

has been well treated by Mr. T. Mellard Reade, F.G.S., in an elaborate and exhaustive paper on the Estuaries of the Mersey, Dee, and Ribble,¹ in which he has made out from three to four distinct periods of submergence and upheaval, and he insists on the frequency of such movements. This idea seems to me to be well borne out by the number of sea and land surfaces shown in such a trifling thickness of strata as at Tramore. At the same time, we must remember that extensive denudation might have taken place between each deposit, although this is not denoted by what is going on there at present, since we see one part of the bog submerged and silted over, while the other is still growing.

With regard to other parts of our own coasts, I have no doubt that the same phenomena have been also observed; but I have no opportunity of verifying this at present. However, the shelly gravel of Dundalk² may possibly be due to something of the same nature, and this is undoubtedly true in the case of the remarkable shell and peat deposit underlying Belfast:³ while another instance in the South of Ireland is furnished by the Estuary of Wexford, of which, through the kindness of G. H. Kinahan, Esq., M.R.I.A., I am in possession of some details showing that recent oscillations have been going on there to a great extent. Around the coast, submerged bog is common, and in the Estuary itself the following section is noted by him:⁴—

“North Mudlands, Wexford Estuary, at the Engine House at the ancient island called ‘The Ridge.’

	Ft.	In.
4. Marl	16	0
3. Peat	5	0
2. Grey muddy stuff	1	5
1. Marl		

“The top of the marl, No. 4, is a few fathoms (about four) below average high-water mark. This section was procured while sinking the foundation of the Engine House.”

NOTICES OF MEMOIRS.

I.—THE UPPER RHINE VALLEY IN TERTIARY AND DILUVIAL TIMES.

By Dr. F. SANDBERGER.

Das Ausland. No. 50. 15th December, 1873.

Translated by Mrs. A. C. Ramsay.

OF all the German rivers, there are few the history of which is more interesting than that which has gradually resulted in the physical development of the valley of the Rhine. It runs from Basel as far as Rastadt in a broad valley, which, in an earlier form,

¹ Post-glacial Geology of Lancashire and Cheshire, by T. Mellard Reade, C.E., F.G.S., etc., Proc. Liverpool Geol. Soc., November, 1871. An instance of blue mud penetrating into cracks in the Boulder-clay beneath is noted (p. 45, Detailed Sections), just as in the Sections given above. (See GEOL. MAG. 1872, Vol. IX. p. 111.)

² On the Shelly Gravel underlying Dundalk, by Gen. Portlock, F.R.S., etc., Journ. Dub. Geol. Soc. vol. i.

³ Mr. J. Grainger, 22nd Report Brit. Assoc., 1852, p. 42. Also Ex. pl. Memoir (Sheet 36), Geol. Survey, Ireland, p. 38.

⁴ MS. note.

dates from immediately before the deposition of the Upper Bunter Sandstone, and divides the Palæozoic rocks of south-western Germany into two independent mountain ranges, viz. the Black Forest and the Vosges. From thence northward during the Triassic and Jurassic epochs it remained as a narrow sea-gulf, connected to the south with the Franco-Swiss Jurassic sea, and to the east by a narrow strait between Langenbruck and the Lowenstein Hills with that of Swabia. Slowly the sea-bottom rose and formed, during the Cretaceous and in the beginning of the Tertiary period, a continent, of the inhabitants of which we have at present no knowledge. About the time when the deposition of the Calcaire Grossier indicated continental land on the south and east sides of the great Paris Basin, which was soon covered with freshwater lakes, this event was shortly afterwards followed by strata in similar lakes in what is now the Upper Rhine valley.

From the Upper Saone, over the Jura and Alsace to near Heidelberg, we meet with small patches of light coloured limestone, everywhere filled with the same land and marsh shells, whose nearest analogues are still living in tropical Asia, and in smaller numbers in tropical America. Among them, but still very sparingly, some species begin to appear, which at present are confined to the Mediterranean district. Large Carnivora of the *Lophiodon* species, such as that described by Cuvier from Buxweiler in Alsace, lurked in the thickets on the lake-banks, whilst Crocodiles and bony-plated fish lived in the waters. Of the once abundant Flora nothing remains to us but a few fruits. We however cannot doubt but that it possessed the same preponderating tropical character as the shells. The Upper Rhine valley did not remain long under these conditions, the population of the freshwater lakes and their environs gradually changed, as is easily shown by a comparison of the shells and vertebrata of the older limestones of Buxweiler with those of the more recent beds at Brunstadt in Alsace, and Kleinkems in Upper Baden. *Lophiodon* is replaced by *Anthracotheurium*, more nearly resembling the pig, and along with it we find that most important mammal of the Paris Basin, made so famous by Cuvier, the pachydermatous *Palæotherium*. This typical form is remarkably interesting, standing as it does between the deteriorating forms of the modern Tapirs and the Horse, from which it differs so widely, and in south-western Germany it must have lived in great numbers, especially on the Swabian Hills. In the Middle and Lower Rheinthal the *Palæotherium* is nevertheless as sparingly represented as the *Lophiodon*. Luxuriant forests surrounded the morasses, the beloved home of the *Anthracotheurium*; here also a Fan-palm, *Sabal major*, most nearly allied to the Swamp Palmetto of Southern North America, has left, at Lobsann near Weissenburg, numerous impressions of its graceful fans; whilst whole banks of the so-called Needle-coal testify to the abundance of *Conifera*.

