

THE PLEISTOCENE DEPOSITS OF THE ILFORD AND WANSTEAD DISTRICT.

BY MARTIN A. C. HINTON.

(Read June 2nd, 1899.)

SINCE 1838, when Prof. Morris wrote a description of the Ilford beds,* much has been written on the Drift of the district. A review of the literature of the Thames Valley Drift was published in the *Memoirs of the Geological Survey* ("The Geology of London," vol. i, 1889, pp. 353-387).

A series of papers, in part relating to the Thames Valley, was published in the *Geological Magazine* during 1872 by Prof. James Geikie.† In my opinion his conclusions are incontestable, in so far as they relate to the Palæolithic era, and have never been satisfactorily answered by those holding contrary views.

Another paper to which I shall specially refer is that by Messrs. Kennard and B. B. Woodward, "On the Post-Pliocene non-marine Mollusca of Essex,"‡ in which a complete list of the Ilford shells is given.

HIGH-TERRACE DRIFT.

Wanstead.

Of this patch, extending from Leytonstone to Wanstead, only the south-eastern corner lies within our district. In a small gravel-pit, about a furlong north-west of Wanstead Park, and at a height of about 80 ft. O.D., some interesting sections have been noted.

In the western face of the pit may be seen beds of bleached pebbles and shingly gravel, probably indications of old land-surfaces, such as might be formed by the level of the river falling during dry seasons. In March, 1898, the following section was exposed on the northern side of this pit :

1. Stratified gravel	1-2 ft.
2. Contorted and lenticular beds of sand	1-2 ft.
3. Gravel, much contorted	4-5 ft.
4. Seams of sand, bluish clay, marl, and gravel, very much contorted	1-4 ft.
5. Gravel slightly contorted... ..	2-5 ft.

This section shows that the contorted and disturbed material is overlain by undisturbed gravel. The overlying gravel is undoubtedly Pleistocene, and, in my opinion, proves the age of the disturbance. The contortion was possibly caused by the grounding and partial melting of a large ice-raft on a shoal in

* Prof. John Morris, "On the Deposits containing Carnivora and other Mammalia in the Valley of the Thames." *Ann. Mag. Nat. Hist.*, Ser. II, vol. ii, 1838, pp. 539-548.

† Afterwards incorporated in "The Great Ice-Age," 1874, pp. 431-503.

‡ *Essex Naturalist*, vol. x, 1897, pp. 87-109.

the stream. The fact of its having partly melted, or at least of the deposition of part of its detritus, is shown by the seams of marl and of a blue clay, which resembles ordinary boulder clay both in tenacity and constitution. The ice, thus relieved of its burden, gradually floated away. This phenomenon would only occur in a district subject to a severe climate, and the evidence to be noted below supports this view.

Last October, I found a seam of the dioxide of manganese in this pit at a depth of about 12 ft.,* and associated with it was a portion of a skeleton of *Equus caballus*, the only fossil found. Flint implements are rare in this pit, and only a few small flakes were found, but elsewhere in this patch of Drift they have been met with in abundance.

Barkingside.

On the left bank of the river Roding are two patches of High-Terrace Drift. That furthest south shows no section, with the exception of a few ditch exposures, but its boundary may be easily traced. The other is much larger, and only the western portion lies within our district. At St. Swithin's Gravel pit (90 ft. O.D.) occurs a gravel, overlying sand, similar to that at Wanstead, but without contortion. "Trail" is often well developed in this pit. Mr. Crouch mentions that the gravel here is sometimes slightly faulted, which may be due to slipping. Loam is seen capping the gravel in the pit and also in a road-cutting near by. This loam has not been noted by the Geological Survey. I obtained a considerable number of bones of a small *Bos primigenius* or *Bison priscus*. I have also found several palæolithic flint-flakes and implements. Mr. Hatton, the late proprietor, informed me that teeth of ox and of horse have been found.

