[*From the* Quarterly Journal *of the* Geological Society *for May* 1880.]

ON MAMMALIAN REMAINS AND TREE-TRUNKS IN QUARTERNARY SANDS.

On Mammalian Remains *and* Tree-trunks *in* Quaternary Sands *at* Reading. By Edward B. Poulton, Esq., M.A., F.G.S., of Jesus College, Oxford, Burdett-Coutts Scholar of the University, formerly Demonstrator in the Biological Department of the University Museum.

The pit furnishing some interesting sections to be described in the following paper is situated on the Redlands estate, at Reading, a little east of the new Grammar School, and about a mile south-east of the market-place. The pit is about halfway up the south slope of the conjoined Thames and Kennet valleys, and is 36 feet above the river-level. It has been worked for gravel and sand for some years, and recently for clay; and the gravel-bed, from 10 to 15 feet in thickness, has been cleared out over an area 276 feet in length from north to south, and of about the same average length from east to west, where, however, the boundaries are irregular and, to the east, partly effaced. The beds exposed in the north face are far more perfect and instructive than elsewhere. This face, about 20–25 feet in average height, and, where completely exposed, 65 feet in length, is drawn to a scale of $\frac{1}{15}$ in. to the foot in fig. 1.

A. About 12 feet thick, represents the gravels and recent strata overlying certain reconstructed beds of sand and clay.
(1) 1 foot 6 inches thick, is the superficial alluvium containing elements derived from the waste of the gravel below.
(2) 2 feet 6 inches thick, is transitional between the alluvium and the underlying gravel. It consists of rounded and subangular flints scattered thinly through a base of yellow clayey soil.
(3) 8 feet thick, is the gravel containing bones of land-mammalia. A rough stratification is apparent; and there are some intercalated beds of sand. A considerable thickness of this, with long, ramified, lateral prolongations, is seen about the centre of the exposed gravel. There is a large amount of ferruginous cement, and everywhere a deep staining of iron oxide.

No river-shells were detected, although I made a careful search for them, assisted by much earnest inspection of kind friends. I found a flake about halfway up the gravel-bed; but this may have fallen from the higher alluvium, although this derivation appears doubtful, because the vertical face of the cliff affords such slight opportunity for lodgment*. The elements of the gravel are derived from the following sources, in the order of their relative preponderance:—

(*a*) *Chalk.* Subangular flints, derived from the waste of the chalk, are the chief constituents of this gravel. Some few are quite

* Since writing the above another, more perfect flake was found by me (April 8th) on a gravel-path near the pit. The gravel certainly came from the pit; and it is highly probable that the flake was carried with it. Neither of the specimens can be referred with certainty to either the Neolithic or the Palæolithic period.

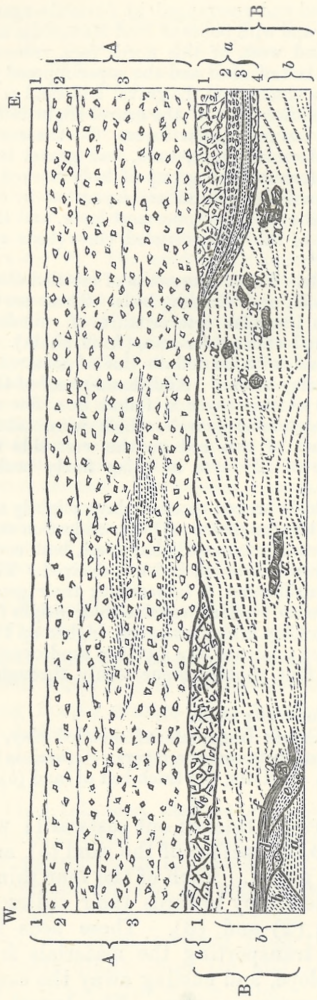


Fig. 1.—*Section in North Face of Pit near Reading.* (Scale $\frac{1}{5}$ inch to 1 foot.)

unworn and have sharp edges; they must have been transported by floating ice-blocks and so have escaped rolling. Flint casts of *Ananchytes* and *Galerites* are tolerably common; and one good example of a Ventriculite was found. Of the more perishable constituents of the Chalk, a few rounded nodules of hard chalk and a worn fragment of *Inoceramus*-shell were found.