Below this the Rhine plain sinks gradually from Delsberg as far as Bingen and Kreuznach, and from the south-west the sea broke into the extensive depression, and spread along the present

bases of the Black Forest, Odenwald, the Vosges, and Haardt, as far as the Hundsruck Taunus and Spessarts, completely changing the previous contour. The banks of that inland sea, now the Mayence Basin, are everywhere still visible. Banks of oysters, covered with parasitical shells, corals, sea-acorns, heaped bones of the sea-cow, numberless sharks' teeth, called in the Pfalz "birds' tongues," are to be found near Delsberg and Lörrach, as also near Landau, Kreutznach, Geisenheim, and Wellenfurchen, often extending for miles, and they are also found in other places, such as Lahn and Heppenheim. Rich, however, as was the organic life developed in these seas (the number of species belonging to the different divisions of the animal kingdom hitherto found amounts to about 350), it cannot be compared with what we now find in tropical seas. The number of forms which are included in the European seas of the present day have markedly increased, though large thick shells are more sparse, and reef-building corals are entirely wanting. A part of this district did not remain long covered by the sea. As gradually as it sank it rose again, passing through all the stages from strongly saline brackish water to a freshwater lake. The animal remains which are found in the stratified beds of pure sea-sand and clay demonstrate this. First, the Oysters, which had begun to return, though smaller in form, vanish, followed by the *Veneridæ* and *Cerithiæ*; and only the tough Mussels, which still held their place in the almost entirely unfreshened parts of the eastern sea, along with pure freshwater species, are found in the upper beds of the Mayence Basin, in which myriads of the little marsh shell *Hydrobia* are found in the Limestone everywhere seen on the route from Mayence to Wiesbaden in the Salzbachthal.

It is in this same Limestone, on the opposite side of the Rhine, that the Vertebrate Fauna of Weissenau lies buried, the richness of which is only excelled by a few places in southern Europe, such as Pikermi near Athens, or Mount Lebéron in the south of France. Hornless Ruminants, Civet cats, and small Marsupials, as they appeared in the early times, still existed in great numbers. Instead of the *Palæotherium* we find Tapirs, and now, but rarely, that slender *Hippotherium*, whose dentition resembles the milk-teeth of the Horse so strongly as to bespeak its embryonic type. Instead of the *Anthracootherium*, we still only find the *Hyootherium*, a middle form between the Brazilian Musk-swine and the Asiatic *Babirussa*. A hornless Rhinoceros (*Aceratherium*) was already common. The smaller animal population, consisting of Martens, Moles, and Hamsters, shows a leaning, not without significance, towards the existing forms of the temperate zone. The constant progress in this direction is all the more striking when one compares the inland shells of the somewhat older limestone of Hochheim with those of Wiesbaden.

Thus we find :—

	Species of tropical Asiatic type.	Tropical and sub-tropical. America.	Canary Isles.	S. Europe.			
At Hochheim...	11	...	16	...	9	...	21
At Wiesbaden..	3	...	3	...	2	...	17

From thence downwards in time we cannot follow the sub-

sequent remodelling of the Rhine valley so well, for the coarse gravel of Eppelsheim and other places round Mayence and Worms shows a deteriorating and apparently far younger Vertebrate Fauna, differing so widely from that of the Hydrobian Limestone that it is impossible not to recognize the gap between the two. It is, however, only in the Mayence Basin that these gaps are visible. In France they appear to be so completely filled up by three successive Faunas that the gradual replacing of the older species by newer ones nearly related to them is demonstrated with the greatest certainty. Near Eppelsheim we find, instead of the hornless Ruminant *Dorcatherium*, and Stags, the south Asiatic Muntjack (Prox), with simple bifurcate horns, along with Rhinoceroses with and without horns. These, however, do not long remain the largest forms in this wonderful Fauna, as they are soon surpassed by the gigantic Proboscidiens, represented by *Dinotherium* and *Mastodon*. Swarms of *Hippotherium* lived in the woods; Stags on the prairies, often threatened by an immense carnivore (*Machairodus*), whose teeth exhibited the true type of the beast of prey on a scale yet more fearful than that of the Tiger; while the smaller predacious animals of the Civet-cat type had apparently to content themselves for food with the small vegetable feeders, which were for them but meagre booty.

The condition of the Upper Rheintal during this time was still very different from what it is at present, for what is now the Kaiserstuhl, standing isolated in the plain, was then joined to the nearest Jurassic hills, and formed with them a watershed. On the south side of this the brooks carried Vosges pebbles as far as Delsberg in the Bernese Jura, in which the remains of *Dinotherium* are buried; while where the Birs now hastens northward to the Rhine, a river, which held the same course as the Rhine does now, brought Schwarzwald and Vosges stones, and some from the Langenbruck district of the Jura to Eppelsheim. From this time onward the gradual development of the valley becomes more difficult to follow. It appears as if the greater part of the strata of the older deposits, still remaining elsewhere till the beginning of the Diluvial period, have been partly carried away by denudation during the modelling of the older into the modern river-valley, and have partly been covered with newer pebbles to so great a height since this later modification, that traces of these old terraces can be recognized in but very few places.

