

TRANSACTIONS
OF THE
ESSEX FIELD CLUB.

EDITED BY
WILLIAM COLE, HONORARY SECRETARY.

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*"Come forth into the light of things,
Let Nature be your teacher."*—WORDSWORTH.

THE AUTHORS ONLY ARE RESPONSIBLE FOR THE STATEMENTS AND
OPINIONS CONTAINED IN THEIR RESPECTIVE PAPERS.

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TRANSACTIONS
OF
THE ESSEX FIELD CLUB.¹

I.

THE ANCIENT FAUNA OF ESSEX.

By HENRY WOODWARD, LL.D., F.R.S., F.G.S.,
Keeper of the Department of Geology, British Museum (Natural History).

[A Lecture delivered to the members of the Club, at the British Museum of Natural History, South Kensington, on Saturday, May 13th, 1882.]

THE Essex Field Club is fortunate in being located in a suburban district where an open space is reserved of a larger extent than that of all the parks and pleasure-grounds of the metropolis united. Six of the larger parks combined do not contain more than 1800 acres, whereas Epping Forest still claims between five and six thousand acres. To your Society now belongs in some degree the task of jealously guarding for the public that wide tract of woodland which has been so munificently bestowed on the people of London. The trees and wild plants need friendly care and fostering, and if, as it is to be hoped, our native song-birds and animals are to have a fair chance of existence, "nor gun, nor snare, nor limed twig" should be permitted by the Conservators and Verderers within their domains.

¹ [Much inconvenience having been occasioned in cataloguing and referring to our publications by shortened titles which by no means represent the scope of the Society, the Council has authorised the Editor to use the above words in future in the 'Transactions' and other issues of the Club. Writers and cataloguers making references to our publications are requested to quote them as "Transactions" or "Proceedings" (as the case may be) of "The Essex Field Club," the present part being the commencement of the *third* volume.—ED.]

Even among the members of a Naturalists' Field Club there is at times no doubt a tendency to become the unintentional extirpators of some rare plant or insect when the resort of the one or the *habitat* of the other has been made public in its Proceedings.

But there must always be a wide distinction drawn between the true Naturalist and the ordinary collector. I earnestly trust that you all belong to the former type, and, if you collect, you will be careful not to exterminate a species for the mere purpose of obtaining duplicates for exchange.

I wish now briefly to refer to the historical records of Epping Forest and the neighbouring area, so far as I have been enabled to gather them.

So lately as A. D. 1700 the entire tract between the rivers Roding and Lea was forest-land, the greater part covered with timber.

In the Notes to Bowen's Map of Essex (1748) it is stated, "Epping Forest was formerly of very large extent, but its limits were settled and restrained by Act of Parliament (17 Car. I.), according to which regulation it is now about fourteen miles long and ten broad. 'Tis full of game, and well stocked with deer, said to be the largest and fattest in the kingdom."

Epping Forest, with the neighbouring forest of Hainault, which was disafforested about thirty years ago, was originally called the Forest of Essex, or the ancient Royal Forest of Waltham. It is said to have extended at one time over a very vast district, including in the reign of Henry III. (1228) almost the entire county of Essex; while in the reign of Edward I. (1298-1300) the perambulation, if correct, comprised lands running down to the townships of Havering, Dagenham, Barking, and other places in the neighbourhood of the Thames. In the reign of Henry II. (1154), the Forest of Middlesex extended from Houndsditch to about twelve miles north of London, and belonged to the Corporation of the City of London. The Forest is described as abounding in Wolves, Wild Boars, Stags, and Wild Bulls. So late as the time of Henry VI. (1485), Wolves were met with

there. This tract was not disafforested until 1777 (17 Geo. III. c. 17). Chapman and André's Map of Essex (1777) is the earliest accurate map of this county, and shows at least a portion of the tract under consideration still covered with forest-trees, and styled "Walthamstow Forest." Indeed so late as the first Ordnance Survey Map (published in 1805) the "Lower Forest" extended close to Maryland Point, Stratford.

Turning from the written evidence of the Epping Forest district, it is of no small interest to ascertain what can be learnt from the unwritten records of prehistoric times which have been preserved to us in the ancient and modern river-valley deposits, the brick-earths, shell-marls, and peat, so characteristic of large portions of this area. Bearing in mind the former continuity and extent of Epping and Walthamstow Forests, and the very recent date at which a large part of this area has been enclosed and cultivated, we can the more readily understand how it has happened that such interesting prehistoric remains as are here met with, only a few feet below the surface, have remained hidden for so many centuries, undisturbed by that most restless of all beings—Man,—to be unearthed at this time, when their interest can be appreciated and their significance understood.

The best illustration of the remains of the more recent fauna of the river-valleys of the Lea and the Roding was that exposed in the district of Walthamstow, which, in 1868-69, was laid bare by the East London Water-works Company in preparing their large filter-beds and reservoirs, which extended from the Lea Bridge Road in a northerly direction beyond Tottenham Railway Station, and occupied at that time the area marked on the maps as Walthamstow Forest. Their works in 1869 covered more than one hundred acres, the depth of the general floor nowhere exceeding ten feet; but the trenches made for the "puddled walls" in the centre of the artificial embankments went down to a depth of twenty to twenty-four feet. The subjoined sections, taken by me in the summer of 1869, will serve to show the nature of these deposits:—

Sections exposed during the construction of the Reservoirs of the East London Water-works Company, at Walthamstow.

Fig. 1.—Section at the South-east corner of the Eastern Reservoir:—

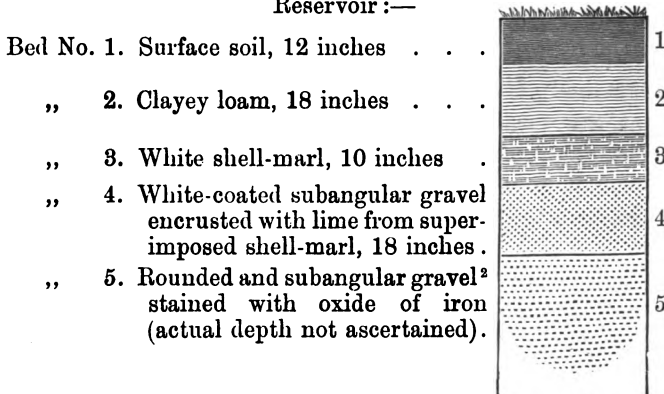
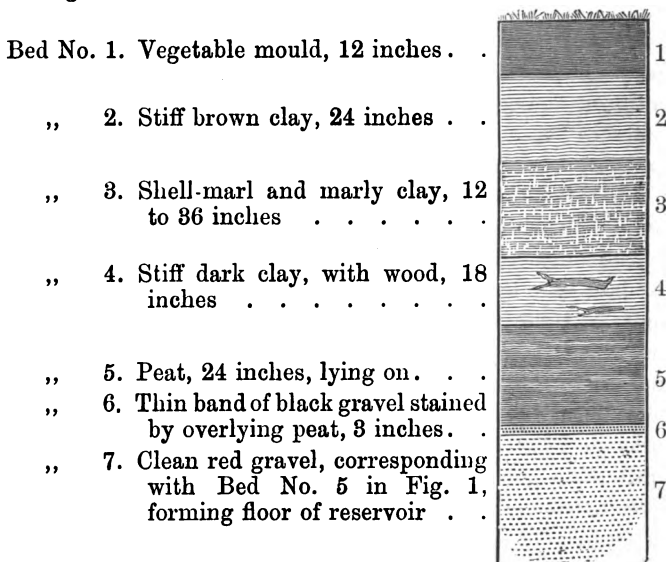
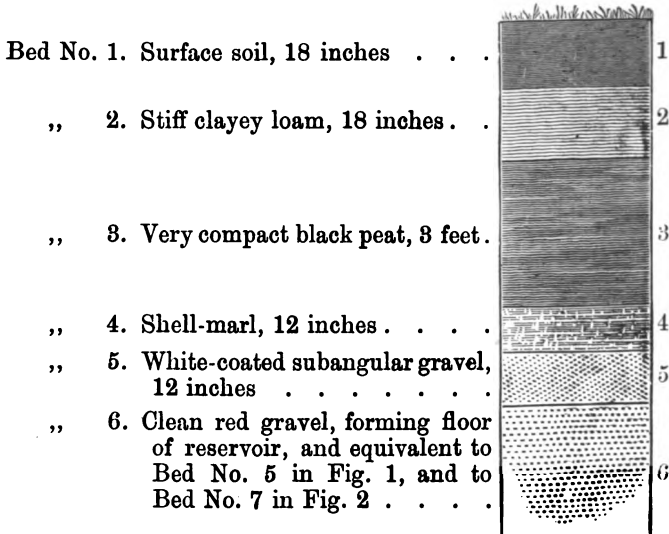