(β) *Tertiaries.* There is a considerable proportion of rounded flints derived from the destruction of these beds. A fair specimen of *Ostrea bellovacina* from the same source was also found.

(γ) *High-level gravels.* There occurs, thinly scattered through all parts of the gravel, a small proportion of rounded quartzite masses derived from the waste of the high-level gravels that once formed an uninterrupted layer across the then unexcavated valley.

(δ) *Occasional elements transported from a distance.* Worn fragments of *Ostrea* (chiefly *O. dilatata*) occur; and one worn *Nerincæa* was found from the Oolites near Oxford. A small piece of blue, fissile limestone, when broken, showed the characteristic structure of Forest Marble. This must have been carried 41 miles if derived from the nearest source, Islip on the river Ray, d ˙ if it followed the general direction of the river-valley without taking the sinuous curves of a river.

This description holds good for all the gravels of the four faces of the pit. The west and north are still well seen; the east and south are now entirely covered up.

B. The reconstructed beds, about 9 feet thick. These consist of Tertiary elements (Woolwich and Reading beds, and to some extent the basement

beds of the London Clay) altered and rearranged by fluviatile agency and interpenetrated by river-gravels and with bones of land Mammalia and tree-trunks. At either end, east and west, of this north face, reconstructed clays intervene between a thick bed of sand and the superimposed gravels. Centrally, however, the clays are absent, and the gravel and sand come into contact. Here, however, in the lower part of the gravel slight indications of the clay may often be found, but no regular layer. To the east end of the section many layers of intermixed clay, sand, and gravel intervene between the gravels and sand, forming the group of beds marked *a* (1, 2, 3, 4) in fig. 1, while the west gravels and sand are separated by only one subdivision, the equivalent of the eastern uppermost layer, and therefore marked *a* (1). The characters of the reconstructed clays (beds *a*) are as follows:—

(1) 2 feet thick, east and west side. Large fragments of mottled clays from the upper part of the Woolwich and Reading beds. These are entirely unstratified, and there is an irregular intermixture of rounded flints (from waste of Tertiaries) and subangular ones (from chalk). Above, this layer passes into the gravel, with no definite line of demarcation, by the gradual cessation of the clay-masses. Additional proof of the Post-glacial and fluviatile origin of this layer is found in a few rounded quartzite masses, from the high-level gravels, which were taken from its lowest part. In one part of this bed on the west side the clay masses more resemble those of (2) layer in being finely broken and slightly laminate.

(2) 1 foot 6 inches, east side. Finely broken mottled clays, slightly stratified and containing fragments of bivalve shells. The stratification and shell-fragments are entirely quaternarily imposed characters, both completely absent in the Tertiary clay from which the bed was derived. The shells are so fragmentary that identification is impossible; their general appearance, however, is such as to render probable their origin from the basement beds of the London Clay, which crops out higher up the slope. The last 4 inches of this layer graduate into a yellow sand overlying the white sand (3). Scattered flint pebbles occur thinly throughout the layer.

(3) 6 inches thick, east side. Fine white sand.

(4) 6 inches thick, east side. Coarse fragments of mottled clay, roughly stratified, and with white sand between the layers. Gravel is present, especially in the lowest part, overlying the thick bed of sand (*b*).

These four beds, above described, thicken out eastward; while to the west the lower ones rise to the surface of the sand (*b*), and they all die out between it and the gravel. Each of the four thins away at this point; and there is a tendency towards their coalescence or interlamination, especially in (2) and (3). These beds indicate powerful and rapid currents transporting the materials from the Tertiary clays higher up the slope, and cutting away the sands previously deposited by gentler aqueous agency. The lowest bed (4) on the east side, and (1) on the west, overlie the sands quite unconformably, the laminæ of the latter being cut through very sharply. The currents must have been very powerful to remove *masses* of the extremely tough and stiff mottled clays. They cannot have been long continued, or the clay masses would not have been angular but would have been further disintegrated and redeposited elsewhere, losing the readily apparent characters by which their origin is at once seen. The broken lumps are of exactly the same colour and structure as the undisturbed beds higher up the slope. The

force of the aqueous agency is further seen in the steep incline on which the beds are deposited; deposition in comparatively still water would have produced horizontality in the strata.