The Rhine valley has no equivalent of the Fauna of Perrier in France and of Norwich in England, which contains, along with the latest *Mastodon*, the oldest true Elephant; neither has it the newer "Forest-beds," those old forests sunk under the sea, which extend forty miles out from the coast of Norfolk; nor the contemporary sands of St. Priest and St. Martial in France, where we find *Machairodus* along with the first typical Bears and Dogs, gigantic Stags and Red Deer, Stags of Virginian type with serrated horns bent inwards (*Cervus verticornis* of Boyd Dawkins), and Aurochs. We might, from their Flora, assign the well-known brown coal-beds near Durkheim, in the Rhine valley, to this period; but as yet they

have not yielded any vertebrata nor shells; and there is also a gap between the Eppelsheim Fauna and that of the Middle Diluvial epoch not yet filled up.

When and how the dam in the Upper Rhine valley by Schaffhausen and Freiburg was destroyed, and how the river found a free course to the north, this is neither the time nor the place to decide; this however is certain, the remodelling of the present river-bed must have required an extraordinarily long time, and indeed was already in existence at the commencement of the Glacial epoch. Along almost the whole line from Basel to Bonn we meet, at a height ranging up to 150 metres above the present river, an old river-bed, which stretches, according to the contour of the land on either side, from three to six miles inland to the hill boundaries, which then formed the river-bank, and is still easily recognized as river-terraces. The lower bed consists of pebbles and sand, on which lies Hill-löss. In the present river-valley, but at a much less height above the present water-level, we again find gravel, often more than thirty metres thick, and Valley-löss. In this we first find, here and there, interstratified thin brown coal-beds, as, for example, at Steinbach near Baden-Baden, analogous to the beds at Utznach and Dürnten in Switzerland, and Imberg near Sonthofen in Bavaria. As far down as Heidelberg the gravel still contains Alpine pebbles and rolled moraine rubbish from the gigantic glaciers of the Rhine, as I have mentioned elsewhere. That the river must have required a very long time to cut out its channel to the lower gravel-bed, now forty metres above its present level, in addition to the 110 metres of the 150 metre-level mentioned above, requires no further explanation. It had, however, to dispose of an extra bulk of water in certain seasons, as it does now—a point to which I will return later.

This hypothesis of a long lapse of time agrees not only with the mechanical modelling work of the river, but also with the totally different character of the Fauna at the beginning and the end of the period, which I shall proceed to show immediately.

In the Rhine valley the larger Vertebrata are found, as in other river valleys, chiefly in bays formed by the debouchment of side-valleys into the chief one, as for example at Istein.

With regard to this latter view, the old Main delta, in the immediate neighbourhood of Hochheim, and from thence as far as Walluf, is known as the most celebrated and fertile finding-place for Diluvial Vertebrata on the whole Rhine, and in the sandpits by Mosbach near Biebrich, and also at Schierstein, they are exceedingly numerous. The pebbles form a veritable pattern card of all the rocks of the Main district. Along with the Sericit shale and Quartzite of the Taunus, and the Tertiary stones and Basalts of the neighbourhood of Frankfort, are found the Muschelkalk of the Kinzeggthal and Bunter sandstone of the same district. Hornblende and Gneiss from Aschaffenburg, and, indeed, even the almost indestructible siliceous shale from the upper Main in the Fichtelgebirge, are not wanting. The coarser gravels contain the larger Vertebrata; the

pebble-beds, interstratified with sand, the smaller bones and horns and the larger river-shells; and in the sand is a rich collection of land and freshwater shells. The Mosbach Fauna has already been made the subject of a learned paper by A. Braun and Herman von Meyer, and since then the interest felt in the German Diluvial formation has greatly increased. At present I can name 73 species of shells, and 24 Vertebrata, but I must be brief about them.

The greater part of the Mollusca are still living in the Main valley, more particularly in the upper part near and above Bamberg; others—viz. *Valvata naticina*, *Macrostoma*, and *Hyalina viridula*—are only found in the north-east and the north of Europe; *Pupa columella* still lives near St. Petersburg, in Lapland, and on the Gemmi; *Patula solaria* in the eastern Alps and the Silesian hills; others attain their southern limit at Frankfort. On the whole it is manifest that a much colder climate than that of the Mainzthal at the present day must have obtained at the time of the deposition of the Mosbach sands. The great difference visible between early times and now is presented yet more forcibly by the Vertebrata than by the shells. There we find, along with the Horse, Roe and Red Deer, Wild Boar, Badger, and Water-rat, still living in the neighbourhood, and the Beaver, the last specimen of which was killed near Mainz in the beginning of this century; the Elk and Auroch or *Urus*, which since the middle ages has been driven back to the marshy woods of northern Europe, Reindeer, now only living in Polar regions, Marmots, natives of the High Alps, all bearing witness to the Ice period. The gigantic Cave-bear, the Giant Stag (*Cervus megaloceros*), possibly the mighty Schelch of the Nibelungen, were still among the beasts hunted during the oldest “Stone period,” Elephant, Rhinoceros, and River-horse, all strange to the Europe of to-day. Elephants are represented by two species, one, the lesser, akin to the African *E. antiquus* (Falconer), and the larger one resembling the Asiatic, the Mammoth. The finding of the Mammoth, and also of the Rhinoceros of the Löss, in perpetual ice in Siberia, covered with hair that adequately protected them from the northern winter, shows that they were not southern forms accidentally mixed with those belonging to the Arctic climate. The Hippopotamus only can be pressed into this view of the subject, inasmuch as Mosbach is its northern limit. But as this solitary animal might also have had a hairy covering, it is impossible to adduce it as any tenable ground for a contrary decision.