Fig. 2.—Section at South-west corner of Reservoir:—



² This gravel (No. 5), which forms the floor of the reservoir, is of very considerable thickness. At one spot, where pumping for "pudding" had been going on, a hole more than ten feet in depth from the surface of the gravel-bed still showed the same gravel with abundance of water.

Fig. 3.—Section in the Eastern Reservoir, and near the Embankment between the Eastern and Western Reservoirs:—



The beds above the shell-marl, and in some parts of the area those below it also, contained abundant remains of old forest vegetation; large areas of the upper loamy and peaty beds, where exposed in the course of the works by the removal of the more superficial layers, exhibiting the ancient remains of trees with their spreading roots still *in situ*, but in most instances converted into lignite and coated with bog-iron ore. Hazel-nuts were also abundant, and one could easily detect evidences of the presence of the oak and the alder. Other trees were probably present, and could no doubt have been determined by a microscopic examination of their wood. The peat, especially in Section No. 3, was exceedingly stiff and compact.

The shell-bed on the Eastern and Northern sides of the area exposed, exhibited many instances of oblique lamination, indicative of currents and a winding river-course. Most of the bivalve shells had their valves united, the *Uniones* reposing in their natural position as in life; whilst the opercula remained in the apertures of many of the *Paludina*.

The following is a list of the land and fresh-water shells which were obtained by me from the shell-marl at the Reservoirs of the East London Water-works Company, Walthamstow Marshes, Essex:—

<i>Helix hortensis</i> , Müller.	<i>Linnea truncatula</i> , Müll., sp.
„ <i>nemoralis</i> , Linn.	<i>Planorbis corneus</i> , Linn., sp.
„ <i>arbustorum</i> , Linn.	„ <i>carinatus</i> , Müll., sp.
„ <i>ericetorum</i> , Müll.	„ <i>vortex</i> , Linn., sp.
„ <i>caperata</i> , Montf.	<i>Ancylus fluviatilis</i> , Müll., sp.
„ <i>hispida</i> , Linn.	<i>Valvata piscinalis</i> , Müll.
<i>Succinea putris</i> , Linn.	<i>Bithinia tentaculata</i> , Linn.
<i>Zua lubrica</i> , Müll.	„ <i>ventricosa</i> , Gray.
<i>Clausilia bidens</i> , Müll.	<i>Neritina fluviatilis</i> , Linn.
<i>Linnea stagnalis</i> , Linn.	<i>Unio tumidus</i> , Retz.
„ <i>peregra</i> , Müll., sp.	„ <i>pictorum</i> , Linn.
„ <i>auricularia</i> , Linn., sp.	<i>Pisidium amnicum</i> , Müll.
„ <i>palustris</i> , Linn., sp.	<i>Cyclas cornea</i> , Linn.

Besides the Mollusca, the peat and shell-marl together yielded many evidences of man and his works. There were numerous skulls and portions of skeletons of both historic and prehistoric Britons, and remains of weapons showing the same variety of date. There were also found bronze spears and arrow-heads, a bronze knife, a bronze handle of a late Celtic dagger, and various examples of late Celtic earthen pots (some hand-made, and some turned with a wheel); and lastly, a flint scraper which I extracted myself from an undisturbed bed of dark loamy clay, three feet below the surface.

List of Mammalian and other remains obtained from the peat and shell-marl at the Reservoirs of the East London Water-works Company, Walthamstow Marshes, Essex (1869):—

MAMMALIA.

- Man.—By his osseous remains, and implements in stone, bone, bronze, and iron.
- Canis lupus*, Linn. The Wolf.—Common.
- Vulpes vulgaris*, Briss. Fox.—Not common.
- Castor europæus*, Owen. Beaver.—Several examples.
- Equus caballus*, Linn. Horse.—Abundant.
- Sus scrofa-ferox*, Linn. Wild Boar.—Abundant.

- Cervus elaphus*, Linn. Red Deer.—Abundant, of all ages.³
 ,, *capreolus*, Linn. Roebuck.—Not common.
 ,, *dama*, Linn. Fallow Deer.—One antler (probably recent).
 ,, *tarandus*, Linn. Reindeer.—Antlers, rare.
Alces palmatus (*C. alces*), Linn. Elk.—Rare.
Capra hircus, Linn. Goat.—Abundant, many skulls of kids.
Bos primigenius, Boj. Gigantic Ox.—Not common.
 ,, *longifrons*, Owen. Small Ox.—Common.
 ,, *frontosus*? Nilss.—Rare.

AVES.

- Haliastur pelagicus*. Sea Eagle.—(Tibia) Rare.
Sp.?—A few bones.

PISCES.

- Sp.*?—(Vertebræ, &c.) Rare.

From the lower beds reached in excavating for the “ puddle-wall ” were obtained :—

- Elephas primigenius*, Blum.—Portions of tusk and molar tooth.
Bos primigenius, Bojanus.—Head and horn cores.
Cervus strongyloceros, Owen.—Base of a gigantic antler.

The most interesting of the animal-remains from these later deposits are :—The Roebuck (*Cervus capreolus*), the Wild Boar (*Sus scrofa-ferox*), the Wolf (*Canis lupus*), the Gigantic Ox (*Bos primigenius*), the Elk (*Alces palmatus*), the Reindeer (*Cervus tarandus*), and the Beaver (*Castor europæus*).

The Roebuck is now confined to Scotland, but it was formerly as widely distributed as the Red Deer through our English Forests.

The Wild Boar⁴ is now exterminated in this country ; but, judging by its remains, it was once most abundant in the forests of Essex.

The Wolf⁵ has also been entirely killed out in this country. Its remains prove that it was very abundant in Walthamstow Forest.

³ The antlers and tynes of the Red Deer were in many instances cut previously to their having been imbedded.

⁴ See Harting's ' Extinct British Animals,' 8vo, 1880, pp. 77—114.

⁵ *Op. cit.*, pp. 115—205.

The Gigantic Ox (*Bos primigenius*) is quite extinct as a species. The Reindeer and the Elk, though killed off in this country, still survive in Norway, Siberia, and in North America.

