression in the development of the group from its commencement in the Cambrian to its extinction in the Coal-period.

A Pre-Cambrian Island, at St. David's, Pembrokeshire. By J. W. Salter, Esq., A.L.S., F.G.S.

HAVING been occupied for a fortnight this summer in searching (with Mr. H. Hicks) the Cambrian rocks of St. David's for the Olenoid Trilobites mentioned in the last paper, the author paid some attention to the relations of the central trap-rock of the district, which runs in a broad mass, a mile or two wide, from Llanreithan to the headland of St. David's, and is continued out to sea in Ramsey Island. As the purple rocks, sandstones, and slates of the whole Lower Cambrian division are thrown up at high angles, all but vertical, on either flank of this mass, which forms the axis of the whole country, there is no difficulty in studying its behaviour in contact with the Cambrians. If it were an intrusive trap of later date, it would penetrate them here and there, or at least alter them at the point of contact, as the neighbouring granite of Brawdy and Roch actually does. On the contrary, wherever the boundary can be seen, steatitic and felspathic schist unaltered, and beds of thick conglomerate, mark the line, and are often very conspicuous. These conglomerates—of quartz-rock, jasper, felstone, &c.—may or may not have been derived from the immediate neighbourhood. They are traceable along the south and north sides of the trap-region, and are followed by sandstones of various degrees of coarseness, but indicating by the ripple-mark, as well as the coarse material, that they were accumulated in shallow water; and, as we know that pebbles, often as large as swan's eggs, are not carried far out to sea, but mark either a submarine shoal or a coast-line, we are compelled to assign them to a source near at hand. The upper beds of the Lower Cambrian formation are finer-grained and lighter-coloured, and pass insensibly into *grey* and then into thin *black* beds of the Lingula-flags, with trappean ashes and lava-flows,—the great Upper Cambrian formation.

Comparing this order of things with what occurs in North Wales, one is struck with the wonderful similarity in the two regions; coarse conglomerate and purple shale, red sandstones, and then grey rocks, passing into black, deep-water shales. Crossing the channel, it is the same; the Lower Cambrian rocks of Wicklow give evidence of accumulation in shallow water; and Sir R. I. Murchison has shown us exactly the same thing, even exaggerated, in the conglomerates of north-western Scotland; but these rest directly on the old Laurentian rocks, from which they seem to have been derived. The Hebrides and the west coast of Sutherland were land or shallow water when the Cambrian pebble-beds were formed around them. We do not know the land which supplied the pebble-bands and sandstones of North Wales and Shropshire; but the researches of Dr. H. B. Holl have shown us that the Malvern Hills were a low reef of rocks at this time; and everything points to a shallow sea, studded with islets and reefs, as the condition of things which existed in our area, probably also in Normandy and the Channel Islands, at this time. Again, the old Laurentian gneiss is remarkable for its syenitic character. Syenite is common; true granite is comparatively rare in these old rocks. This is the case in Canada, where they are best seen. Dr. Holl has shown it to be the case at Malvern, and hence we should look for it in Wales. The mass of igneous rock, which forms the back bone of the St. David's peninsula, and which supports, without penetrating them, the shallow-water accumulations of the older Cambrian around it, is syenitic in character. The quartz-veins penetrating it may well have supplied the pebbles; and the felspathic matter was the origin of the softer schists of the rocks which lie around it. That there was shallow water, with rocky ground close by, is evident; and in the absence of any evidence to the contrary, the author suggests that the syenitic trap of St. David's is a part of the old pre-Cambrian land. As he did not visit Ramsey Island the evidence is incomplete. It will be necessary to see whether the Cambrians there are affected by the trap, or lie upon it unaltered, as he believes is the case with those of St. David's.

On the White Lias of Dorsetshire. By Dr. Wright, F.R.S.E., F.G.S.