The association of Cave-bear, Mammoth, Reindeer, and Auroch all in one deposit at Mosbach, completely confutes the classification, by Lartet and Dupont, of the prehistoric times of the French and Belgian caves, into the Cave-bear, Mammoth, and Reindeer periods, and so forth—a theory which could not be established in the neighbouring Lahnthal, and which Boyd Dawkins has rightly abandoned for England. No trace of Man, not the simplest, rudest, splintered stone, has yet been found in the Mosbach sand; and yet the conditions of the deposit prove to demonstration that these are precisely of the same age as the flint-flake beds in the valleys of the Somme and the

Thames, etc., and on one as well as the other lies the Valley-löss, the Marl-mud of the Diluvial period, with which we must close our observations.

The fertility of the Nile valley is the only thing to which we can compare that of the Rhine, Main, Danube, and Rhone valleys, arising as it does from a kindred source, and this fertility already claims for this kind of hill country especial notice in the national economy. It is also important in the highest degree to the geologist as the result of the enormous successive periodical inundations of the Diluvial period. One absolute fact, easily calculated, may be deduced from it, viz. that in these times the Rhine at Strasburg carried 48 times as much water as it now does at its highest, and this will explain the enormous thickness of the mud. That this only relates to deposits at high-water levels is shown most clearly by the shells of the Löss. They are almost entirely land-shells, and are certainly such as lived in the immediate vicinity of the river and its tributaries. High Alpine and hyperborean forms are found in them as well as in the Mosbach sand; but the true Alpine forms, such as *Clausilia gracilis* and *Helix pilosa*, are only found in the streams proceeding from the Alps, or in their great tributaries, generally spreading to the northwards. But the forms identical with those now living in the Main and Rhine valleys, so largely represented in the Löss, are never so common in the present high-water deposits; for example, the little amber shell, *Succinea oblonga*, now a rarity in the Main and Rhine valleys, is quite a common shell at St. Petersburg and Stockholm. The Vertebrata (15 species) are mostly the same as those in the Mosbach sand, but of Elephants we only have the Mammoth; the *Rhinoceros Merckii*, with the nose-*cloison* only half bony, is supplemented by the hairy Siberian *Rh. tichorhinus*, the nose-*cloison* of which is quite bony; the Hippopotamus is quite extinct, and Reindeer and Wapiti (*Cervus Canadensis*) are much more plentiful than at Mosbach. Of beasts of prey, we have here at first the Cave-lion and the Cave-hyæna, along with which, in the caves of the Lahnthal, are also found the Cave-wolf and Fox. It is most remarkable that of late our best osteologists have identified the Cave-hyæna with the South African *H. crocuta*. If this be so, it would be an anomaly without parallel in the history of Diluvial animals, indicating an emigration of a species of the Glacial period into a tropical climate, and for this reason this view must certainly be received with caution.

With the Löss the Diluvial period closes. No deposit more recent contains any complete series of extinct species; and if a division is to be made anywhere between *Diluvial* and *Alluvial* periods, it must be made here.

We know that Man must have lived at that time, and that, scantily fed and roughly clothed, he waged war with the giant beasts of the olden time, over whom he remained the victor through the intellectual superiority which separates him from the nearest and most highly-gifted animals.

II.—THE OLD RHINE VALLEY. By DR. HIBBERT, F.R.S.

THE physical structure of the Old Rhine Valley is treated of by Dr. Hibbert in "The History of the Extinct Volcanos of the Basin of Neuwied," published more than 40 years ago,¹ in which he gives his views for inferring that the Rhine has not always followed its present course from south to north. The subject is noticed in the chapter on the state of the Rheinland at the commencement of the Tertiary epoch, illustrated by a sketch of the Tertiary geography of the Lower Rheinland, showing the division of the Upper and Lower Rhine basins. In consequence of a barrier of high land stretching across the present site of the Straits of Bingen, and thus filling up the small geographical space intervening between the chains of the Hundsruock and the Taunus, the marine basin from Mayence to Basle² had no connexion with the present channel of the Rhine from Bingen to Cologne, or farther north. Its waters flowed in a direction quite opposite to that they now maintain, being from *north to south*, while its southerly extremity was connected with the other marine basins of Europe by means of narrow channels. The first commencement of the drainage of the Lower Rhine was through a prolonged rent (due to some elevation of the Rheinland), which commenced near the present site of Bingen, and was continued in a northerly direction as far as that of Coblentz, where the freshwater basin of Neuwied commenced, which was of some extent, and considerably elevated above the level of the sea. The discharge from this basin was effected through a subsequent fissure of disruption, gradually widened and deepened, by which the water from the ancient lake of Neuwied was conveyed to the then extensive lower freshwater basin of Cologne, which overflow, in part of its course north of Andernach, must have been originally precipitated in the form of a cataract. Into the inquiry, whether a still lower freshwater expanse occupied the site of the lower flats of Holland, extending even to the shores of England, or into what sea the ultimate drainage of this chain of lakes was conducted, Dr. Hibbert does not enter, as being beyond the limits of his memoir.