The Beaver, once common in many parts of England, Scotland, and Wales, as is proved by its fossil remains in our peat deposits, has also given its name to many places, as "Beverley," in Yorkshire; "*Llyn-yr-afange*," or the Beaver's Lake; "*Nant-yr-afancwm*," or the Vale of the Beavers; &c. It was very abundant at Walthamstow, and elsewhere in Essex and Cambridgeshire.⁶

The only European Beavers now met with are said to inhabit the lowlands near the mouths of the Danube and Volga; and in some of the rivers which take their rise in the Ural Mountains. Its antiquity is proved not only by its wide geographical range through Europe and North America,—as far as Vancouver's Island; but also from the fact that both in America and in this country it was represented at an earlier period by a gigantic predecessor, the *Trogontherium cuvieri* from the Norfolk Forest Bed, and the *Castoroides ohioiticus* from Ohio, U.S.A.

I should like to say a few words with regard to the Beaver. The Beaver was found in considerable numbers at Walthamstow, and equally so through the Fen-land of Cambridge, at Copford in Essex, and in fact all through our Eastern counties. There can be no doubt, I think, from an examination of the peat-deposit and the large quantity of trees not connected with stumps, that the Beaver must have lived here for a very long time; and wherever the Beaver lived, there it is sure to have constructed dams. I believe that the Beaver had been in this district, as he is now in America, an important geological agent. His work, while producing enjoyment to himself, is eminently destructive to the district which he

⁶ Some account of the European Beaver will be found in Owen's 'British Fossil Mammals and Birds,' 8vo, 1846, pp. 190—200; and Harting's 'Extinct British Animals,' 8vo, 1880, pp. 33—60. The *Trogontherium* is described by Owen, Brit. Foss. Mamm., pp. 185—189; and Geol. Mag., 1869, vol. vi., pp. 49—56. See also Dr. H. Woodward, Geol. Mag., 1869, vol. vi., pp. 69 and 388.

occupies. Every stream is converted by the Beavers into a series of falls with beaver-dams, and large, deep, clear, still pools of water. It is evident that, if ever a big flood came down such rivers, these beaver-dams would be quite calculated to cause an overflow and an inundation of the Forest for miles around. Many of the forest-trees could not stand this excessive damp, and would give way to *Sphagnum* or bog-moss; and large tracts thus flooded would be converted into peaty, marshy fen-land. That I believe to be the origin of the fen-lands over a great part of our Eastern counties. Of course, geologically, there is another aspect of the question which we must not omit to mention; that is, the strata in this area are of a soft clayey, chalky, or sandy character, and lend themselves admirably to the action of denuding agents: but I have no doubt that the Beaver helped these agents most effectively. By damming back the water of its streams it destroyed the Forest, and converted it by degrees into a primitive marsh.⁷

We must now pass from the consideration of the series of deposits characterised by the fauna nearest to that existing at the present day to those belonging to an earlier date, but which are also found in the valleys of the Thames, the Lea, and the Roding, and which underlie the more superficial deposits of which we have already spoken. They consist mainly of gravels, sands, and brick-earth, and are all of fluviatile origin, being marked by the presence of land and

⁷ "The flow of streams is sometimes interfered with, or even diverted by the operations of animals. Thus the Beaver, by cutting down trees (sometimes one foot or more in diameter) and constructing dams with the stems and branches, checks the flow of water-courses, intercepts floating materials, and sometimes even diverts the water into new channels. This action is typically displayed in Canada and in the Rocky Mountain regions of the United States. Thousands of acres in many valleys have been converted into lakes, which, intercepting the sediment carried down by the streams, and being likewise invaded by marshy vegetation, have subsequently become morass, and finally meadow-land. The extent to which, in these regions, the alluvial formations of valleys have been modified and extended by the operations of the Beaver is almost incredible" (Geikie's 'Geology,' p. 455). See also 'The American Beaver and his Works,' by Lewis H. Morgan, Philadelphia, 1868.

fresh-water Mollusca, and the bones of land animals. These deposits are well seen at Ilford, and similar deposits are found at Crayford, Erith, and Grays. In these older deposits it will be seen that the Thames Valley gravel overlies the yellow sand and brick-earth. The age of these yellow sands and clayey brick-earths is very well marked, for they everywhere contain that most characteristic bivalve shell—*Cyrena fluminalis*.⁸ It is excessively interesting to note that this little mollusk is now known only as an inhabitant of the River Nile, so that its distribution was once very much wider over Europe than at present. It no doubt indicates a great



Fig. 4.—The Musk-Ox (*Ovibos moschatus*), now only found living on the treeless barrens of Arctic America and Asia. It was shot on North Grinnell Land during the last Arctic voyage of the 'Alert' and 'Discovery.' Its remains have been found at Maidenhead; at Green Street Green, in Kent; at Crayford; and Grays. [Reproduced, by permission, from the Guide Book to the Geological Department in the British Museum of Natural History.]

geological and climatic change, and most certainly marks the lapse of a long period of time. In the brick-earth we become acquainted with a land-fauna of which only a stray form or two now exist. Thanks to the researches of Sir Antonio Brady and others, we are able to record from these brick-

⁸ *Cyrena consobrina*, Caill. Voy. Egypt, 2, t. 61, fig. 10, 11. Morris, Cat. Brit. Foss., 1854, p. 199.—Grays, Ilford, Erith.

earths the remains of the Lion, the Bear, the Mammoth, the Straight-tusked Elephant, the Small-nosed Rhinoceros, the fossil Horse, the Gigantic Irish Deer, the Bison, the Reindeer, the Musk-Ox (fig. 4), the Elk, the Marmot, the Fox, and the Red Deer; and to this list might be added from other localities of similar age, the Hyæna, the Sabre-toothed Tiger, the Antelope, the Glutton, the Gigantic Beaver, the Southern Elephant, and Sedgwick's Deer—a very large Deer with branching antlers, which, with the Gigantic Beaver and *Elephas meridionalis*, occur in the Norfolk forest-bed. If we divide these animals into groups, we shall find first a series from the South, such as the Sabre-toothed Tiger, the Cave Lion, the Hyæna, the Straight-tusked Elephant, the Southern Elephant, the *Rhinoceros leptorhinus*, *Rhinoceros megarhinus*, and the Hippopotamus. Then there are a number of Eastern forms, such as the Lynx, the Mammoth, the Woolly Rhinoceros, the Gigantic Ox, the Bison—which now remains preserved by the Emperor of Russia in Lithuania—and the Brown Bear; for my colleague, Mr. Wm. Davies, F.G.S., informs me that a subsequent examination of these remains of the Bear from Ilford proved them to belong to the Brown Bear, *Ursus ferox*, and not the old species, *Ursus spelæus*. Then we have a number of extreme Northern forms associated in this same series of brick-earths, such as the Musk Ox, the Reindeer, the Elk, the Marmot, the Lemming, the *Lagomys*, and the Glutton. The Pouched Marmot, *Spermophilus*, occurs in the Thames Valley. The Lemming and the Tailless Hare have not yet been found here, but in the valley of the Avon; the Glutton, another Arctic form, has been found in the caves of Banwell, Bleadon, and Gower. The Sabre-toothed Tiger⁹ does not occur in Essex, but it has been found in Norfolk associated with the Gigantic Beaver. Then, in addition to those animals which have come from the South, the East, and the North, there are certain forms—the

⁹ The range of the *Machairodus* or Sabre-toothed Tiger is truly remarkable. Its remains have been obtained from South America; from British and French caves; from Epplesheim; from the Val d'Arno, Italy; and from the Sewalik Hills, in India (see fig. 7, p. 15).