THE author first gave a sketch of the Lias formation as displayed in the grand coast-section between Down Cliffs and Pinney Bay, on the coast of Dorset, in which all the different beds of the

Upper, Middle, and Lower Lias rise in succession from the shore into the cliff at a very low angle. Near the base of the series, and underlying the grey limestone beds containing *Ammonites Bucklandi*, *Lima gigantea*, and *Gryphæa incurva*, is a series of light-coloured limestones and shales, which at Pinney Bay are well seen in the coast-section, and inland are equally well exposed in the quarries at Up-Lyme and near Axminster. These are the beds which were called 'White Lias' by Buckland, De la Beche, Conybeare, and others. Now, if that term was to be retained, we must give a more correct definition of it than hitherto, seeing that the series included light-coloured limestones belonging to two distinct zones of life. In the upper half we have 20 feet of limestones and shales, containing *Ammonites planorbis* and its varieties, *Am. Johnstoni* and *Am. torus*, with small *Lima punctata*; and in the lower beds of this upper half, *Ostrea liassica*, *Modiola minima*, *Cidaris Edwardsii*, *Hemipedina Bechei*, *H. Bowerbankii*, and, in fact, nearly all the species that characterize the *zone of Ammonites planorbis*: with these mollusca are associated the bones of *Ichthyosaurus* and *Plesiosaurus*. The bottom bed of this zone consists of a light-coloured limestone, known as the 'Anvil-ledge;' the marl resting upon it contains *Ostrea liassica*, *Modiola minima*, and *Pullastra* (*Axinus*) *arenicola*; the latter shell the author had not found in any higher bed, although it occurs abundantly in many of the beds of the lower half of the series. The 'Anvil-bed' may be therefore regarded as near the boundary between the under and upper divisions of the White Lias: below it are rubbly beds of limestone, with marly partings and concretionary bands, followed by laminated beds of fine cream-coloured limestone, splitting into thin layers, underlain by compact, concretionary, cream-coloured limestone, breaking up into cuboidal fragments when struck with the hammer: below these come nodular masses, forming a bed four feet thick, resting upon a band of the 'Landscape-stone,' or true 'Cotham marble,' nine inches thick. The series of limestones lying between 'Anvil-ledge' and the 'Cotham marble,' inclusive, is from 18 to 20 feet thick. The fossils contained therein are chiefly small Conchifera in the state of moulds. Dr. Wright had collected *Modiola*, *Lima*, *Cardium*, *Avicula*, *Axinus*, *Monotis*, and *Pecten*, from the rubbly beds beneath 'Anvil-ledge,' both at Up-Lyme and Pinney Bay; but the imperfect state of the moulds rendered the determination of the species impossible. The 'Cotham marble' overlies a greenish shale, resting upon another bed of white limestone. Below this is a nodular band, resting on a thick bed of hard grey shale; and underneath are greenish marls, overlying a thin band of light-coloured concretionary limestone, containing *Estheria minuta*. Below this characteristic band are six or eight beds of greenish marls and dark shales, containing very good specimens of *Pecten Valoniensis*, *Cardium Rhæticum*, *Avicula contorta*, *Axinus* (*Pullastra*) *arenicola*, and *Placunopsis*. All the beds from the 'Cotham marble' downwards, to the east of the fault at Pinney Bay, must be followed out at low ebb during spring-tides. The same strata may be seen in the cliff at Charton, and at Culverhole Point, where the

Black Shales are associated with the Bone-bed, which is well developed at the latter place.

From the foregoing observations, the author concludes that the upper half of the White Lias of Dorset appertains to the zone of *Ammonites planorbis* (Lower Lias); the lower half, to the zone of the Avicula-contorta-beds, or Upper Trias. The Ammonites-planorbis-beds are very similar to the beds of the same zone in Warwickshire, Somersetshire, and Gloucestershire,—with this difference, that they consist of light-coloured limestones and clays. The Avicula-contorta-series differs, however, in having a considerable thickness of cream-coloured concretionary limestone in the upper part, instead of the laminated clays which this zone contains in its upper part in Gloucestershire, Somersetshire, and Glamorganshire.

On the Genus Pteraspis. By E. Ray Lankester, Esq.