It is thus seen that the Hundsruock and Taunus were the dividing range from which, at an early period, the streams were directed north and south, and the inversion of the current of the basin of the Upper Rhine was subsequently effected by the last elevation of the European Alps, which was the most considerable in the vicinity of the lake of Constance, and effected a change in the level of all the districts along the valley of the Rhine extending from Basle to Bingen, and perhaps even beyond the ancient barrier of Bingen, as far as the basins of Neuwied and Cologne, so that a continuous declivity was thus formed along the united courses of the Upper and Lower Rhine.

In short, says Dr. Hibbert, the sum of the change effected by the elevation of the Alps was as follows:—The waters of the upper

¹ London, 1832.

² M. Boue considers this a marine basin of an early Tertiary period.

freshwater basin of the Rhine, which had originally flowed from the present site of Mayence to Basle, in a direction *north* and *south*, towards the great inland sea of Europe, must now have suddenly changed their course from *south* to *north*, and, in escaping across the barrier of Bingen, where a cataract of the most formidable and overwhelming character must have been formed, would eventually press forwards towards the inferior basins of Neuwied and Cologne, and thence to the ocean, which then covered the present flats of Holland.

J. M.

III.—A COMPARISON OF THE LOWER EOCENE OF BELGIUM AND ENGLAND WITH THAT OF THE PARIS BASIN. By M. HÉBERT. (Ann. Scien. Géologiques, vol. iv. art. 4.)

IN this paper M. Hébert substantiates the opinion which he has long held as to the position and succession of the Lower Eocene strata in the above-named areas, and which is not quite in accordance with the views of other geologists. This subject has already been treated of abroad, by MM. D'Archaic, Raulin, and Dewalque; and in this country the valuable papers published in 1852 and 1855 by Mr. Prestwich and in 1866 by Mr. W. Whitaker are doubtless well known to students of Tertiary geology.

M. Hébert divides the Lower Eocene into Upper and Lower: the former, according to this author, being represented in all three countries; whilst the lower is found only in France and Belgium, and is wanting in England.

The paper is divided into three parts, namely:—(1), the sands of Bracheux and their equivalents in Belgium and England; (2), the beds comprised between the sands of Bracheux and the Calcaire Grossier; and (3), the beds comprised between the sands of Bracheux and the Cretaceous series.

1.—The sands of Bracheux constitute the equivalent of the Lower Landéuien of Dumont, and contain the following characteristic species, which are found in both deposits, namely:—*Panopæa Vaudini*, Desh., *Thracia Prestwichii*, Desh., *Pholadomya cuneata*, Sby., *Ph. Koninckii*, Nyst, *Cytherea fallax*, Desh., *Cyprina Morrisii*, Sby., *Cucullæa crassatina*, Desh., *Pecten breviauritus*, Desh., *Turritella bellonacina*, Desh., *Natica Deshayesiana*, Nyst. These sands present two distinct fossiliferous horizons, that of Bracheux, and that of Jonchery and of Châlons-sur-Vesle. The two beds are well shown at the hill of Brimont, where they are divided by a sandstone with vegetable impressions. At present, neither in Belgium nor elsewhere is there any representative of this upper zone. As to the lower horizon of Bracheux, it is not less apparent in England than in Belgium, being there represented by the Thanet sands.

Independently of *Ph. cuneata*, *Ph. Koninckii*, *Cyp. Morrisii*, *Cuc. crassatina*, cited above, and which are characteristic of the Thanet sands, M. Hébert has found at Bracheux and Herne Bay *Psammobia Edwardsii*, Morr., and *Corbula Regulbiensis*, Morris; at Châlons-sur-Vesle and at Jonchery *Cytherea orbicularis*, Edw., and *Scalaria Bowerbankii*, Morris (*vide* Desh.); at Vaux-sous-Laon *Pecten Prest-*

wichii, Morris. Thus the palæontological relations are as strong between the sands of Bracheux and Thanet as between these and the Lower Landénien—a fact which is further attested by the lists of determined species given by Mr. Prestwich in 1852, and completed by Mr. Whitaker in 1866, and which are not found in beds higher than the Woolwich series.

2. (a). The Woolwich beds, Lignites of Soissons, and the Upper Landénien.

The identity of the fauna of the Lignites of Soissons and the Woolwich beds is complete, for in the Paris basin the fauna of the lignites has little relation with that of the Bracheux sands, or even with that of Jonchery, its nearest representative.