These High-Terrace gravels contain an abundance of large, smooth, and apparently ice-worn foreign rocks, fragments of Triassic sandstones, Lickey and other quartzites, and of sarsen-stones, which have not been subjected to any great amount of water-action. Among the other foreign materials are large boulders of Carboniferous chert, of gneiss, and occasionally mica-schist. The presence of these large boulders may be due to the transporting power of masses of ice, acting upon a river-bank containing moraine matter. Many of the quartz and flint-pebbles are also of large size. The smaller material consists chiefly of flint and quartz with a few Triassic sandstone pebbles.

Dr. Corner possesses a flint implement found in Middle-Terrace gravel, but evidently derived from High-Terrace Drift, as shown by its abraded condition, which bears distinct ice-striae on its *fractured surfaces*.

* Martin A. C. Hinton, "On Manganese in River Gravels." *Science Gossip*, vol. vi, 1899, New Series, pp. 146, 147.

MIDDLE OR LOW-TERRACE DEPOSITS.

Great Ilford.

The deposits of Great Ilford form part of a sheet of Drift which extends from the left bank of the river Roding to near Hornchurch. Of this great sheet, only the western portion lies within the district under discussion; but as this portion includes the Brickearths it is of much interest. The principal sections are situated at a height of 44 ft. O.D., on the northern side of the railway and on the left-hand side of the footpath which leads to the iron foot-bridge, in a pit known locally as the "Sam's Green," "Cauliflower," or "Page's" pit. The sections exposed are of great extent and have yielded a large number of fossils, including the greater part of Dr. Corner's collection and the whole of my own. The sections vary from time to time as the pit is gradually worked towards the north. In 1897 the following section was exposed on the northern side:

a.	Gravel (Trail)	...	...	...	...	2 ft.
b.	{ b ¹ Dark brown brickearth with shells	...	...	...	...	...
	{ b ² Light brown brickearth with shells	...	...	...	...	15 ft.
c.	Very sandy loam with bones and shells	...	...	...	...	...
d.	Sand	...	...	...	...	6 ft.

This section was chiefly remarkable on account of the number of well preserved mammalian remains exhumed. In the winter of 1897-8, the workmen came upon a portion of a skeleton of *Elephas primigenius*, with one of the tusks almost complete; but the only specimen obtained, was a small upper molar tooth with the crowns but little worn.

The following section on the northern side of the pit was noted by me on the 30th May, 1898:

a.	Gravel and loam (Trail), the pebbles nearly all having their long axes vertical	...	...	2-7 ft.
b.	Brown loam	...	...	4-9 ft.
c.	Buff loam	...	...	3 ft.
d.	Sand, seen to	...	...	4 ft.

This section is remarkable for the great development of the "Trail." The underlying bed is much contorted.

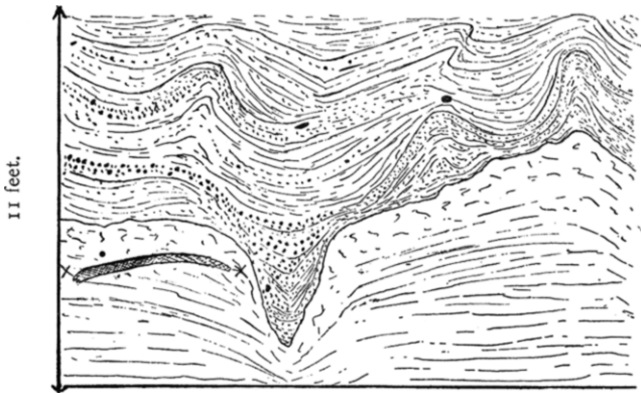
The best section is on the western side of the pit. It differs very little from year to year, and Dr. Corner informs me that in 1898 it was practically the same as in 1893. The following beds are seen:

a.	Gravel and loam (Trail), very well marked in places	1-4 ft.
	{ Sandy loam, more argillaceous in places	1-4 ft.
	{ Shell-bed, inconstant, containing numerous shells,	...
b.	{ also bones of <i>Bos primigenius</i>	9in.-1 ft.
	{ Sandy loam	4 ft.
	{ Shell-bed, resting on the eroded surface of Bed c	6in.-1 ft.
c.	Buff-coloured loam and marl, with race; somewhat sandy (Bone-bed)	1-5 ft.
d.	White sand with a few shells	5 ft.
	A well sunk in 1897 passed through sand and gravel	30 ft.