THE author commenced with the history and literature of the genus, remarking that little had been hitherto published that tended to give very definite notions of the various species, whilst the genus *Cephalaspis*, on the other hand, had received considerable attention from Sir Philip Egerton. Professor Huxley had intended to work out the species of *Pteraspis*, and had accumulated a great number of specimens for the purpose; but, after publishing a very accurate restoration of the *Pteraspis rostrata*, he had let the matter drop, and had now very kindly lent all his material to the author. Mr. Lankester then described at some length the affinities of, and differences between, *Cephalaspis* and *Pteraspis*, remarking that in both the shield was an ossification of merely dermal tissue, and showed very remarkable characters; in *Pteraspis* presenting a structure which was without parallel in the animal kingdom, and which had been very admirably described by Professor Huxley. He then proceeded to show that this peculiar form of ossification in *Pteraspis* is accompanied by a peculiar form of suture; the plates, which, connected together, form the head-plate, being not joined by interlocking sutures, as in *Coccosteus* and others, but anchylosed. He proposed to divide the present genus *Pteraspis* into three—*Pteraspis*, *Cyathaspis*, and *Scaphaspis*,—distinguished by the following characters, and containing the species here enumerated :—

Pteraspis. — Shield composed of *seven* anchylosed, but *distinct*, pieces; namely, a central disc, a prolonged rostrum, two orbital plates, two lateral 'cornua,' and a posterior spine.
Species—*Pt. rostrata*, Ag.; *Pt. Crouchii*, Salter MS.

Cyathaspis.—Shield composed of *four distinct* pieces or plates; namely, a central disc, a short rostrum, and two lateral cornua; spine reduced to a mere point.
Species—*Cy. Banksii*, Huxl. and Salt.; *Cy. Symondsii*, sp. n.

Scaphaspis.—*No distinct* pieces recognizable in the large oval head-plate spine represented by the acute termination of the disc.
Species—*Sc. Lewisii*, Ag.; *Sc. Lloydii*, Ag.; *Sc. truncata*, Huxl. and Salt.; *Sc. Ludensis*, Salter.

The characters of the *Pteraspis Crouchii*, an undescribed species with a very long snout, were then given; and *Cyathaspis Symondsii*, a new species found in the Cornstones of Herefordshire, and named by the author after the Rev. W. Symonds, of Pendock, was characterized.

On the Occurrence of Fish-remains in the Old Red Sandstone of Portishead, near Bristol. By W. H. Baily, Esq., F.L.S., F.G.S., Palæontologist of the Geol. Surv., Ireland.

THE headland to the north of Woodhill Bay consists of a steep ridge of the Carboniferous Limestone (lower part ?), dipping at about 60° to the NNE., and fossiliferous. The lower beds, of a pink colour, and full of Crinoidal joints and Corals, appear for a short distance at the northern extremity of the bay. The shores of the bay beyond this become flat for about a quarter of a mile, and are covered with shingle, principally derived from the Old Red Sandstone cliffs, which commence a little beyond Beach Cottage, continuing with tolerable uniformity to a distance of a little more than eleven chains, the greatest elevation being thirty-four feet. The ground above this, however, which forms the commencement of Portishead Down, rises to a much greater height, its highest point, near Down Farm, as shown on Mr. Sanders's map, being 364 feet. The section exposed consists of alternations of deep-red, micaceous, flaggy beds, of various thicknesses, with shales and compact sandstones, the sandstone predominating, and sometimes becoming conglomeratic: the dip, near the cottage, is about 20° S. This tract of Old Red Sandstone, as shown by the maps, extends along the coast, to the SW., for about four miles, appearing occasionally on the beach, and sometimes covered by the Dolomitic Conglomerate, once thought to be Permian, but now recognized as a member of the New Red Sandstone. Fish-remains occur both in the conglomerate and micaceous flags. Specimens have been obtained by the Rev. B. Blenkiron from the loose shingle of the beach, one of them being evidently from a conglomerate, the other from the micaceous flags. Mr. Baily obtained a scale of *Holoptychius*, two years since, from the base of a conglomerate in the cliff. At a recent visit he found scales of what he believes to be the same species of Fish, associated with Plant-remains, also *in sitû*, in the micaceous flags which appear on the beach at a little below high-water mark. A peculiar bone on one of these slabs probably belonged to the head; with it is a scale of *Holoptychius nobilissimus*. On the other slab is a scale probably of *Glyptolepis elegans*, and another fragment having a structure like *Bothriolepis* or *Asterolepis*. The occurrence of these fish, which Agassiz includes in his Cœlacanth division—a division which, as he observes, takes the place, in the Old Red Sandstone, of the Ganoids, which more especially characterize the Carboniferous epoch—may serve, Mr. Baily suggested, to point out the relations of the beds in which they occur with those of Scotland, described by Sir R. Murchison as the conglomerates of Scat-Craig, which, he observes, may be referred to strata of a rather younger age than the lowest fish-beds of Lethen Bar, Clune, &c., or the Caithness strata in which we first meet with the *Holoptychius nobilissimus*.