(*b*) This stratum consists of a bed of sand 9 feet thick where it extends upwards to the gravels with no intervening clays. Its base is not seen in this north face; for water is reached at the level drawn on the section. It is derived mainly from the destruction of the "Buff Sands" of the Woolwich and Reading series. The sands are generally white, but often yellow or orange, from ferruginous staining, especially near the included tree-trunks, one of which often discolors the sand for a few feet round it. The sand-grains immediately surrounding the trunks are often bound together into an extremely hard conglomerate by a ferruginous cement; and the whole is generally firmly adherent to the trunk itself. Small pebbles occasionally occur in the sands. The whole bed gives one the impression that it was subject to long-continued but gentle fluviatile action, as compared with the clays above. The condition of the bones found in this bed is in favour of this view; for they are very waterworn and yet unbroken, while those of the gravel above are often broken sharply but their surfaces are far more perfect. Curiously the shifting currents and eddies of fluviatile deposition have produced a result strikingly like the original "Buff Sands" from which these beds were derived. The general irregular arrangement of the bedding only is given over the main part of the section (although the imbedded plant-remains (*x*) exposed in the face are accurately placed); but to the west and below, a series of beds showing the oblique laminations very distinctly are drawn carefully to scale.

The beds are lettered in the order of their deposition.

(*a*). The first deposited, and forming the axis of the group, is horizontal, and was therefore probably thrown down in comparatively still water. The laminæ are of coarse yellow and white sand, becoming deeply orange from ferruginous colouring in some parts. Small pebbles are common; and there are thin laminated clay-seams in the lower part and to the west—additional proofs of the gentle aqueous agency.

(*b*). Then followed swifter currents from the east and directed downwards, cutting away the west part of (*a*), so that its laminæ terminate abruptly in a slope of 45°. Against this, as the current became gentler, the bed (*b*) was deposited of fine white sand below, coarse above.

(*c*) and (*d*). Then currents from the west cut away (*b*) and (*a*) nearly horizontally, and (*c*) and (*d*) were deposited on them. These are of very fine white sand. There is an unconformability between (*c*) and (*d*) to the west, caused by some change in the current after (*c*) was thrown down. East, they form one bed.

(*e*). After this, more rapid currents from the west removed the east part of (*d*) and (*a*); and on the steep slope thus formed the fine white sand forming the bed (*e*) was deposited. In its lower part a few angular lumps of bluish clay occur, evidences of the rapidity of the currents, probably derived from the destruction of the "Leaf-beds."

(*f*). Finally gentler currents from the west planed off the tops of (*b*) (*d*) and (*e*), and on them deposited the laminated sandy clay

(*f*). This contains traces of vegetable matter in which no structure can be made out; and there is much oxide of iron in the layers and concentrically laminated nodules. I found in this clay a few rounded flints still retaining their green coating and thus proving that the materials had partially been derived from the lowest bed of the Woolwich and Reading series, the layer of green-coated flints just above the Chalk. This rendered probable the view that the laminated clay itself was derived from the destruction of the Leaf-beds, which occur just above the green-coated flints in the undisturbed Eocene strata. The clay much resembles that of the Leaf-beds in its blue colour. The sandy intermixture is, of course, a newly imposed character given during the redeposition among these beds of sand. The clay is horizontal west, but east it descends a steepish slope; and towards the bottom of this a large tree-trunk (*x*) is seen, partially enclosed in the clay, and exposed in transverse section. The relation of the tree-trunk to the slope gives the impression that this water-logged mass, rolling down under the slow action of the current from the west, has been the cause of the cutting away of (*e*) to a slope, while further west the beds (*b*) and (*d*) are planed off horizontally. Further probability is given to this view by the fact that east of the trunk the clay-band again becomes horizontal before it dies away, in a few feet.