Dr. Cotton* noted a similar development of Drift occurring S.W. of Uphall. That this great development is influenced by the presence or absence of the underlying gravel is shown by the fact that between the two places the brickearth attains a thickness of about 20 ft., and that it rests directly upon the London Clay.† Hence the Ilford gravel must lie in hollows or old channels of erosion in the London Clay. Since it is extremely likely that these hollows would be the first portion filled up when the deposition of the gravel and sand commenced, it is probable that the gravel and sand of Ilford form the oldest part of the Middle or Lower Terrace Drifts of the district.

The large section on the western side of the pit differed somewhat in 1899. In 1898 and the preceding years, the "Bone-bed" was observed to overlie the sand. On cutting back the sand (in 1899), it was seen that the "Bone-bed" became more sandy, and finally developed into an interstratified series of sand and marl, dipping to the north at an angle of 10 deg. Only the lower shell-bed was to be seen, and towards the south it thinned out altogether.

FIG. 1.—SECTION OF CONTORTED DRIFT IN THE CAULIFLOWER BRICKYARD, ILFORD. x—x. Tusk of an elephant.



The finest examples of Trail that I have noted at Ilford were exposed in this pit in the spring of 1899. On the western side, some of the furrows were over 8 ft. in depth, and filled with gravel and sand. The gravel consists of beds of flint- and quartz-pebbles (mostly with their long axes vertical) and of thin layers of sub-angular shingly flint and quartz material, the fragments lying in all positions. At one point, just below where the "Trail" commenced to cut down into the loam, a portion of an elephant's

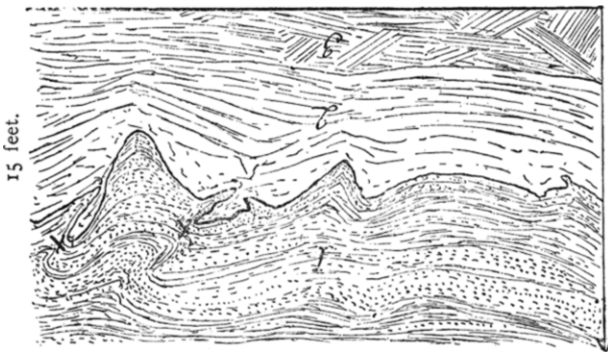
* Dr. R. P. Cotton, "On the Pliocene Deposits of the Valley of the Thames at Ilford." *Ann. Mag. Nat. Hist.*, vol. xx, 1847, pp. 164-9.

† S. V. Wood, Junr., "On the Structure of the Thames Valley, and of its contained Deposits." *Geol. Mag.*, vol. iii, 1866, pp. 57-63, 99-107.

tusk, crushed into small fragments, was seen (Fig. 1). On the eastern side, an even finer section of the contorted Drift was seen (Fig. 2). This exhibited several furrows, varying from 8 to 9 ft. in depth, and filled with similar *débris* to that occurring in the other parts of the pit. The contorted loam was in places forced up into long thin necks, projecting into the furrows. This, with the crushed tusk mentioned above, may be taken as evidence of the crushing action of ice.

FIG. 2.—SECTION OF CONTORTED DRIFT IN THE CAULIFLOWER BRICKYARD, ILFORD.

1. Gravel and Sand of Trail.
2. Contorted loam, torn up into necks at *x*.
3. Sand (much indurated) false bedded in places.