Mr. Whitaker cites (Quart. Journ. Geol. Soc. 1866, vol. xxii. p. 404) the following species as common to the Thanet sands and those of Woolwich:—*Corbula Arnouldi*, Nyst, *Cucullæa crassatina*, Lam., *Cyprina Morrisii*, Sby., *Cytherea orbicularis*, Edw., *Glycimeris rutupiensis*, Morr., *Nucula fragilis*, Desh., *Ostrea Bellovacina*, Lam., *Pectunculus terebratularis*, Lam., *Psammobia Edwardsii*, Morr., *Thracia oblata*, Sby. Two of these species are peculiar to the Woolwich series; others range higher, even to the London Clay; and some are characteristic of the Bracheux sands. Thus, from the succession of the mineral characters, which is the same in the two basins of England and France, from the identity of the faunas, and the relations which unite these faunas in England, we are acquainted with the complete succession of the phenomena, and there is no possibility of intercalating between the Bracheux sands and the lignites a deposit of a different nature, such as the Rilly limestone, notwithstanding the occurrence of a certain number of freshwater fossils common to the fauna of this limestone and that of Jonchery. The relations between the sands of Bracheux and the lignites is still more close in Belgium, so that Dumont has comprised them both in his *Système Landénien*. The Upper Landénien corresponds to the lignites of Soissons, for we there find the lignite beds and the principal fossils of this fauna.

2. (b). *The Clays of Yprés or Lower Yprésien.—London Clay.—Lacuna in the Paris Basin.—Emergence.—Oldhaven Beds.*

In Belgium the beds with *Cyrena cuneiformis* are directly covered by the Clay of Yprés, above which occur the glauconiferous sands with *Nummulites planulatus*, *Turritella edita*, and *T. hybrida*, and other fossils characteristic of the sands of Cuise. This clay, which is the perfect representative of the London Clay of England, is wanting in France, so that, as suggested by Dumont,¹ the French area was probably emerged during the formation of the Clays of Yprés and London. M. Hébert believes there are proofs of this emergence, and cites a pebble-bed at Vignolles, between the lignites and the Mercin sands, similar to those of Cuise, as a proof of an interruption in the deposition, or a lacuna; these pebbles having been produced

¹ Bull. de l'Acad. Roy. de Belgique, t. xix.

during the return of the sea after an emersion of greater or less duration.

The Oldhaven beds which underlie the London Clay are also wanting in the Paris basin, nor have they any representative in the Belgian area.

2. (c). *Upper Yprésien and Panisélien.—Sands of Cuise.—Lower Bagshot Sands.*

Above the Clay of Flanders (Lower Yprésien) are the argillaceous sands of the Upper Yprésien, terminated by fossiliferous beds which are characterized by species of the sands of Cuise, among which are *Num. planulatus*, Br.; *Turr. edita*, Sow.; *T. hybrida*, Desh.; *Crassatella propingua*, Wat.; *Lucina squamula*, Desh. It is above the last beds with *Num. planulatus* that M. Hébert defines the upper limit of the Lower Eocene. There is also so much analogy both mineralogically and palæontologically between the Upper Yprésien and Panisélien, that he considers they ought to be united in a single group.

This reunion into a single stage of the Upper Yprésien and Panisélien, and the general correspondence with the part of the sands of Soissons which is superior to the lignites, that is, the sands of Cuise, has long since been made by Mr. Prestwich,¹ and although some doubt, and even difference of opinion, has been expressed by the Belgian geologists on this point, M. Hébert is of the same opinion as Mr. Prestwich.

Thus there are three great marine faunas, that of Bracheux, that of the London Clay, and that of the Cuise Sands; these, however, are not equally developed throughout the whole area, in consequence of the physical changes and oscillations of level which the surface has undergone during the whole period of their formation.

3. *Strata comprised between the Bracheux Sands and the Chalk.*

These are divided into different beds by M. Hébert, as shown in the Table below, commencing with the lowest or *Calcaire de Mons* reposing on the eroded surface of the White Chalk, and containing a rich marine fauna resembling, but differing from specifically, that of the *Calcaire grossier*, as well as some land and freshwater genera; its equivalent is wanting in the Paris basin. These beds underwent denudation prior to the deposition of the Lower Heersien sands, during which the conglomerates of Nemours and Rilly were formed.

The Lower Heersien sands of Belgium are considered to be equivalent to the Rilly sands of France, and the Upper Heersien sands as equal to the Rilly limestone, so rich in land and freshwater mollusca, and the strontian-bearing marls of Meudon. The overlying Heersien marine marls of Belgium are represented in the Paris basin by the conglomerate of Meudon and the marls of Dormans; these marls and all the underlying strata, according to M. Hébert, being below the Bracheux sands, and forming the lower group of the Lower Eocene strata.

¹ Quart. Journ. Geol. Soc. vol. ii. 1855.

The following abstract gives M. Hébert's views respecting the correlation of the Lower Eocene strata, but which are not in accordance with other geologists, including Mr. Prestwich, whose opinion will be found in "Memoire sur la position géologique des sables et du calcaire lacustre de Rilly" (Marne), Bull. Soc. Géol. France, 2 ser. tom. x. p. 300; and also "On the Structure of the Strata between the London Clay and the Chalk in the London and Hampshire Basin" (Quart. Journ. Geol. Soc. 1853, vol. 6, p. 252, and 1855, vol. 8, p. 255).