Gigantic Beaver, the Gigantic Irish Deer (fig. 5), Sedgwick's Deer, the Red Deer (still living), the Horse, and the Fox.

It would be interesting if we could by any possibility picture to ourselves the conditions of life, and the conditions of



Fig. 5.—Skeleton of Gigantic Irish Deer *Cervus (Megaceros) hibernicus*, Owen. Met with in the shell-marls and clays beneath the peat-bogs in Ireland. [Reproduced, by the courtesy of Messrs. A. and C. Black, from Prof. Owen's 'Palæontology,' p. 405.]

climate in Britain under which animals of such varied characters lived, the remains of which are met with in a single series of deposits such as the Thames Valley affords! We cannot avoid the conclusion that a very great change must have

taken place in the physical as well as the climatic conditions of this country to enable animals of such varied habits, many of whom possess strong migratory instincts, to have inhabited our Island. It seems absolutely necessary that we must carry back the period at which these animals lived, to a time when our Island was not separated from the Continent, as it now is, but when the North Sea and the Straits of Dover were all closed and formed one solid stretch of land, passing from the Humber across to Heligoland and the coast of Denmark, and also from Norfolk to Holland and from Dover to France. Then again, the southern portions of our island must have been connected with Brittany. It would only require an elevation of six hundred feet to connect England with Ireland,—and someone has said that it would be a very happy event if we were so connected with Ireland now, because then the people could not clamour, as they are doing, for separation. The Rhine, the Meuse, and Moselle must have, at that time, all flowed northward. But what is most interesting is, that there are certain banks very well known to the fisherman, where good dredging is done, and good trawling,—particularly the one known as the “Dogger Bank,”—which have yielded, from the beginning of this century up to the present time probably many thousand remains of the true Mammoth, *Elephas primigenius* (fig. 6), the one which in past times spread over the whole of Northern Europe, and whose remains have been found so abundantly in the frozen mud-cliffs described by Kotzebue; and also along the Lena, the Yenisei, and all the Northern rivers which have their embouchure into the Arctic Sea. The remains of these animals are no doubt spread out over a vast extent of the floor of what is now the North Sea, and the fishermen were in the habit of bringing to Yarmouth, together with the fish, the remains of the Mammoth which they had dredged up.¹⁰ Mr. J. J. Owles,

¹⁰ Mr. Samuel Woodward (Author of the ‘Geology of Norfolk,’ and father of the writer) records that no fewer than 2000 Elephant-grinders had been dredged up from the Oyster-bed off Happisburgh, Norfolk, by the fishermen between 1820 and 1833. See also Falconer’s ‘Palæontological Memoirs’; 1868, vol. ii., p. 204.

of Yarmouth, has paid great attention to this subject, and has made a very large collection, which is now in the south-east gallery of this Museum; forming a most striking series of the remains of the Mammoth, comprising an enormous number of tusks as well as molar-teeth.¹¹ Many of the tusks are of great

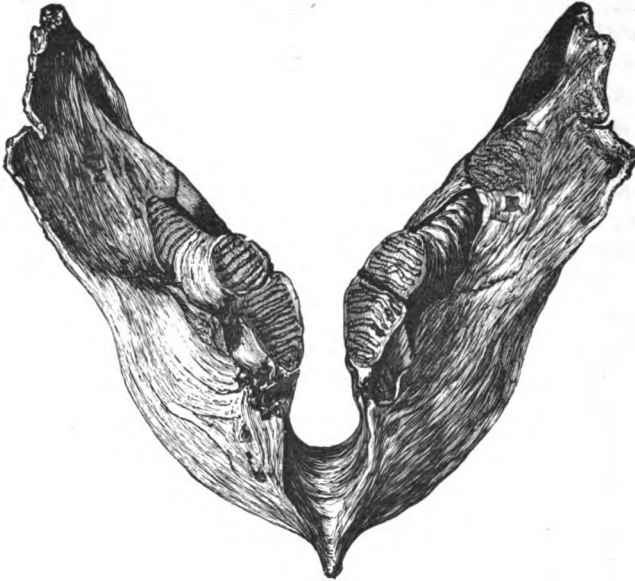


Fig. 6.—Lower Jaw of Mammoth (*Elephas primigenius*) dredged off the Dogger Bank, in the North Sea, 1837. (See *Geol. Mag.* 1878. Decade II. vol. v., pl. xii., p. 443). The original is preserved in the British Museum (see Pier-case 16). [Reproduced, by permission, from the Guide to the Geological Gallery of the British Museum.]

length and singular curvature; they all exhibit a double twist, and this is the characteristic of all the specimens of the Mammoth-tusks found in Siberia. This mausoleum of the Mammoth is also rich in remains of the Reindeer, the Gigantic Ox, and other animals; and all along the coast have been found abundant evidences of *Elephas meridionalis*, the

¹¹ See an interesting paper on the Pleistocene Mammals dredged off the Eastern Coast, by Wm. Davies, F.G.S. *Geol. Mag.* 1878. Decade II., vol. v., p. 97.

Woolly Rhinoceros, the Big-nosed Rhinoceros, the Gigantic Beaver, and many other of the animals already mentioned, including the Sabre-toothed Tiger, which has also been found at Kent's Cave, Torquay; so that we have evidence in two places at least of its occurrence. An elevation of six hundred feet would change not only the physical conditions of our island, but also its climate. Instead of that variable mildness which now characterises our winter season, we should have then a more Continental climate, more severe cold would be experienced in winter, and also a greater heat in summer. Then, too, it must be remembered that our highlands would be standing at a greater elevation. Our Scotch mountains, instead of every year shedding their mantle of snow, would at that period have retained snow all the year round; the Welsh mountains would also have been deeply immersed in snow, and probably have remained covered during the whole year. The great valley of the North Sea at that time would have formed a grand grazing ground for the herds of Elephants, Reindeer, Wild Horses, and other large herbivores; whilst the Sabre-toothed Tiger, the Lion, the Bear, the Hyæna, and Wolf, would have had ample opportunity for following their calling in the same area. My colleague, Mr. William Davies, has made an interesting suggestion as to the cause of the paucity of the remains of the Carnivora in these deposits. We seldom find remains of these carnivores: we meet with a fragment here and a fragment there, but they bear no proportion to those of the herbivores. The explanation



Fig. 7.—Skull of the Great Sabre-toothed Tiger (*Machairodus*), from the Newer Tertiary deposits of South America. [Reproduced, by permission, from the Guide to the Department of Geology in the British Museum.]

seems to be this: these animals were not only more active, but the majority of them were nocturnal in their habits; and no doubt when the Herbivora were overtaken by floods it was frequently in the night when they were asleep—just the time when the Tigers, Lions, Bears, and Wolves would be wide awake; and they would probably get up the nearest tree or escape to the higher ground, or some other suitable place, and so avoid the catastrophe. And, indeed, many of them must have escaped, or we should have a far larger proportion of their remains; though it must always be borne in mind that one pair of Lions or one pair of Bears occupied a very large tract of country; and therefore we should not expect them to be in such numerical abundance as the Herbivora on which they fed.