In March, 1893, Dr. Corner discovered a flint flake or knife in the lowest shell-bed of the western section of the pit, and this year he has found another in the same place. So far as we are aware, these are the first traces of human work known from the brickearth at Ilford.

The section exposed on the northern side of the pit in 1899 was as follows:

a. Gravel, sand, and clay (Trail)	...	...	...	3-4 ft.
b. Sandy loam, contorted in its upper part...	...	...	...	4-6 ft.
c. Brown loam with mammalian bones and teeth,	...	...	...	...
about	...	...	...	6 ft.

The sun cracks that occur in the beds form an interesting feature occasionally to be seen in this pit. They consist of vertical fissures filled with sand, which is often cemented into a hard mass by iron-oxides. They are of two distinct ages, Pleistocene and Recent, and may be distinguished by the following characteristics: Those of Recent age are the more abundant, and invariably reach the surface. Many of them are formed each summer after the surface soil is removed. The

infilling material, when present, is seldom consolidated. So numerous are these fissures, that, in the upper portion of the beds, it is a matter of great rarity to find any of the abundant mammalian remains unbroken by them. On the other hand the Pleistocene suncracks may be regarded as those not reaching the surface, and always filled with material which is more or less consolidated by oxides of iron, and occasionally by the black di-oxide of manganese. These Pleistocene suncracks in the beds of loam, are to be explained by the action of the heat of the sun acting upon mud-banks when the river was low, causing the mud to contract and form fissures, which, when the river again rose, became filled with detritus and were ultimately covered with fresh deposits of loam or other material.

In August, 1898, I noted a section in the old pit on the right-hand side of the footpath leading to the iron footbridge, which is one of three described by Prof. Morris in 1838. It has been abandoned now for several years, but I was able to make out the following details :

a.	Gravel and sand ("Trail")	...	...	...	3-4 ft.
b.	Brown loam, bottom part much obscured	...	...	...	4 ft.
b. (?)	Pebbly loam	...	...	...	4-6 ft.
c.	Thin layers of sand and clay with fragments of shells	...	...	...	4 ft.

The beds lettered "c" appear to be very constant at Ilford, sometimes in the form of buff loam, and sometimes as above. In some places bones are extremely abundant, the layer being termed the "Bone-bed" by the workmen. Wherever this bed is argillaceous, it is also very calcareous and full of large nodules of "race."

Westward of the River Roding.

From Great Ilford towards Manor Park the Drift becomes thinner, being nowhere more than 20 ft. in thickness, and generally much less, as the following sections will show :

Excavations for houses in Carlyle Road, Manor Park :

1.	Gravel and sand with a Palæolithic flake	...	...	6-8 ft.
2	Sand with bones of <i>Equus caballus</i> and <i>Bos primigenius</i>	...	...	12-14 ft.
	London Clay throwing out water at a depth of	...	...	20 ft.

Further east in the same road was seen :

1.	Gravel with thin seams of sand	...	...	4-5 ft.
2.	Sand	...	...	10 ft.
	London Clay throwing out water at a depth of	...	...	15 ft.

At the City of London Cemetery the gravel is in places only 8 or 9 ft. in thickness, and London Clay is to be seen at the bottom of many of the graves. Flint implements are very abundant in the gravel.

LIST OF VERTEBRATA FROM ILFORD.