Imbedded Remains. These have nearly all been found in the excavations at this north face; and hence the whole organic remains of the pit are best described here, since nothing different has been found in other parts. Omitting the indication of man by the flake probably belonging to the gravel (A), the remains of the pit are of three kinds—Mammalian bones and teeth, tree-trunks, and derived shells.

Mammalian Remains. These have been partly found in the gravel (A) and partly in the sand B (*b*). Many were found in the laminated coarse sand marked (*a*) to the west and below, thus occurring quite 8 feet below the under surface of the gravel (A). The bones and teeth were distributed in various directions to different collectors; and those from the gravel and sand have been indiscriminately mixed. The difference, however, is generally easily recognizable, remains from the gravel being broken rather than waterworn, usually stained yellow with iron oxide, and sometimes still showing the smaller constituents of the gravel adherent to their surface, while those from the sand are more waterworn and whiter. In some cases I have direct testimony as to the beds in which they were found. The identification of the species, or even in some cases naming the bones, was extremely difficult; but putting together the characters of the bones and teeth, the following list was made out, and may be taken as trustworthy:—

ELEPHAS PRIMIGENIUS.

(1) Two perfect molar teeth of young individual between sand (*b*) and gravel (A), also fragments of teeth from gravel.

(2) Portion of left scapula with part of glenoid cavity. Gravel (A).
(3) Proximal epiphysis, with articular surface intact, of one of the first phalanges of right hind foot. From sand (*b*).
(4) Many fragments from gravel are evidently *Elephas* from their size, but they are unidentifiable.

BOS PRIMIGENIUS.

(1) Right scaphoid, in good condition. Sand.
(2) Right distal articular extremity of right metacarpal or metatarsal. Sand.
(3) One of the last dorsal vertebræ of a young individual, the posterior epiphysis being lost. (Sand?) This broken specimen can only be considered approximately identified.

EQUUS FOSSILIS.

(1) Two molar teeth and some fragments. One certainly came from between the sand and gravel; the rest are undecided.
(2) One of the last two lumbar vertebræ, much waterworn. (Sand.)
(3) First phalanx (?). Gravel.
(4) Proximal half of left metacarpal, very small specimen. Between sand and gravel.

RHINOCEROS TICHORHINUS (?).

A portion of the articular surface of an astragalus shows undoubted perissodactyle characters, and is too large and shallow for *Equus*. It may be *Rhinoceros*. (Gravel.)

For the loan of the specimens from which the above list has been made, or for information on this subject, I have to thank Mr. F. W. Andrewes, of Christ Church, Oxford; Mr. C. H. Armstrong, of Friar's Street, Reading; and Mr. Walter Palmer, of The Acacias, Reading. In some of the most difficult identifications I have to thank Prof. Flower, and Mr. Jackson and Mr. Robertson of the University Museum, for much kind help, and above all Prof. Rolleston for the use of the splendid collection of comparative osteology and for the teaching that I have had in that subject in his department during many years.

Tree-trunks. These occurred in the sand-bed B (*b*) exclusively, and chiefly in its lower part. Those at present exposed in the face are seen in fig. 1 (*x*, *x*), generally in transverse section. The trunks are a foot or more in diameter, and some of them several feet in length. They are always horizontal, and had probably been carried down by the stream from some distant locality, as I could never detect any traces of lateral branches or, indeed, any indications of bark. The structure is very much obscured by the iron oxide with which they are impregnated. All attempts to render the tissue transparent failed; and hence some siliceous replacement is probable together with the iron. Sometimes the wood is friable or even pulpy, sometimes extremely hard and interpenetrated by quartz-grains in a ferruginous matrix. At first the attempt was made to grind sections of this indurated part; but much labour, with a very doubtful prospect of success, was saved by examining the softer tissue as an opaque object by reflected light. Some less-altered fibres from the centre of a mass of wood whose periphery was quite obscured by iron oxide were chosen for examination. This central tissue split up

readily into its component fibres on being merely touched with the needle; and these, when examined with a No. 4 Hartnack, in the manner mentioned above, showed all the characteristic appearances of the tissue of *Pinus*. Fragments of the medullary rays were seen quite distinctly crossing the pitted vessels at right angles. I have to thank Prof. Lawson for his kind help in working at, and making out the structure of, the wood.

