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to the late stage of the pleistocene, when the arctic animals were present in this country and on the continent in full force. He may have been in Europe before, and while the ice covered large tracts of land in this country, North Germany and Scandinavia, or in pre-glacial and glacial times, and he was an inhabitant of the Denbighshire caves after the ice of the second ice-period had passed away from that region.

On the EVIDENCE AFFORDED by the GRAVELS and BRICK-EARTH.
By PROF. T. MCKENNY HUGHES, M.A.

PROF. HUGHES said: I will confine my remarks to the East Anglian district, in which it has been stated that evidence of the existence of man before the close of the glacial period has recently been found. I have no reason to doubt the finding of the implements in the beds from which they are said to have been procured. Their occurrence in the section near Brandon has long been known, and also in many similar deposits throughout East Anglia. The only point that is new, is the assertion that these beds are of glacial age.

The question is entirely geological, and must be answered by an appeal to sections. I will endeavour to explain these in such a way that any one who wishes to go into the details may readily find the important points.

I shall use the word glacial in a wide sense, so as to include everything, from the beginning to the end of the last time, when conditions of extreme cold prevailed *in the area in question, or in adjoining areas so situated that by supplying ice, or influencing the climate they must have directly and greatly affected the area in question.* I avoid entering into the controversy as to whether there were one or more periods of extreme cold in late geological times, and also whether man may not have lived in France or Africa or a lost land in the Indian Ocean, while glacial conditions prevailed in Britain, just as man now lives in North Britain and Norway, while glacial conditions prevail in the interior and off the coasts of Labrador and Greenland.

We have in East Anglia deposits of post-tertiary age which for our present inquiry may be conveniently grouped under two heads.

B. The older, consisting of (1) an irregular lower boulder-clay succeeded by (2) stratified sands and gravels with subordinate loam or boulder-clay, and (3) an upper boulder-clay.

A. The newer deposits, being the products of the denudation by sea, rivers, rain, &c., of the above, and of any still older beds exposed. The beds belonging to the older series *B*, which occur in

the area of which I propose to speak, are to be referred chiefly to the middle group (2), which, to avoid repetition, I may speak of as the Hatfield Beds (probably the equivalents of the Middle Glacial of Searles Wood), and well seen in the railway cuttings north of Hatfield and elsewhere in that neighbourhood.

They may be traced from Hatfield, over the chalk spur by Welwyn, by Hertford and Ware (*see* "Quarterly Journal Geological Society," August, 1868) into the valley by Parndon and Harlow. They are seen at intervals, *e.g.*, by Saffron Walden, Chesterford, Whittesford, &c., assuming, as they go north, more and more of the character they have in the Brandon and Thetford districts.

It is obvious that these deposits partially filled the valleys and hollows, and that since their emergence, extensive valleys have been scooped out through them, generally along the old lines.

The earlier products of this denudation are of course of very great antiquity, and to them I would refer all the beds in East Anglia in which flint implements have been found.

Loams occur at various horizons in the older series *B*, and loams of various age and origin, are found in the newer series *A*. These loams are generally all so much alike, that it would be quite impossible to identify them with any certainty in separate sections by their lithological character alone.

Moreover, where an overlying loam is derived from an immediately underlying loam, it is often impossible to draw any line between them in one section, especially if the section is so small that the discordant overlap cannot be made out.

Even in chalk, the *remanié* top part cannot be distinguished from the somewhat weathered lower part, except where surface flints are found embedded. How much less can we expect to distinguish the resorted from the undisturbed material in the case of loam? Fortunately, however, most of the sections appealed to for evidence of the glacial or inter-glacial age of man in East Anglia are of considerable extent, and owing to various happy circumstances tolerably clear.

I will now give my interpretation of them. In the large pit at the new Waterworks for Thetford, there is a loam on blue clay, which rests on a loam similar to that above, and below this, boulder-clay has been proved to 60 feet. All these I refer to *B*. In the adjoining pits it can be seen that a newer loam, sand and gravel rests irregularly now on one, now on the other of the above-mentioned beds. These I refer to *A*.

In an old pit, north of Thetford Station, gravel (*A*) may be seen resting irregularly on blue gault-like clay (*B*). In a large pit north-east of Thetford Station there is a section about 32 feet deep, in which the upper loam, sand and gravel (*A*), is seen resting irregularly on boulder-clay (*B*), which is here often

composed almost entirely of chalk. At the base of the troughs and pans of the upper loam, &c. (*A*), there are generally lines of sifted or sorted material, such as, *e.g.*, sometimes a bed which seems derived almost entirely from the Kimmeridge clay, or from the Neocomian. The different specific gravity of the material would probably be sufficient to explain such washing together of different material out of the drift to various positions in the channel.