	Uphall pit	Cauliflower pit
MAMMALIA.		
<i>Homo</i> (implements)	×	×
<i>Canis lupus</i> , Linn.	×	×
<i>Canis vulpes</i> , Linn.	×	
<i>Felis leo</i> , Linn.	×	
<i>Ursus arctos</i> , Linn.	×	×
<i>Ursus ferox</i> , Richd.	×	×
<i>Bison bonasus</i> , Linn. var. <i>priscus</i> , Boj.	×	×
<i>Bos taurus</i> , Linn. var. <i>primigenius</i> , Boj.	×	×
<i>Cervus elaphus</i> , Linn.	×	×
<i>Cervus giganteus</i> , Blum.	×	×
<i>Capreolus caprea</i> , Gray	×	×
<i>Elephas antiquus</i> , Falc.	×	×
<i>Elephas primigenius</i> , Blum.	×	×
<i>Equus caballus</i> , Linn.	×	×
<i>Hippopotamus amphibius</i> , Linn.	×	
<i>Ovis</i> ?	?	
<i>Rhinoceros antiquitatis</i> , Blum.	×	
<i>Rhinoceros leptorhinus</i> , Owen	×	×
<i>Rhinoceros megarhinus</i> , Christ.	×	×
RODENTIA.		
<i>Microtus (Arvicola) amphibius</i> , Linn.	×	×
<i>Microtus (Arvicola) arvalis</i> ?, Pall.		×
<i>Castor fiber</i> , Linn.	×	
AVES.		
<i>Anas</i> sp.	×	×
<i>Anser</i> sp.	×	
<i>Diomedea exulans</i> , Linn.	×	
PISCES.		
<i>Esox lucius</i> , Linn.	×	

NOTES ON THE VERTEBRATA.

CARNIVORA.—Among the carnivora found fossil at Ilford, *Canis* is the most abundant. Dr. Corner possesses a fine skull of *Canis lupus* from the "Trail," which I regard as a genuine Pleistocene fossil. The remains of *Ursus* are rare. Rarest of all is *Felis*.

UNGULATA.—The more abundant species are *Bos primigenius* and *Bison priscus*. It is the general rule to refer bovine bones to the former species as it is not generally deemed safe to venture to distinguish between them, except in cases where the skull and horn-cores are preserved. On this account the abundance of *Bos primigenius* may be somewhat exaggerated.

Cervus elaphus is the common form of deer found at Ilford, FEBRUARY, 1900.]

but *Cervus megaceros* is extremely rare. *Cervus tarandus* is unknown from any Pleistocene deposit in the Thames Valley below London, although it has been found in the Holocene of Walthamstow.

Equus caballus is fairly common, and is generally of medium size. Of the specimen from the High-Terrace Drift of Wanstead, exhibited at the Conversazione of the Association in 1898, the rudimentary metacarpal and metatarsal bones were of large size. Besides these, a case of unequal ossification of the tarsal bones of both legs was exhibited.

Elephas primigenius is the common form and in addition a peculiar variety occurs.*

Rhinoceros leptorhinus occurs in great number, *R. megarhinus* is fairly abundant, but remains of *R. antiquitatis* are very rare, and have not been recorded from the Cauliflower brickyard.

RODENTIA.—*Castor fiber*. A very fine series of bones of *C. fiber*, obtained from Uphall, is preserved in the Museum of Practical Geology (Cotton Collection). *Microtus (Arvicola) amphibius*, the water vole, is also recorded from Uphall, and specimens are in the Cotton Collection.

These two species were the only small Rodentia known from Ilford until 1898, when I discovered in the Cauliflower Pit a small cheek-tooth and portion of a femur. The cheek-tooth Mr. Newton has identified as the second right upper molar of *Microtus (Arvicola) amphibius*—a species already known from Uphall. The femur, however, supplies us with a new record for Ilford. Mr. Newton says that, from its size, it is referable to a small field vole, and corresponds most nearly with *Microtus (Arvicola) arvalis*. These specimens indicate a possible source from which more of these small vertebrates may be obtained.