On the Pterodactyle, as Evidence of a new Sub-class of Vertebrata (Saurornia). By Harry Seeley, F.G.S., of the Woodwardian Museum, Cambridge.

The author described the basi-occipital, basi-temporal, basi-sphenoid, ex-occipital, supra-occipital, parietal, alisphenoid, squamosal, petrosal, quadrate, quadrato-jugal, orbito-ethmo-sphenoid, vomer, os articulare, proximal end of the lower jaw, the pre-maxillary, maxillary, and dentary bones of the head: and all the characters concurred in suggesting that, but for the teeth, there is nothing to distinguish the Pterodactyle from a Bird. It approached most nearly to the common Cock. The pectoral arch was also described, and the furcula shown to be attached to the radial processes of the humeri. The author then went through the comparative osteology of the remainder of the skeleton, and showed that it supported the conclusion from the skull.

The writings of Buckland, Owen, Huxley, Cuvier, Von Meyer, Goldfuss, Wagner, Quenstedt, and others, were then reviewed, and shown to contain nothing which really supported the hypothesis that Pterodactyles were Reptiles. The *Sauropsida* were therefore divided into three sections,—*Aves*, *Saurornia*, and *Reptilia*;—the *Saurornia* being Birds with teeth; with peculiar wings; tarsus and metatarsus separate; and reptilian types of vertebræ, like the fossil Birds *Pelagornis* and *Palæocolymbus* of the Upper Greensand.

Mr. Seeley then described as new species, *Pterodactylus Huxleyi*, *Pt. machærorhynchus*, *Pt. Hopkinsi*, *Pt. Oweni*, and *Pt.* (?) *Carteri*; completed the descriptions of Professor Owen's species, *Pt. Sedgwicki*, *Pt. Fittoni*, *Pt. Woodwardi*, and *Pt. simus*; and identified *Pt. Cuvieri*; thus adding six: so that now there are ten species from the Upper Greensand; one, *Pt. Cuvieri*, being common to the Greensand and Chalk.

[As the Monograph of the *Saurornia* and *Aves* from the Greensand is ready for publication, Mr. Seeley would be glad if gentlemen having specimens of Pterodactyles or Birds would favour him by communicating the nature of their fossils.]

CORRESPONDENCE.

'PRÆGLACIAL' AND GLACIAL DRIFT.

To the Editors of the Geological Magazine.

Gentlemen,—Would your correspondent Mr. Kinahan be so kind as to state his reasons for supposing that the gravelly drift *underlying* the Boulder-clay, is 'the drift of the country *before* the Glacial Period?'

I believe that wherever there is a sufficiently thick remnant of Glacial Drift, it will be found to consist of three divisions:—*Firstly*, a bed of clean sand and shingle, containing Glacial Shells and some transported materials; but not such a large number of Erratics as the true Boulder-clay; *secondly*, true Boulder-clay with Glacial Shells, and generally, though not invariably, transported blocks;

thirdly, a bed of clean sand and gravel underlying the clay, and containing similar shells and a few boulders, exactly like the top bed.

This three-fold division is, of course, not invariable; as sometime one or two of the members may be absent and the true Boulder-clay, or the Upper Gravel, may rest on the fundamental rock. It is, however, well developed in the Severn-valley above Ironbridge. where each bed in consecutive superposition attains a thickness of 60 or 70 feet. The middle bed, or Boulder-clay proper, although very various in its composition, does not graduate into either the top or bottom gravel, but can be defined to a few inches. The Shells, however, of the whole range, including the underlying gravel, are precisely identical; and their general series indicate a cold climate.

It would be interesting to know whether the gravelly drift of Ireland, underlying the Boulder-clay, is merely this bottom-bed of gravel or whether its fossil fauna gives evidence of its deposition before the Glacial Period; also whether there is any marked absence of the glacial striations which have been noticed where the Boulder-clay proper rests immediately on a hard fundamental rock.