It may be interesting to inquire how it happens that the remains of both northern and southern forms are found commingled together in these deposits. When those immense herds of Mammoths occupied the North Sea Valley and the adjacent countries, it seems probable that the conditions of climate in the extreme North of Europe and Asia had previously become unbearable for them, and they had been driven south. At any rate, if they did not remain all the year, they migrated south every winter. All the Arctic species would come down into this country for the winter, and stay here until the summer invited such animals as the Reindeer, the Elk, and the Musk-Ox to migrate northward in great herds, as they do at the present day on the Continent, towards the feeding grounds, which in winter are uncongenial to them, but in summer afford them rich pasturage. In the same way, in the summer season, the Rhinoceros, the Hippopotamus, and other more southern animals, with great herds of Wild Horses, would no doubt advance northwards and westwards with the change of season. Such climatal and physical conditions enable us to explain that curious admixture of animal-remains found in these deposits, which otherwise would not be so easy to comprehend. We are moreover confirmed in this view by the fact that we find the same state

of things in Central France. There the old cave-folk lived, apparently, upon the Horse and the Reindeer equally, for from their remains it is quite evident they must have hunted them season and season about. It is interesting to notice that the remains of these animals are spread over all the metropolitan area, even beneath the ground upon which the New Natural History Museum is built. Beneath us is the old river-valley gravel of the Thames, and in it were found remains of the Mammoth and the Ox. In Gray's Inn Lane the skeleton of a Mammoth and a palæolithic flint implement were

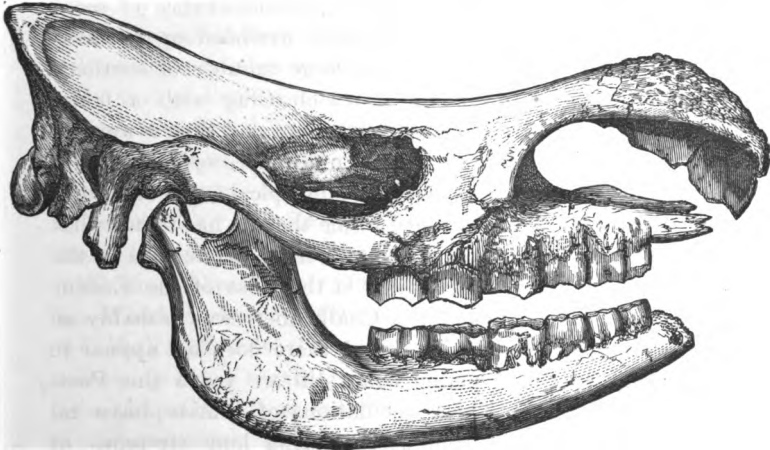


Fig. 8.—Skull and lower jaw of *Rhinoceros leptorhinus*, Owen, from the Pleistocene Brick-earth of the Thames Valley, at Ilford, Essex. The original, from the collection of the late Sir Antonio Brady, F.G.S., is now in the British Museum. See Geol. Mag. 1874. Decade II., vol. i., p. 398, pl. xv. [This woodcut is obligingly lent by Messrs. Cassell & Co., from their 'Natural History,' vol. ii., p. 334.]

found associated together. In Piccadilly, close to where Burlington House stands, the remains of Hippopotamus were found; and also at Peckham and at Woolwich, and all along the Thames, their remains are more or less abundant. In the Museum there is a very perfect skull of *Rhinoceros leptorhinus*, found at Ilford (fig. 8). Three species of *Rhinoceros* occur in these old brick-earths, the Woolly Rhinoceros which belonged to the northern fauna came south,

meeting here with the *Rhinoceros leptorhinus* and *megarhinus*. Still further back in time, it seems as if there must have been a still colder period, marked by glacial deposits on the top of the high grounds forming the divisions between the Thames, the Roding, and the Lea, and also on such high grounds as at Muswell Hill. Then after this period, which must have been one of submergence as well as of cold, we had no doubt a cold period of emergence, when the land stood higher than at present. That gradually passed away and was succeeded by a somewhat warmer period, marked by a corresponding change in the fauna of the valley, and the predominance of more southern forms; and that must have extended up to those Norfolk beds which have yielded a large number of southern forms. Then we reach the Norwich Crag with a fauna characteristic of a period of depression, and then a warmer period, marked by the Red and Coralline Crags of Suffolk. Lastly an Eocene Period, with its subtropical fauna and flora.

Mr. Gardner has mentioned to me that he has found what appears to him to be evidence of a truly Arctic flora in the Reading plant-beds; so that just at the close of the Eocene Period, and at the top of the Chalk, there was probably an intervening cold land period. But there does not appear to have been any cold period again till we reach the Post-Tertiary deposits. These oscillations of climate have no doubt recurred again and again during long stretches of time, but with vast intervals between. We must not suppose for a moment that the land has risen and fallen like the mercury in a barometer. These processes of elevation and subsidence have been very slow, and have occupied inconceivably long periods of time; and when one is asked to believe in repeated glacial periods marked by only a few feet thickness of strata, one ought to be very careful in receiving such doctrines. I do not believe that any sound geologist who has carefully considered what is involved in any great change of climate can ever entertain such an idea. It takes a very, very long period of centuries or thousands of years to bring about any considerable climatal change. We can easily imagine a local change taking place;

but it would be only local; considerable changes of level, for instance, have taken place in our own Thames Valley. Below high-water-mark, in the neighbourhood of Victoria and Albert Docks at Plaistow, there are abundant evidences of deposits such as I have spoken of, and a canoe has been found, showing that primitive man was there when the valley stood at a far higher level than now. Mr. Searles Wood in some of his papers mentions trees *in situ* at many points below the present level of the Thames, affording good evidence that in prehistoric times the level of the Thames stood considerably higher than it does now; and that savage men, if not civilised men, at that time occupied the country.

Probably no independent geological investigator since the early days of Buckland, Trimmer, and Morris, has paid such careful attention to the structure of the Thames Valley, and of its contained deposits, as Mr. Searles V. Wood, F.G.S. Numerous papers on this subject have been communicated by him to the 'Quarterly Journal of the Geological Society' and to the 'Geological Magazine.'

Writing thereon in 1866 (Geol. Mag., vol. iii., p. 59), Mr. Wood observes: "The brick-earth of Ilford, both that of Uphall and that of the London-road Field, is a deposit *underlying* the Thames gravel, and unconformable to it." He also speaks of it as *anterior* in date to the similar deposit of Grays, which likewise contained *Cyrena fluminalis* and other purely fresh-water shells.

In a letter to me (dated March 10, 1874) Mr. Wood says:—

"When I wrote the paper in vol. iii. of the Geol. Mag. (1866), I was under the impression that, though the Grays brick-earth was clearly newer than the main sheet of the Thames gravel (it forming distinctly a terrace beneath it), the *Cyrena* brick-earth of Ilford, and of Crayford and Erith, was anterior to, and passed underneath, it. Some year or two afterwards, however, I satisfied myself that this was an error as concerned Crayford and Erith, and I wrote a letter to the 'Geological Magazine' (Oct. 10, 1868, vol. vi., p. 534) directly, to acknowledge this.