AVES.—Portion of an ulna of *Anas* sp. is preserved in the Museum of Practical Geology (Cotton Coll.) from Ilford, and there is also a fragment in Dr. Corner's collection. These are the only specimens known from the Thames Valley Drift. *Anser* sp. is represented by a portion of an ulna, in the Cotton Coll. The specimen is the only one known from Ilford, but the species occurs at Crayford. A left ulna of *Diomedea exulans*, from Ilford, is preserved in the Museum of Practical Geology. There is some doubt as to this being a Pleistocene fossil, but its general appearance is not unlike that of many of the bones obtained at the Cauliflower pit. I am of opinion that it is a genuine Pleistocene fossil.

PISCES.—The sole representative of the fishes is *Esox lucius*, the pike, preserved in the British Museum (Brady Coll.).

* W. A. Davies, "On a Variety of *Elephas primigenius* from Ilford," "Cat. Pleist. Vertebrata in the Brady Collection," 1874. P. 4. See also E. T. Newton's "Vertebrata of the Forest Bed," *Mem. Geol. Surv.*, 1882, p. 106.

It will thus be seen that twenty-six vertebrates occur at Ilford, of which twenty-five are known from Uphall and seventeen from the Cauliflower pit. Of these vertebrates, twenty-two are mammals, three are birds, and one a fish.

CONCLUSIONS.

The High-Level Drift of the Ilford and Wanstead district, as we have seen, gives strong evidence of the rigorous nature of the climate during the earlier part of the Palæolithic period. At Wanstead there is unmistakable evidence of the rivers having been frozen in winter; and, on the breaking up of the ice, of huge ice-rafts floating down, contorting the deposits in process of formation wherever they grounded, and depositing their burdens of detritus. Similar occurrences were brought to the notice of the Association by Mr. Allen Brown when dealing with the High Terrace Drift of Acton and Ealing.* The antiquity of these disturbances admits of no argument, for in the cases above mentioned they have been overlain by Pleistocene deposits. Furthermore, they are on a scale that is never attained by the ordinary surface-derangements, and more particularly was this the case in the occurrences noted by Mr. Allen Brown.

In the fauna of the High-Terrace Drifts of the Thames Valley, we find that, among the Mollusca,† there is but one record of a southern shell occurring in these deposits, viz., *Corbicula fluminalis* from Dartford Brent. It does not follow, however, that because *Corbicula fluminalis* has now a southern range it indicates a warm climate. It must be noted that this form occurs in the Red and Norwich Crag and in the inter-glacial beds of Kelsea. The latter beds I take to be equivalent in age to the earlier Palæolithic deposits, and as they contain, besides *Corbicula fluminalis*, the marine shells *Cyprina islandica* and *Tellina balthica*, in all probability it could withstand a cold climate. The other shells are of a northern facies, or, at least, could have withstood a cold climate.

Of the Mammalia we find only such forms as the ox, horse, mammoth, and woolly rhinoceros.

But when we examine the fauna of the Lower-Terrace brick-earths we find that instead of the scanty species and numbers of the High-Terrace Drift we have evidence of an extremely rich fauna. The herbivorous Mammalia include the southern forms, such as hippopotamus, rhinoceros, and elephant, while of the Carnivora, lion and hyæna occur.

With regard to the Mollusca, a similar contrast is exhibited

* J. Allen Brown, "Notes on the High-Level Drift between Hanwell and Iver." *Proc. Geol. Assoc.*, vol. xiv, 1895, p. 153.

† B. B. Woodward, "On the Pleistocene (Non-marine) Mollusca of the London District." *Proc. Geol. Assoc.*, vol. xi, 1890, pp. 335-388.

between the present and the Palæolithic faunas. The Pleistocene molluscan fauna, as represented in the fossiliferous brick-earths, is admitted to be richer than that now existing. Though many of the species range from North Africa to the North of Europe, still, seeing that they attain their maximum development, as a whole, in the warm southern regions of Europe to-day, is it not reasonable to assume that their great Pleistocene development took place during a period in which the climate was as genial as it is in these islands at the present time? Numerous specimens of *Littorina rudis* have been found in the brick-earth at Crayford, and *Paludestrina ventrosa* is known from Crayford, Ilford, and Grays. The examples of *Littorina rudis* are all dwarfed and are exactly similar to a form living at Tilbury, while *Paludestrina ventrosa* is a well-known brackish-water shell. A record by Prof. Seeley of *Scrobicularia piperata* from the Ilford brickearth* led to an inquiry as to the correctness of its occurrence. Prof. Seeley very kindly gave me the following information in reply. He says :

