

RAISED BEACHES AND SUBMERGED FORESTS.

ABSTRACT OF PAPER BY R. N. WORTH, F.G.S., ETC.

(Read January 22nd, 1885.)

THE Lecturer's remarks with regard to the Raised Beaches and Submerged Forests of the Plymouth area were as follows :

The Hoe Raised Beaches attracted notice more than sixty years ago. The earliest published record of them with which I am acquainted is by the Rev. Richard Hennah, F.G.S., in 1817;¹ and a few years later he summed up his observations in the following words :

"In many parts of the Hoe, on the declivity towards the sea, about fifteen or twenty feet above high-water mark, and in other places also, there is a bed of sand and water-worn pebbles, varying in thickness, from less than a foot to that of two or three, cemented together in layers, which layers, however, are composed of pebbles about the same size . . . strongly indicating that this was, at a remote period, the level of the sea."²

That Mr. Hennah was the discoverer of this Beach, first distinctly exposed by the cutting of a road round the Hoe in 1816, is stated by Dr. Edward Moore.³

In 1832 the Beach, as it then appeared, was described by Sir H. de la Beche,⁴ and it is subsequently mentioned by him, in 1839,⁵ as one of those most worthy of observation in the Western Counties, though not then described. In the latter year, however, it was not only described, but figured (in part), by Mr. J. C. Bellamy, as it appeared in the month of May. He states that at the Western Hoe, "at an elevation of *about fifty feet above the present sea,*" a "most interesting section" had been exposed, "*about twenty feet in depth.*"⁶ He then proceeds :

¹ *Geo. Trans.* 1st Series, vol. iv. p. 412.

² *Succinct Account of the Lime Rocks of Plymouth*, p. 58.

³ *Rep. Brit. Assoc.* (1841) *Trans. Secs.* p. 62.

⁴ *Geological Manual.* ⁵ *Rep. Dev. Corn. and W. Som.* p. 428.

⁶ *Natural Hist. of S. Devon*, pp. 114-5. The italics are Mr. Bellamy's.

"The entire body of the beach rested on *smoothened* rock ; it *sloped* very gently seawards, that is to say, southwards, and had *no inclination to dip east or west*, as if the upheaving force had tilted it to one of those points. The mass consisted of *thin beds or layers*, from one to four or five inches thick, *regularly superposed or stratified*, and varying most systematically *from extremely fine sand to tolerable-sized pebbles*, the several sorts *never appearing to exchange position*, but keeping uniformly to those beds to which they belonged in regard of size. Each layer formed a *solid cake*, increasing in compactness towards the centre of its depth. The layers also were greatly cemented together ; but not so firmly as were the components of each distinctive stratum. The *top differed from the rest*, in being several feet thick, and in being composed of sand of uniform size, and in great measure loose or incoherent."

We are fortunately enabled to supplement this description from Dr. Moore's paper already cited, which deals with the Beach at practically the same date. The abstract of his paper states:¹

"The raised beach . . . has lately, by the extension of the quarry near which it was situated, been almost entirely removed. . . . It was ascertained to occupy a depression in the face of the limestone cliff, 100 feet wide and forty deep ; its base is thirty-five feet above the present sea at high-water spring tides ; it runs upwards and backwards twenty feet, inclining inwards with the slope of the rock, and is covered by ten feet of gravel, thus making its entire elevation sixty-five feet above the present sea level. It is composed of fragments of rocks of the neighbouring shore, such as limestone, slate, red sandstone, and reddish porphyry, together with quantities of granitic sand, which is arranged in consolidated horizontal layers or false bedding, with intervals of loose sand ; a few shells (*Patella* and *Buccinum*) have been found in it ; and recently on its upper part, ten feet below the surface of the present soil, were discovered bones and teeth of the elephant, rhinoceros, bear, horse, and deer ;² also caudal vertebrae of the whale, and the lower valve of a large oyster."

For some forty years from the date of this paper the "Raised Beach on the Hoe" was almost a matter of pure history. On the

¹ *Rep. Brit. Assoc.* (1841) Trans. Sec. pp. 62-3.

² These had nothing to do with the beach, but were simply *on* it. They were very fragile, and belonged to a deposit of the cave era. The bones of the whale, on the contrary, were water-worn.