TABLE SHOWING THE SYNCHRONISM OF THE LOWER EOCENE IN THE BASINS OF PARIS, BELGIUM, AND ENGLAND.

		PARIS BASIN. Lower Calcaire Grossier.	BELGIUM. Bruxellien.	ENGLAND. Bracklesham.
LOWER EOCENE.	UPPER GROUP.	Sands with <i>Nummulites planulatus</i>	Panisélien	Lower Bagshot Sands. London Clay. Oldhaven Beds. Woolwich Beds. Thanet Beds.
		Sands without fossils	Upper Yprésien.	
		Wanting	Clay of Ypres	
		Wanting	?	
		Plastic clay and Lignites	Upper Landénien	
		Sands of Bracheux	Lower Landénien	
		DENUATION.	DENUATION.	
	LOWER GROUP.	Marl of Dormans.	Heersien Marine Marls.	} Wanting.
		Conglomerate of Meudon. } Calcaire de Rilly, Strontian Marls of Meudon		
		Sands of Rilly.....	Upper Heersien Sands .	
Poudingue de Nemours		Lower Heersien Sands .		
Wanting		Gap and Denudation		
	Calcaire de Mons			

General remarks.—It is to be observed that during the period corresponding to the lower group of the preceding table, the basin of Paris as well as that of Belgium have undergone considerable denudation, so that the deposits of this period no longer exist as continuous strata, but only as outliers, as is shown by the limestone of Mons, the Heersien marl, the Rilly limestone, etc. These districts have been, during the early Tertiary period, the seat of oscillations, by which they have been alternately emerged and submerged. In the stationary interval of these movements deposits have taken place, but the incoming and retiring waters have carried off the greater portion of these deposits.

It had been the same at the close of the Cretaceous period. The different strata of the Upper Chalk (*Craie Supérieure*) posterior to the chalk of Meudon,—the chalk of Cibly, the Maestricht chalk, the pisolitic limestone, have been deposited and denuded under similar conditions to those above described. It is the cause of the numerous lacunæ that are observed, specially in the Paris basin, in the transition from the Cretaceous to the Tertiary period. M. Hébert points out that he has frequently shown how the sea, at the time of the Chalk of Meudon, the Upper Chalk and Lower Eocene, penetrated into the Paris basin by Belgium. The basin of Paris at these periods was

a gulf dependent on the North Sea, the opening to which was between the Ardennes and the Boulonnais, already elevated above the sea level. It is thus natural, as we advance to the North Sea, that the lacunæ will be less. Belgium would furnish an intermediate term, and it is one of these terms that MM. Cornet and Briart have described. If we could explore the bottom of the North Sea, other terms would appear, for Belgium itself only increases the number of lacunæ.

But that which we call the North Sea is still only a gulf, having a communication with the ocean between the Shetland Isles and Norway; this gulf has undergone oscillations, and has perhaps been sometimes dry land. The complete continuity between these deposits cannot be well recognized, and it will be necessary to seek them in the great oceanic depressions.

However it may be, we conceive that certain species of the pisolitic limestone, the *Voluta robusta* for example, have continued to live in the North Sea, and returned to live in Belgium with new species at the period of the Mons limestone. The sea at this time, or a little after, penetrated into the Paris basin, leaving there some slight marine sediments, as those at the base of the Rilly sands; and after its departure, when the basin was transformed into a lake, some species, as *Cerithium inopinatum*, and a genus near to *Liotia*, lived in the brackish waters of the environs of Paris at the time when the eastern part of the basin became a lake, the lake of *Physa gigantea* and *Paludina aspersa*.

It is scarcely possible, in our present state of knowledge, to believe otherwise. We see the intimate relations there are between the Rilly limestone and that of Mons.

The basin of Mons has doubtless been emerged, and the limestone denuded before the incoming of the fresh water, which is shown by the older Heersien deposits. It remains to be proved if the fauna of these waters was similar to that of Rilly. These have been replaced by marine waters at a time which appears to correspond to the formation of the conglomerate of Meudon; and during the deposition of the white calcareous marls with *Pholadomya cuneata*, the white calcareous marls of Dormans without fossils would be deposited in the Paris basin.

It is only after this succession of deposits that the invasion of the sea of Bracheux occurred, with its sands and rolled pebbles, eroding the Heersien system and the more ancient deposits of the Mons basin, as the marls of Dormans, the Rilly limestone and the underlying beds in the Paris basin, and forming an horizon well defined, above which the stratification becomes clear and undoubted.

“In returning to this subject,” says M. Hébert, “after an interval of twenty years, I can only confirm my former opinion respecting the Rilly limestone, and surely if the facts discovered during this period tend to prove I was then in error, I should readily recognize it, as I prefer to correct myself rather than be corrected by others; but before all I prefer to see truth established on a solid base, even if it should be at my expense.”

J. M.

IV.—BRIEF ABSTRACTS.

DAVEY, E. C. The "Sponge-Gravel" Beds at Coxwell, near Faringdon; with an Appendix on Cole's Pits. Paper contributed to the Newbury Field Club. 8vo. pp. 14. 19 photographic illustrations (18 of fossils). *Wantage*, [1874].