"*Scrobicularia* was found, and the determination is given on my authority from specimens shown me in the pit at Ilford. They were rather small. I did not take any myself. . . . I will see if any specimens can be traced. My impression is that two or three entire and one or two broken valves were found. . . . The Ilford occurrence of *Scrobicularia* is interesting to anyone who has studied its distribution and variation on the mudflats of brackish water inlets on the Coast of Suffolk, where it may be found side by side with freshwater shells."

In 1872 the Rev. O. Fisher suggested that at the time the Crayford brickearths were deposited "The Thames could hardly have been a tributary of the Rhine, but must have possessed an estuary of its own as at present, and probably the tide came even higher up than it does now."†

Mr. Whitaker, however, did not agree with this view, and stated that "There is nothing in the fossils to show the presence of this tidal action."‡ The presence of these marine and estuarine forms, however, lends great support to the Rev. O. Fisher's views.

When we examine the lithological character of the brick-earth and the gradual passage into it of the gravel below, we are led to the conclusion that between the deposition of the gravel and that of the brick-earth, there was a general amelioration of climate. Can the "Trail" be referred to ice-agency? In my opinion it can, and for the following reasons: The contortion of the Drift when seen on a large scale, can only be ascribed to a heavy weight ploughing through and over it; also the position of the pebbles, which have, as a rule, their long axes in a vertical

* "Handbook of the London Geological Field Class."

† *Geol. Mag.*, vol. ix, pp. 268-9.

‡ "Geol. of London," vol. i, p. 636.

position, showing that the force was exerted in a vertical and not in a horizontal direction. The occurrence, noted when discussing the Ilford section, of an elephant tusk crushed by the "Trail," is very weighty, if not conclusive, evidence as to the cause of this phenomenon.

From this evidence there seems but one conclusion to be drawn. The earlier part of the period was undoubtedly characterised by a severe climate as shown by both the stratigraphical and the palæontological evidence. Contrasting, however, the abundance either in numbers or in species, or contrasting the conditions of life of representatives of the Low-Terrace mammalia now living, with those exhibited by the representatives of the High-Terrace deposits, we are forced to the inevitable conclusion that all these facts tell of a less rigorous climate, and of conditions that would be impossible, unless we regard these deposits as belonging to one of the interglacial periods since the formation of the great Chalky Boulder Clay. That the severe conditions returned once more is shown by the presence of the "Trail."

The succession of the Pleistocene deposits of the Lower Thames Valley may be tabulated as follows :

- | | | | | | |
|--|-----|-------------------|-----|------------------------------|----------------|
| 4. Trail | ... | ... | ... | Close of Palæolithic period. | Cold period. |
| 3. Middle Terrace Gravels (in part) and Brick-earths | { | Newer Palæolithic | ... | ... | Genial period. |
| 2. Middle Terrace Gravels (in part) | | | | | |
| 1. High Terrace Drift | { | Older Palæolithic | ... | ... | Cold period. |
| | | | | | |

My especial thanks are due to the following gentlemen : to Dr. Frank Corner, M.R.C.S., F.G.S., for the loan of specimens from his collection ; to Mr. A. S. Kennard and Mr. B. B. Woodward, F.L.S., F.G.S., for their kind determination of the Ilford mollusca ; to Mr. E. T. Newton, F.R.S., and Mr. H. A. Allen, for their aid in naming the mammalia, and also to Mr. Pringle, M.A., B.Sc., of the Museum of Practical Geology, for his kindness in connection with this paper.