Derived Remains. Between the sand and gravel, where these come into contact and the clays are absent, a curious admixture of derived and proper remains occurs. As shown in the above list, teeth of horse and *Elephas* and a bone of horse were found here; but with them were the following derived remains:—

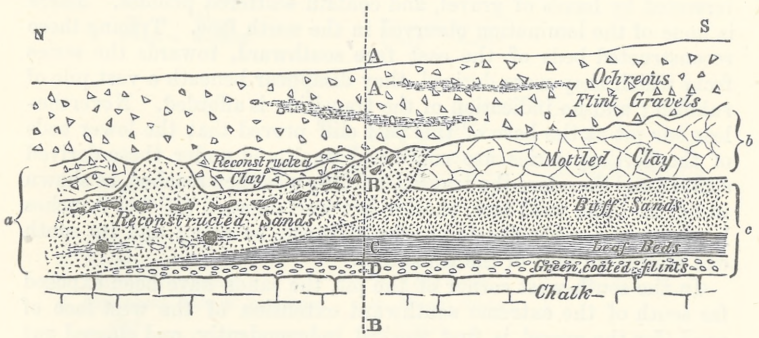
(1) *Ostrea dilatata*, from the Oolites at Oxford, abundant but worn.
(2) Worn fragments of *Inoceramus* from the Chalk; and a worn Belemnite, probably from the same source.
(3) *Ostrea bellovacina* from the Woolwich and Reading Series. Abundant and perfect.
(4) Shell-masses from the basement beds of the London Clay, with many of the shells still very perfect and recognizable (*Natica*, *Pectunculus*, &c.).

This heterogeneous collection, found at one horizon only in the deposits, serves to indicate the diverse and widely separated strata from which the bed has been formed.

I was anxious to procure the entire section of this interesting and very perfect face, and thus to gain a complete knowledge of all the beds over the Chalk at this point. However, on digging at the base of the sands, water came in at all points along the face. This is held up by some clay-bands above the Chalk; and their top was reached by the spade. The clay may be the reconstructed Leaf-beds, or perhaps these beds continued under the reconstructed sands in an unaltered condition. The sand was so full of water at this level (about 1 foot beneath base of cliff) that we could not complete the section. Hence in fig. 1 the face terminates below in a water-line. To reach the Chalk we chose a spot 78 feet south of, and at right angles to, the east end of the north face, just under the imperfect and irregular east face of the pit. Here we suffered no inconvenience from the water, and the Chalk was reached in about 5 feet. The pit was dug by Mr. F. W. Andrewes (my friend and former pupil) and myself; and I must express my hearty thanks to Mr. Andrewes for his help in the really considerable labour of cutting through the stiff clay, as well as for many other services in connexion with this work. The owner of the pit, Mr. Winter, kindly gave us permission to do as we liked, and afforded us every assistance in his power. The pit sunk was 5 feet long by 2 feet wide; and the Chalk was seen at a point 5 feet 4 inches below the greatest depth reached by the men, and as nearly as possible 30 feet from the surface. Careful measurements of the beds dug through in the pit, and those above, gave the following results. The dotted vertical line (AB) in fig. 2 shows the section here described:—

			ft.	in.
Quaternary.	A.	*Alluvium and concealed gravel*	6	8
		Gravel exposed	10	0
	B.	*Reconstructed clays*	absent.	
		Reconstructed sands	8	3
Tertiary (Lower Eocene).	C.	1. *Laminated clays* (blue, yellow and grey, with plant-remains)	1	1
		2. *Sand and thin clay*		2
		3. *Laminated clays* (bluer than 1, but with plant-remains as there)		7
		4. *Yellow sand* (with an indurated ferruginous layer below, 1–2 in.)		3
		5. *Homogeneous blue clay* (non-laminate, with concretions of iron-pyrites and a little vegetable matter)	2	2
	D.	*Green-coated pebbles*, and sand (no fossils)		$9\frac{1}{3}$
Secondary.		*Chalk.*		
		Total	29	$11\frac{1}{3}$