"The Ilford bed lying flush with the gravel sheet of that part of Essex does not present the means of determination by section; but I cannot doubt, however, that it is identical

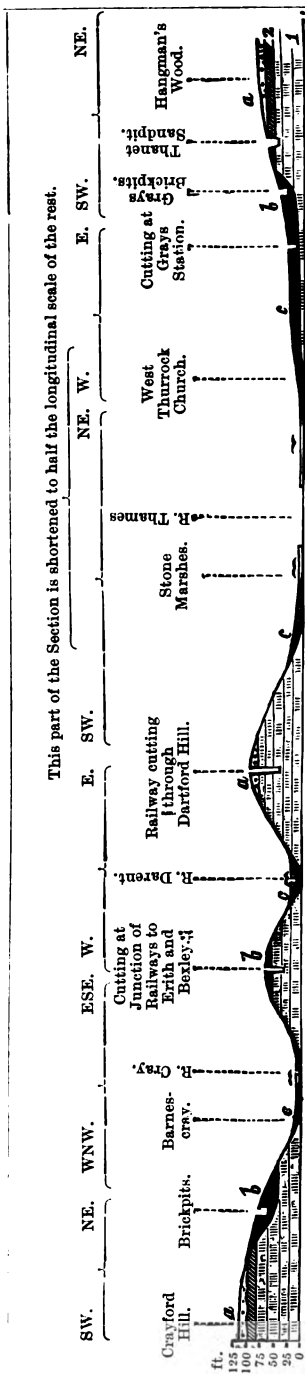
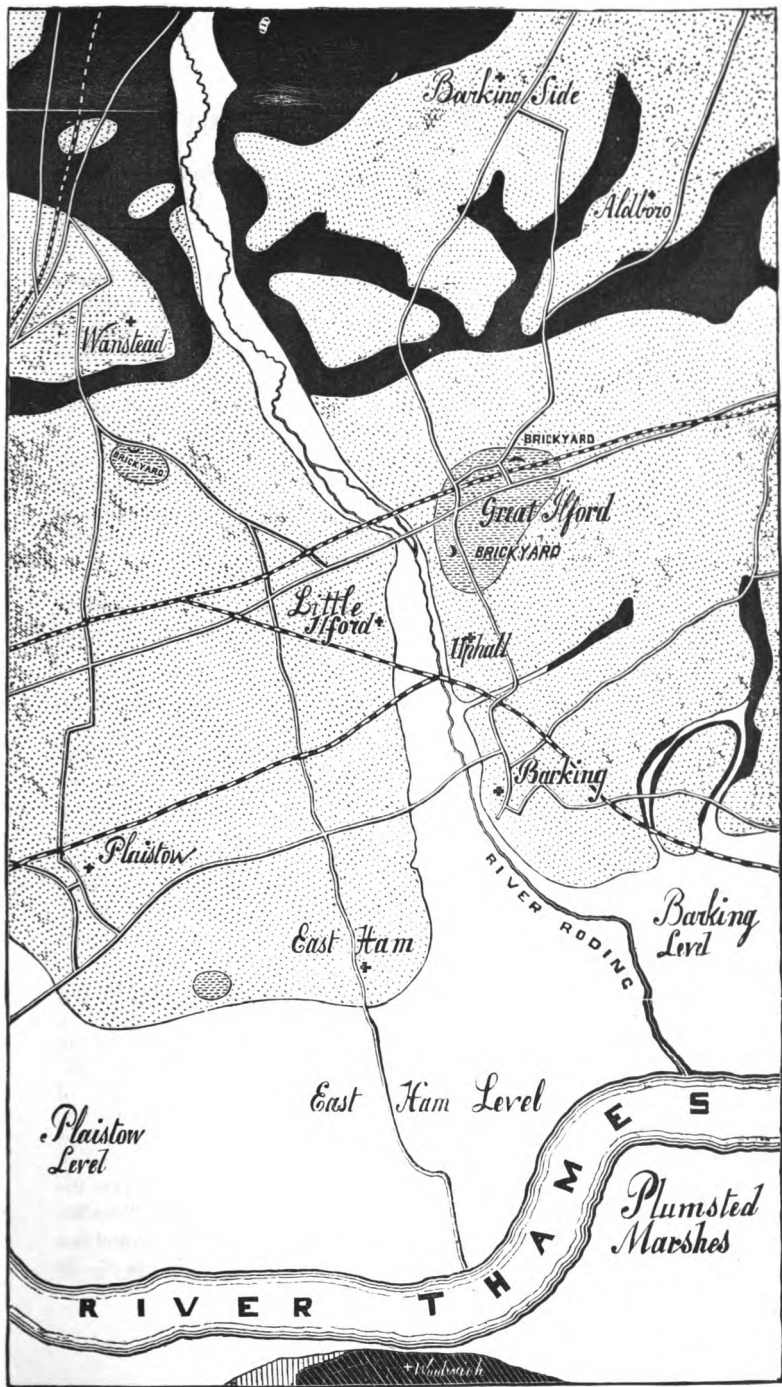


Fig. 9.—SECTION FROM CRAYFORD TO HANGMAN'S WOOD. Length: Nine Miles along an Irregular Line. Prepared by Mr. S. V. Wood, F.G.S.

[Reproduced from Sir Antonio Brady's Catalogue of the Ilford Mammalia, 1874.]

1. The Chalk.
 2. The Thanet Sand.
- a. Thames Gravel of the Highest Elevation and which covers Dartford Heath. } Formed when the Sea occupied the Weald, and the Cyrena Brick-earth. } Drainage from the Thames area passed into it.
- b. Cyrena Brick-earth.
- c. Gravel (with some Brick-earth) formed since Drainage acquired its present direction. Recent Alluvium.
- N.B.—The Cyrena Brick-earth at both Grays and Crayford is partially underlain by Gravel.

Fig. 10.—Geological Map of the district around Ilford, whence the great collection of Pleistocene Mammalian remains forming the "Brady Collection" (now in the British Museum of Natural History) was obtained.



in age with the *Cyrena*-beds of Grays, Erith, and Crayford.

“Such being the case, so much of the Section No. 3, given at p. 61 of the ‘Geological Magazine,’ 1866, vol. iii., as shows this brick-earth (x 4’) underlying the gravel (x 4’), is incorrect.

“The subject, however, is obscure; and while the brick-earth at Ilford, Grays, and Erith lies low, and forms a lower terrace to the main sheet of the Thames gravel, it rises at Crayford to a greater elevation, nearly eighty or ninety feet in parts, and forms a high terrace above the gravel of the Cray and Darent Valleys, but below the main gravel sheet which forms Dartford Heath (see bed *b* of Section, fig. 9).

“This anomaly and seeming contradiction is due in my view to the reversal of the drainage during the progress of the formation of the Thames Valley and the denudation of the Weald, as discussed by me in my paper in the Quart. Journ. Geol. Soc., 1871, vol. xxviii., p. 3.”

In order to make the foregoing view more intelligible, Mr. S. V. Wood has most obligingly prepared the accompanying Section¹² (fig. 9), and adds:—

“Crayford is nearer to the region of Wealden elevation than the other localities of the *Cyrena* brick-earth; and this brick-earth has there been so elevated that the gravel of the Cray and Darent Valleys (*c* of fig. 9) forms in places a very distinct deposit occupying the valley-bottoms, and lying at a level considerably below that of the *Cyrena* brick-earth. This gravel *c* is, in my view, a deposit formed since the drainage was reversed into its present direction; the *Cyrena* brick-earth, on the other hand, having been deposited while the drainage from the Thames Valley flowed into the sea which covered the Weald. (See Section).