In the Culford brick pit (near West Stow, Bury St. Edmunds), boulder-clay is seen resting on buff loam, with often a bed of sand to 3 feet in thickness between the clay and the loam. There was not much evidence, but it seemed to me that all the deposits in this section should be referred to the lower series (*B*). So far, I have given sections in which any one may see what I mean by the series *A* and *B*.

Looking from Culford, across the alluvium of a small tributary of the Lark, and above the obvious terrace of gravel at the base of the hills on the other side, we see far up the slope traces of an obscure terrace, becoming more and more clear and well defined as we follow it to the left towards Icklingham. Near the farm at the Icklingham end, there is a deep pit in brick-earth, with pupa, pisidium, bones and antlers. In the upper loams (*A*), all along this terrace, pupa and pisidium are not uncommon. I am not aware that they have ever been found in the underlying series (*B*). Underneath the brick-earth, and exposed at the surface in a pit a little nearer the Beeches Pit, is a bed of gravel just like any ordinary gravel along the river terraces of that district, or of the Thames or the Somme. Further on, where the terrace is almost obliterated, the Beeches Pit occurs. In this pit there is a yellowish loamy boulder-clay (*B*), and in distinct and well-defined hollows in this boulder-clay, a series of loams, sands and gravels (*A*), at the base of which occur bands coloured by black and red oxides of iron and manganese, in which I saw bones and antlers, and in which the flint implements are said to have been found. Patches of rainwash (or head or run of the hill), derived from boulder-clay or chalk or loam, as the case might be, rest irregularly on either *A* or *B*. But no undisturbed boulder-clay overlies the implement-bearing bed.

The next section I shall refer to is that on Broomhill, at Botany Bay Brickworks, near Brandon, in which also flint implements have been found. The workman has been collecting for some time, but has never had a genuine specimen when I have visited the pit. He pointed out the exact position from which he had obtained them, which was in a band of clayey gravel coloured by oxides, and in all respects resembling that

which forms the lining of the troughs and hollows in the Beeches Pit. It seems to be an old deposit, in the upper part of what is now a dry valley, which has been scooped out through a great mass of loam, boulder-clay, &c. (*B*), which had partly filled it. Implements are said to have been found also in the south corner of the same pit where the beds are let down in pipes, and somewhat contorted. Such contortions are often due to the removal of part of the calcareous matter of the chalky gravel or loam or the underlying chalk itself, and the consequent dropping in of the earthy residue and overlying beds. Some of the curves are apparent, not real contortions, being due to the alteration of colour by infiltrating water. But this section is not clear.

On the whole, the evidence goes to show that from the first emergence of land out of the glacial sea, sub-aërial and aqueous denudation have been working at it and cutting it down often along the lines of old pre-glacial valleys, leaving a river terrace here, a mass of rainwash or other talus there; estuarine silt in one place, pond-mud in another, and that man appeared on the scene early in this post-glacial period.

Before that emergence, icebergs and coast-ice carried their load south, and dropped it in the sea (witness the boulder-clays with shells or shore shingle or beds of sand). Sometimes the ice grounded (witness the great furrows and the contortions). Sometimes the sea sifted the material (witness the sorted and stratified gravel, and sand, and loam, and clay). Sometimes the ice dropped it as it got it (witness the boulder-clay with moraine-like masses). Even in the midst of such unfavourable conditions man may have been a not unfrequent visitor, as now, along the shores of arctic seas, but as a matter of fact, there is as yet no evidence that man was there.

On the AGE of the HYÆNA-BED at the VICTORIA CAVE, SETTLE, and its bearing on the ANTIQUITY OF MAN. By R. H. TIDDEMAN, M.A., F.G.S., of H.M. Geological Survey.

It was lately remarked in a discussion at the Geological Society, arising upon Messrs. Mello and Dawkins' papers, on the Creswell Crag Caves, that the "whole matter" of the antiquity of man, so far as the the Victoria Cave bore evidence, resolved itself into a very small point. The speaker, Dr. Murie, went on to state, that "he had examined a certain bone from the cave, hitherto supposed to be a human fibula, and in his opinion it might be almost any bone, and that all ideas of the habits of the