Fig. 2.—*Probable Section of Junction between Tertiary Beds and Quaternary reconstructed Beds.*



a. Reconstructed beds. *b*. Woolwich and Reading beds.
c. Unaltered Tertiary.

The group of beds A and B correspond in this east face to the gravels and recent strata, together with the reconstructed quaternary series of fig. 1 (A and B). Beneath this the beds numbered 1 to 5 (C) were met with. At the point where these were first reached all evidences of reconstruction ceased; there was no intermixture with river-gravels, no imbedded Post-tertiary remains, no disturbance. The laminated clays 1 and 3 obviously represent the "Leaf-beds" discovered by Prof. Prestwich in the cutting of the G. W. R. line to Newbury and Basingstoke. There are none of the delicate impressions, however, shown in the latter beds in that locality or at Katesgrove. The position of the beds C, just over the green-coated pebbles, D, is also indicative of their correspondence with the Leaf-beds.

The whole series 1–5 probably corresponds to the Leaf-beds, with a little local variation. Beneath the bed D, and covering the Chalk, was a flat flint so traversed by vertical fissures that it was easily removed in cubical blocks. It extended over the entire bottom of the pit, and was therefore, as far as we saw it, 5 feet × 2 feet in area, and about 6 inches thick. At the sides it was continuous under the green-coated pebbles; and thus we could not find its true size. But while the undisturbed Tertiary beds thus underlie the sands and clays exposed in the east face, the latter are reconstructed quaternary beds, although their lowest part, just above the Leaf-beds may be undisturbed and Tertiary, as shown in fig. 2, at the line A to B. In nearly the whole height of this eastern exposure of sand (about 8 to 10 feet), and along its whole length (151 feet), irregular bands of clay-fragments occur, some still angular and retaining all the appearance they presented when the river-currents detached them from the unaltered Tertiary beds higher up the slope and transported them to this spot. Above the sand in the east face, as in the north, the reconstructed mottled clays intervene in patches between the sand and gravel. These clays are largely intersected by bands of gravel, and contain scattered pebbles. There is none of the lamination observed in the north face. Tracing these reconstructed beds of the east face southward, towards the series from which they were derived, they disappear beneath a vast pile of rubbish; and no indication of the transition is afforded. Nevertheless our pit at the base of this east cliff proved that the lower beds of the Tertiary series are continued unaltered under these derived strata; and therefore the transitional line was then reached, as shown in fig. 2. The west face, shorter but well exposed (83 feet 6 inches long), is also reconstructed as far as it can be seen; and its south end affords no hint of the transition.

In the south-west corner of the pit, the sands have been exposed far south of the extreme southward extension of the west face of sand (for the gravel is first worked independently, and cleared out over a much greater area than the sand); and here too the beds are reconstructed. Therefore the transitional line cannot be looked for anywhere along the westward, north, and south limits of the pit.

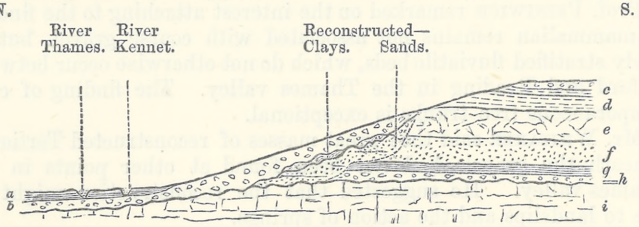
On the other hand, further east, at the base of the former south face (now a slope of turf), the men worked a bed of homogeneous clay for some little time for brick-making; and in the sands below they found no tree-trunks or bones, and there was no evidence of disturbance. The unfossiliferous character of the clay and the oblique lamination of the sands were distinct and characteristic. This south point is 276 feet from the north face. In this distance, therefore, to the south, are the unaltered mottled clays and buff sands of the Woolwich and Reading series, while to the north are reconstructed beds of the elements of these strata intermixed with the remains of a more recent period.