“I should, however, point out, as one of the perplexing features of this obscure subject, that if we follow the gravel *c* from the Cray and Darent Valleys to the edge of the Stone Marshes, and crossing the Thames pursue it from its re-appearance above the West Thurrock Marshes to the edge of

¹² Fig. 9 is reproduced from Sir Antonio Brady’s ‘Catalogue of the Pleistocene Vertebrata from the Neighbourhood of Ilford, Essex,’ London, 1874. For other sections prepared by Mr. S. V. Wood to illustrate the Geology of this area, see “A Day’s Elephant Hunting in Essex,” by Mr. Henry Walker, F.G.S., with folding plate of lithographed sections, and two woodcut sections on p. 32, Trans. Essex Field Club, vol. i., pp. 27—58 (September, 1880).

the *Cyrena* brick-earth at Grays, it seems to inosculate with the gravel which (as shown in the Section at page 62 of the third volume of the 'Geological Magazine'; and Trans. Essex Field Club, vol. i., p. 32) partially underlies the brick-earth at that place. I, however, believe that this inoscultation is not real, but that the gravel, *c*, really lies up against the beds of gravel, sand, and brick-earth which form the *Cyrena*-deposit of that place, and which are shown in the present Section under the letter *b*. All the gravel and brick-earth beds occurring in the valleys of the Thames, and of its tributaries, are now pretty generally admitted by geologists to be posterior to the true Glacial period; and their relation to the extensive deposit of Glacial clay which covers so much of the midland and eastern counties (Bed No. 6) is shown by Section on page 32, Trans. Essex Field Club, vol. i. (reprinted from page 43 of the fifth volume of the 'Geological Magazine,' 1868)."

"To return to the Ilford brick-fields: the *Cyrena* brick-earth here attains a thickness of nearly twenty feet. It may be seen in the field on the London-road resting in one part direct on the London-clay, while in another part it has a thin band of shingly gravel beneath it. In the Uphall brick-field its position relatively to the newest gravel is best shown, the two deposits being unconformable.

"When we consider the limited area from which the collection of the late Sir Antonio Brady has been made, it seems not a little remarkable that it should so well represent the vertebrate fauna characteristic of these deposits, in regard to the number of species; whilst it greatly exceeds in number of specimens any hitherto attempted from this neighbourhood. The relative proportions of the remains of the several families are also such as are generally found in similar deposits in other localities.

"Of the Carnivores the remains are few,—only eleven,—and belong to the Lion, Fox? (one fragment), and the Bear. The first is represented by two examples; but, as we might expect from the known active habits of the Felidæ, their remains are comparatively rare in all aqueous deposits, being more generally found in caves and rock-fissures. Of the Bear one species is recorded as having been found at Ilford, viz., *Ursus ferox*.

“The remains of the Proboscidæ are numerous, and are referable to two species—*Elephas primigenius* and *E. antiquus*. This group is not only numerous in specimens (about three hundred), but also in individuals, of which there are the remains of eighty-four, as indicated by jaws and teeth alone, exclusive of the tusks; of these there are fourteen examples, large and small. Even assuming that many of the limb and other bones might have belonged to one or the other of these individuals, we may still fairly estimate that there are portions of more than one hundred Elephants in the collection; for there are few instances in which more than one bone could be assigned to the same animal. Of the greater portion of the bones of the skeleton there are many fine examples, and they illustrate, together with the teeth and jaws, individuals of every age and size—from the smallest sucking-calf to the animal of most mature age.

“The Pachyderms are represented by three genera, viz., *Rhinoceros*, *Equus*, and *Hippopotamus*; and collectively comprise 121 specimens. Of the *Rhinoceros*, remains of three species are present—*R. leptorhinus*, *R. megarhinus*, and *R. tichorhinus*, those of the first being the most numerous. Of this species there are seventy-seven separate remains, consisting of skulls, jaws, detached teeth, vertebræ, and limb-bones. The Megarhine Rhinoceros, of which there are seven examples, is comparatively rare at Ilford; whilst at Grays, a few miles off, it is the species most frequently found. The Tichorhine Rhinoceros is also rare in this locality, being only represented in the collection by two fragments. The same remark applies to the two species of Elephants occurring in these deposits; for whereas the Mammoth (*Elephas primigenius*) is the common species at Ilford, and *E. antiquus* the less prevalent form, the Grays deposit, on the contrary, yields a larger number of the latter species, whilst the former is there more seldom met with. Of the remains of the Horse there are thirty-four specimens, including a fine fragment of the skull. The Hippopotamus is only represented by a single fragment—the body of a lumbar vertebra.

“The Ruminant remains constitute fully one-half of the

collection, numbering more than 500 specimens, consisting of teeth, skulls, jaws, limb and other bones, with antlers and horn-cores, belonging to the genera *Cervus*, *Bison*, and *Bos*. Of the first there are seven specimens of the Great Irish Deer, and fifty of the Red Deer, besides thirteen fragments of undetermined species; making an aggregate of seventy objects. The *Bison*, judging from the paucity of its remains in the collection,—only thirty-four,—was a rare animal, when compared with those of its congener, the large *Bos*, which exceed 300.

“This evidence of numbers is important as tending to prove that the heavy Bovidæ were either subjected to greater casualties by floods or other causes than the lighter and more fleet Cervidæ, or that they existed in greater numbers and roamed in very much larger herds. It also tends to prove that the Ruminants numerically surpassed the whole of the other Herbivores, the Mammoth alone being comparable in this respect with the Oxen, but surpassing them in size and weight; and compared with which the bones of the Horse and Rhinoceros are but few. This evidence leads to the assumption also that the Rhinoceros was not a common animal in the Pleistocene country whence the bones of the numerous animals deposited at Ilford were derived. For assuming that its habits were similar to those of the existing Rhinoceros, we should expect to meet with its remains generally in places and under conditions better adapted for their preservation, and hence more frequently than those of other co-existing types of Mammalia.

“It is a fact worth noting, that of this assemblage of vertebrate remains it is seldom that two or more bones of the same animal are found in juxtaposition, showing that they did not find their resting-place where the animals died, but have been floated probably for long distances, from the upper tributaries of the ancient Thames, and subsequently deposited in these fluvial beds. But from whatever distance they may have been conveyed to this particular spot, they have been subjected to no rolling or water-

wearing action; for all the angles and ridges of the bones still retain their original natural sharpness.”¹⁸

If we could once more restore the physical features of the Valley of the Thames as it existed in Pleistocene times, we should doubtless find that all those places along its lower course, where considerable deposits of brick-earth occur and where the remains of the larger Mammalia are found in such abundance, as at Ilford, Grays, Erith, &c., mark the sites of ancient bays formed by the debouchment of side-valleys into the principal one, giving rise in flood-times to eddies into which the floating carcasses of land-animals would indubitably be drawn, and would in course of time sink and become entombed in the soft and yielding argillaceous mud beneath.

That many of the remains of land-Mammalia met with in these deposits may have lain for a very long period of time upon the surface of the dry ground before being carried down by floods and entombed in their present resting-place is, I think, rendered highly probable by the following interesting observation made by Mr. Wm. Davies, F.G.S., of the British Museum of Natural History, who writes as follows:—

“During the preparation of fossil remains from the brick-earth, I have had frequent opportunities of noticing points which would otherwise have passed altogether unobserved by any one, as they could only have been seen at the time the specimen was being actually cleared and developed from its sandy or argillaceous matrix.

“I observed, for example, in the skulls of several fossil Oxen numerous shells of the common Land Snails, *Helix nemoralis* and *H. hortensis*, in one instance more than thirty examples, all in good condition.