I think it will be found that the Moel-Tryfaen gravels, the shells of which are still more decidedly Arctic than those of the Severn-valley drifts, probably preceded the true Boulder-clay in deposition; as they are covered up with a tough clayey deposit containing transported materials, many of which occur as large blocks weighing several hundredweights. This top bed is noticed, in the 'Supplement' to 'The Antiquity of Man,' as being only 1 foot 9 inches thick; but since the visit made to Moel-Tryfaen by Sir C. Lyell and Mr. Symonds in 1863, the operations of the Alexandra Slate Company have exposed it to a thickness of from 6 to 15 feet. It has a very irregular, though well defined, junction with the underlying sand-beds. It contains many more large blocks than the sand, and closely resembles in appearance much of the Boulder-clay of the Severn-valley. In addition to the species recorded by Mr. Darbishire Mr. Gwyn Jeffreys has determined the following from among a number of fragments that I collected from the sand-bed at Moel-Tryfaen,—*Tapes virginea*, *Trophon Barvicense*, *Cardium fasciatum*, and *Balanus crenatus*.

A few weeks ago I obtained, between Coddenham and Crowfield in Suffolk, a number of fragments of shells from the outcrop of a bed of clean gravel, which at the latter place is *overlain* by 60 feet of Boulder-clay; but none of them differed from what occur throughout the Glacial Drift of this (Severn-valley) district.

Whilst on the subject of the Glacial Period, it may be worth while recording the existence of an unusually large transported block of grey granite in a pond at the back of Hodnet Hall near Market-Drayton in this county (Shropshire). It measures 8 feet in length, 6½ feet in width, and from 5 to 6 feet in thickness; it is of a rounded form and must weigh from 6 to 8 tons. The country in the neighbourhood is thickly strewn with blocks of granite and greenstone; but none of them at all approach the block at Hodnet in size; indeed it is much larger than any transported block I have seen in the Midland Counties. Thick beds of sand and gravel, containing fragments of Shells, occur to the north of Hodnet.—I am, &c. GEORGE MAW.

BENTHALL HALL, near BROSELEY: *Oct.* 22, 1864.

DISCOVERY OF THE SKELETON OF *LEIODON ANCEPS* IN THE CHALK AT NORWICH.

To the Editors of the GEOLOGICAL MAGAZINE.

AT the base of the high hill enclosed by the boundary of St. Leonard's Priory are some extensive chalk-pits, which, from having been described in Cunningham's Map of Norwich as 'the place where men are customably burnt,' are now known as Lollard's Pit. From the large quantity of chalk yearly removed from this spot, a greater number of the Chalk fossils in the hands of the Norwich collectors are obtained from these pits than from others in the neighbourhood. In 1858 a few vertebræ of *Leiodon anceps* were discovered, and identified by a tooth which was in their immediate proximity. During the past week a number of bones of the same skeleton have been discovered, including about 6 vertebræ, a hundred fragments of other bones, and 4 teeth, two of which are the large cultrate two-edged teeth so much in request among collectors, and two are of the smaller kind from the inner part of the mouth.

It is much to be regretted that so interesting a specimen is in so delicate a state that the bones can only be extracted in fragments; but, however the collector may be disappointed, to the Palæontologist this discovery is a ray of hope that at some future time a better preserved specimen may be discovered.—Yours truly,

NORWICH: *Oct.* 20, 1864. T. G. BAYFIELD.

MISCELLANEOUS.

THERE has lately been found, and added to the national collection, in the valley-gravel near Vauxhall, south of London, a skull of *Bos frontosus*, Nilsson, nearly entire, and having the characteristic downward curve of the horn-cores. The frontal, maxillary, and palatine bones are nearly perfect, and there are six molar teeth *in sitû*. This is the second instance of this species being met with in England. The other specimen was from the Bawdsey Bog, near Felixstow, Suffolk, and was figured in the 'Geologist' for 1862, pl. 15, p. 441. Both the skulls exhibit similar points of difference from the cast of the typical *Bos frontosus* described by Professor Nilsson in K. Vetensk. Akad. Öfversigt, 1847, p. 116, and subsequently figured and described by him in the Ann. and Mag. Nat. Hist. vol. iv. 2nd ser. 1849.—W. D.

WE notice with regret the death of Mr. A. G. BAIN, who was the first to show by map and section, as well as by great collections of fossils, the geological structure of Cape Colony. He died at Cape Town, on the 20th October last, having just landed from England.

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