The "Sponge-Gravel" (Neocomian) crops out over a space of about a mile by a quarter of a mile, and is from 25 to 40 feet thick, forming a plateau based on Kimmeridge Clay, and capped in places by dark ironsand. The bed is a conglomerate of sand and fossils, mostly hardened by a ferruginous cement, and according to some authorities must have been accumulated in a deep clear sea, with currents; whilst others take it to have been deposited in a shallower and more sheltered sea.

There are two large and three small pits, some of which have been worked for a great time, being mentioned by Llwyd (who collected fossils from them) in 1698. In later times they have been the subject of much controversy, having been classified as Lower Greensand, Upper Greensand, and top Chalk (= Maestricht Chalk). The author thinks that Sharpe was led to take this last view from the abundance of Polyzoa; but he finds that of the half hundred species found at Coxwell, not half a dozen occur at Maestricht. He questions also whether there is a single species of Sponge common to the two beds, believing that the *Manon peziza* and *M. pulvinarium* of each are really distinct.

It is now allowed that these fossiliferous gravels belong to the Lower Greensand, or Upper Neocomian, and on these grounds: 1. Similarity with Lower Greensand, at Seend, Godalming, Upware, and Potton. 2. Presence of Lower Greensand Brachiopoda and Echinodermata. 3. Infraposition to the Lower Greensand ironsand of Furze Hill. 4. Dissimilarity from Upper Greensand, which is fairly developed in the neighbourhood.

The fossils are of two sorts—those that lived on the spot, and those derived from beds of Oolitic age. The latter can be distinguished by colour and condition, and they are chiefly the remains of vertebrates; the former are Sponges, Polyzoa, Echinoderms, and bivalve Molluscs, the absence of univalves being remarkable. The Sponges are most important, both as forming a large part of the gravel and from their good preservation. Sharpe names 16 species; but the author would eliminate from his list *Manon Faringdonense* and *Spongia Trigeris*, adding *Scyphia multidigitata*, Mich., and *Manon marginatum*, Goldf. (*Porospongia*, D'Orb.), and altering the name of *Manon pulvinarium*. *Chenendopora fungiformis* is also questionable. These 16 species differ much in form and size; some are funnel-shaped, some are single cylinders, some clusters of slender pipes, and some are solid, etc. Five characteristic sorts are illustrated, by descriptions of *Verticellites anastomosans*, *Tragos Faringdonensis*, *Manon marginatum*, *M. macropora*, and *M. porcatum*.

By the name of "Cole's Pits" is known a number of old overgrown excavations in sand and conglomerate (Neocomian), extending

over fourteen acres, which have been thought to have been the remains of habitations of an early British race, the largest being assigned to no less a person than "King Cole." The author shows that this view is untenable, and that the pits are only the remains of old workings for sandstone and ironstone, as remarked by Godwin-Austen.

W. W.

WALKER, H. The Glacial Drifts of Muswell Hill and Finchley. With Map, Sections, and other Illustrations. pp. 24. London, [1874].

The author describes the various sections of gravel and Boulder-clay at Muswell Hill and Finchley. In accounting for the origin of these beds, he says that at Finchley we see the material of a moraine which has been extended beneath the sea from the land-ice, and distributed, by means other than that of moving water, over the sea bottom; and he also states that the original moraine-form may still be seen in the deposit. He adopts Mr. S. V. Wood's, jun., theory as to the direction whence the glacial clay was brought to Finchley, viz. from Lincolnshire, by a glacier probably 1000 feet thick, ploughing out materials from the Trias, Lias, Oolite, Neocomian, and Chalk, and which had its terminal moraine at Finchley, containing relics of most of these beds.

F. J. B.

REVIEWS.

LE PLESIOSAURUS DOLICHODEIRUS, CONYB., DU MUSÉE TEYLER.

Par T. C. WINKLER. (Haarlem, 1873.)

THE Teyler Museum, so rich in fossils of all kinds, especially those from the lithographic stone of Bavaria, the Oeningen marls, and the Maestricht Chalk, has recently acquired a very fine specimen of the *Plesiosaurus dolichodeirus* from Lyme Regis, which has been carefully described and illustrated by the indefatigable curator, Dr. Winkler, in the third part of vol. iii. of the Archives of the Museum. This, the earliest noticed species, and upon which the genus was founded by Conybeare, was first discovered in a nearly entire state in 1824, and described and figured in the Geol. Trans. (2 ser. vol. ii.), and subsequently by Cuvier in the Ossements fossiles (tome v. 2me. partie). Previous to the discovery of this nearly entire skeleton, remains of the genus had been noticed by Conybeare and De la Beche in 1821 (Geol. Trans. 1 ser. vol. i.), and in the same work (2 ser. vol. i.).

Dr. Winkler's specimen presents the vertebral column entire, some bones of the skull, and the half of the lower jaw, the ribs broken and displaced, the anterior limbs nearly entire, many bones of the posterior limbs, and portions of bones of the pectoral arch and pelvis; the length is about 382 metres. There are 90 vertebræ, of which 38 are considered to be cervical,¹ 21

¹ Prof. Huxley remarks: "The cervical vertebræ may exceed forty in number, though they are generally fewer; and as none of the ribs appear to have been con-