“I cannot help imagining that these snails, whilst still living, may have found their way into the hollow cavity of the skull through the only aperture (the foramen magnum) for the purpose of hibernation—as is common with all *Helices* now living in this country—whilst the skull was still lying on the dry land, where it may have been left for a long time after a flood; or, the animal to which it belonged may

¹⁸ See “Notes on the Pleistocene Deposits yielding Mammalian remains in the vicinity of Ilford, Essex.” By Henry Woodward, F.R.S., and William Davies, F.G.S. (*Geol. Mag.*, 1874. Decade II., vol. i., pp. 390—398).

perhaps have fallen a prey on that very spot to wild beasts, and afterwards the skull may have been cleared of animal matter by predaceous insects. It seems incredible that such a large number of adult snails could have been washed in by water through so small an aperture, and that one the sole opening into the brain-cavity."¹⁴

There is one other point which I would wish briefly to notice: it is the question of the origin of the brick-earth. Mr. Whitaker observes (Geol. Surv. Memoir, 'Guide to the Geology of London and the neighbourhood,' 8vo, 1880, p. 65):—

"The origin of this brick-earth is rather doubtful; in some places it seems to be little else than a mixture of rearranged Lower Tertiary Beds, with barely a trace of bedding; whilst in others it is a more or less finely-bedded sandy clay, or clayey sand; on the north it is possible that it may be allied to the deposits next underlying the Boulder-clay, the 'Middle Glacial' of Mr. S. V. Wood."

From its occurrence in large hollows or in pipes let into the Chalk, and being also said by Mr. Whitaker to be often full of flints, and of variable colour from light brown to grey and red-mottled, there can be little doubt that it may be classed with the "clay with flints," or the "*argile à silex*" of the French geologists. Mr. Whitaker says (*op. cit.*, p. 64):—

"The greater part of the higher ground of the chalk-tracts, both on the north-west and south-east, has a covering of a more or less clayey nature; the upper part of this is often worked for bricks. . . . From the unworn character of the contained flints, the surfaces of some of which are as fresh as if they had come direct from the chalk, we may infer that the deposit has been formed on the spot where it is now found, not from materials transported from a distance, but through the dissolving away of the chalk, of which the pipes give evidence. By this process the carbonate of lime of the chalk would be dissolved away, and the insoluble flints and earthy (aluminous) matters left behind, the last receiving, perhaps, an addition from any pre-existing clayey deposit that might occur over the chalk.

"We may conclude, therefore, that the 'clay with flints'

¹⁴ See Appendix 5, p. 70, to Catalogue of the Pleistocene Vertebrata in the Brady Collection. London, 1874.

[and also the brick-earth, H. W.] is not of definite age, but may have been forming at any time *since* the last emergence of the country from the sea (and its consequent subjection to atmospheric agents) to the present time."

This theory of the atmospheric origin of the clay with flints, and so of the brick-earths of the chalk-area, was put forward by my friend, Mr. W. Whitaker, B.A., F.G.S., in the Geological Survey Memoir to Sheet 7, 1864, and I thoroughly endorse his views.

This brick-earth would be slowly formed upon the upper watershed of the Thames and all its tributaries, and by rains and floods would be washed off the surface and brought down into the quiet reaches, together with the bones of land-animals, and land-snails.

The story of the Thames Valley brick-earths is the same as that of the "red-earth" of our ossiferous caverns in limestone districts. The carbonate of lime is dissolved away by the percolation of rain-water charged with carbonic acid, eating out those great swallow-holes, chasms, and caves for which the Mendip Hills, the Peak in Derbyshire, and the limestone districts of Lancashire and Yorkshire are so famous. This red-earth of the caves is only the insoluble (aluminous) residuum of the limestone in which, as in our brick-earths, the relics of prehistoric man and of the animals he saw and hunted have been found.

The following is a list of the Mammalian remains from Ilford, from the collection of the late Sir Antonio Brady, F.G.S., now preserved in the British Museum of Natural History:—

<i>Felis spelæa.</i>	<i>Megaceros hibernicus.</i>
<i>Canis vulpes.</i>	<i>Cervus elaphus.</i>
<i>Ursus ferox.</i>	" <i>sp.</i>
<i>Elephas primigenius.</i>	<i>Bison priscus.</i>
" <i>antiquus.</i>	<i>Bos primigenius.</i>
<i>Rhinoceros leptorhinus.</i>	Miscellaneous Ruminant re-
" <i>megarhinus.</i>	mains.
" <i>tichorhinus.</i>	<i>Hippopotamus.</i>
<i>Equus fossilis.</i>	Undetermined species.

From other collections—made by Sir John Lubbock, Bart., M.P., F.R.S.; Prof. Boyd-Dawkins, F.R.S.; F. C. J. Spurrell, Esq., F.G.S. :—

Ovibos moschatus. The Musk Ox.

Spermophilus. The Pouched Marmot.

List of Animals characteristic of the Pliocene and Quaternary Deposits of Britain and Western Europe :—

<i>Castor europæus</i> , Owen. [<i>Trogontherium cuvieri</i> , Fischer.]	<i>Capra hircus</i> , Linn.
<i>Mus musculus</i> , Owen.	<i>Ovis aries</i> , Linn.
<i>Arvicola amphibia</i> , Owen.	<i>Cervus elaphus</i> , Linn.
,, <i>agrestis</i> , Fleming.	,, <i>capreolus</i> , Linn.
,, <i>pratensis</i> , Owen.	,, <i>tarandus</i> , Linn.
<i>Spermophilus citillus</i> , Linn.	,, <i>megaceros</i> , Owen.
,, <i>erythrogenoides</i> , Falc.	,, [<i>sedgwickii</i> , Gunn.]
<i>Lagomys spelæus</i> , Owen.	,, [<i>brownii</i> , Dawk.]
<i>Lepus timidus</i> , Linn.	,, <i>dama</i> , Linn.
,, <i>cuniculus</i> , Linn.	<i>Alces malchis</i> , Linn.
<i>Lemmus lemmus</i> , Linn.	<i>Machairodus latidens</i> , Owen.
<i>Elephas primigenius</i> , Blum.	<i>Felis spelæa</i> , Goldf.
,, <i>antiquus</i> , Falconer.	,, <i>antiqua</i> (?).
,, [<i>meridionalis</i> , Nesti.]	,, <i>catus</i> , Owen.
<i>Rhinoceros tichorhinus</i> , Cuv.	,, <i>lynx</i> .
,, <i>leptorhinus</i> , Owen.	<i>Hyæna spelæa</i> , Goldf.
,, <i>megarhinus</i> , Christol.	<i>Canis lupus</i> , Linn.
,, [<i>etruscus</i> , Falc.]	,, <i>vulpes</i> , Briss.
<i>Equus caballus</i> , Linn.	<i>Lutra vulgaris</i> , Owen.
<i>Sus scrofa-ferox</i> , Linn.	<i>Mustela martes</i> , Ray.
<i>Hippopotamus major</i> , Nesti.	,, <i>putorius</i> , Linn.
<i>Bison priscus</i> , Bojanus.	,, <i>erminea</i> , Linn.
<i>Bos primigenius</i> , Bojanus.	<i>Meles taxus</i> , Owen.
,, <i>longifrons</i> , Owen.	<i>Gulo luscus</i> , Linn.
<i>Ovibos moschatus</i> , Pallas.	<i>Ursus spelæus</i> , Blumenbach.
<i>Capra ægagrus</i> , Gmel.	,, <i>arctos</i> , Linn.
	<i>Talpa europæa</i> , Schmerling.
	<i>Sorex vulgaris</i> , Owen.
	,, <i>moschatus</i> , Linn.
	<i>Saiga tartarica</i> , Pallas.

[The names included in square brackets characterise the Norfolk forest-bed.]