Somewhere south of the present exposure of the east face is the line of junction, which may have been in the form of a low cliff or

slope, of which the base was prolonged horizontally under the reconstructed bed (as seen in our pit), gently rising to the south as it approached the cliff. Fig. 2 is a section of the probable transitional line with the beds north and south of it. Such a line would be reached if the east face were exposed up to the south face. The line of junction is dotted in; for its exact direction can, of course, only be surmised. The irregularity in the junction between the unaltered and reconstructed beds, as shown by the latter extending further south at the west side of the pit, is only to be expected when it is remembered that the transitional line represents the sinuous margin of a river, and any little bay indenting the bank would carry the reconstruction into the concavity.

The relation of all these beds exposed in the pit to the whole south slope of the river-valley is well seen by ascending the incline to the limits of the Redlands estate (south). The arrangement is shown in a diagram in fig. 3; and the outcrop of the beds there

Fig. 3.—*Diagrammatic Section of South Bank of River-valley.*
(Slope greatly exaggerated, rise 79 feet in about 1 mile.)



a. Alluvial plain.
b. River-gravel.
c. High-level gravel.
d. Basement beds of London-clay.
e. Mottled clays.
f. Buff sands.
g. Leaf-beds.
h. Green flints.
Woolwich and Reading Series.
i. Chalk.

drawn can be verified quite satisfactorily. The gravel-bed (A in fig. 1) is seen to belong to the general system of the river-gravels.

South of the pit, ascending the slope, these gravels thin off and leave the mottled clay exposed at the surface; higher up these beds are covered by the basement beds of the London Clay, which were well exposed in digging the foundation of a house near the top of the slope. The basement beds are again capped, at the summit (79 feet above the river), by the entirely unstratified, unfossiliferous, high-level gravels, consisting of a large proportion of rounded quartzite masses and subangular flints.

Thus the south slope of the river-valley at the Redlands estate, affords a very perfect example of a typical valley-slope, and in addition presents the more exceptional appearances of the reconstruction of the Tertiary beds by fluviatile agency, in such a manner that the easily removable elements of the latter remain, though altered in structure and intermixed with the organic and inorganic remains of very different ages and widely diverse conditions. And the sec-

tions in this pit add another to the scattered evidences that occur at intervals along the valley of the Thames, proving the existence in some Postglacial time of a larger river occupying its valley and flowing at a level from 20 to 30 feet higher than the present; and in some parts of the pit the beds are so perfect as to afford evidence of the direction even of the minor currents of the river, while the organic remains give us valuable proof as to the fauna and flora that lived on its banks. When my attention was first directed to this pit, I perceived to some extent the interesting nature of the reconstruction, and sent a short account of it to Prof. Prestwich; and he very kindly came down and visited the pit, and pointed out that the reconstruction was even more extensive than I had imagined. I followed out his kind suggestion and made drawings of the best sections, and took careful notes of all parts of the pit; and from these and the specimens I have been able to collect, this paper has been written.

Discussion.

Prof. Prestwich remarked on the interest attaching to the finding of mammalian remains not associated with coarse gravel, but in finely stratified fluviatile beds, which do not otherwise occur between Oxford and Reading in the Thames valley. The finding of contemporaneous tree-trunks is exceptional.

Mr. Whitaker said that great masses of reconstructed Tertiaries beneath the gravels had not been found at other points in the Thames valley. He suggested that the reconstruction might be due to landslips and the action of springs.

Prof. T. McK. Hughes instanced a similar case of the reconstruction of Tertiary beds at the Upnor-Castle section.

The Author said certain proofs of fluviatile action in the reconstructed beds were found in the rolled tree-trunks, the waterworn bones, and the fine lamination of the sands and clays. In some instances the direction of the minor currents could be traced by the finely-bedded sands.