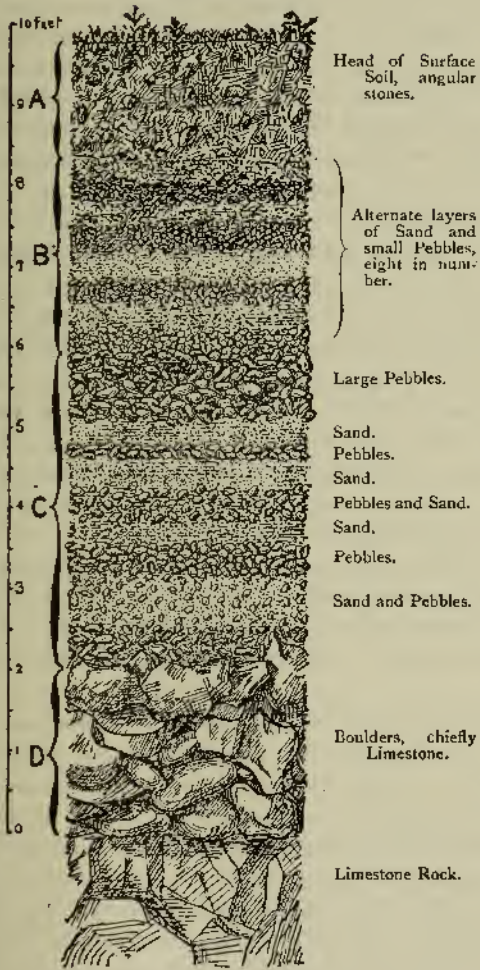
west it had been wholly destroyed by quarrying; on the east, with the exception of a few insignificant fragments on the verge of the cliffs, what remained was hidden by the turf. In June last, however, alterations in the road at the junction of the two divisions of the Hoe caused the hill to be cut back several feet. As a result, not only was the Raised Beach again exposed, but more effectively than at any previous time. Fortunately for the interests of science the workmen were under the direction of Messrs. Harris, Bulteel, and Co., of the Naval Bank; and Captain Daubeny not only at once recognized the importance of the discovery, but afforded every facility for development and examination. In its main features the new exposure fully bore out the accounts of Mr. Bellamy and Dr. Moore, but showed that on several points their descriptions required supplement and emendation.

At its most perfect exposure the Beach was 8 ft. 6 in. in thickness, varying but slightly over a section length of half a dozen yards. When first opened upon its top was 40 feet above the highest point of the modern beach; but as it ascended with an easy slope back into the hill, when the cutting was finished it had been traced to a point three to four feet higher, and its termination had not been reached. The extreme height above the present beach-level would, therefore, approach 45 to 50 feet.

The section was characterized by four well-marked divisions. At the top, immediately beneath the turf, was a head of earth mixed with rubbly angular stones, 18 inches in thickness (*a*). Next came $2\frac{1}{2}$ feet of sand and very small pebbles in layers, apparently eight in number, fairly equal in thickness, approximately horizontal, commencing with sand and ending with a mixture of the two constituents (*b*). Below this was a series of layers of pebbles and sand alternating, 3 ft. 10 in. in total thickness (*c*). The pebbles did not average more than one to two inches in length; but many were much smaller, while a few comparatively ranged up to four and five inches in longest diameter. There were nine layers in this series, and, as a rule, the materials were well assorted as to their respective dimensions, and only in three of the larger was there any noteworthy admixture of pebbles and sand. Lastly (*d*), there came a bed of large blocks of stone, chiefly limestone, with rounded edges, clearly waterworn, and ranging in size up to a couple of hundredweight, and even more. This stratum was two feet in thickness, and rested on a shelf of rock which sloped seawards.

SECTION OF HOE RAISED BEACH.

JULY, 1884.*



* I am indebted for this illustration to the courtesy of the Royal Cornwall Geological Society.

The different layers exhibited varying degrees of cohesion. The upper beds, in the main, were crumbly, but consolidated patches were of frequent occurrence. The lower beds were at points so solid that they defied the pick, and had to be broken up by blasting. Here and there the layers of smaller pebbles appeared to have been considerably influenced by pressure, having assumed an aspect of remarkable solidity, in which the individuality was partially lost. The main cause of cohesion was, however, the infiltration of water charged with carbonate of lime from the limestone bluff.

The most remarkable feature of the Beach was the character of its materials. The modern beaches of the Sound area are in the main formed from the rocks immediately contiguous. At the Hoe they are in chief part of the local limestone. Not so this ancient sea margin. Save in the lowest, or boulder bed, limestone was of quite exceptional occurrence. Pebbles of red and grey grit were much more frequent, and fragments of slate occasionally occurred. The predominant constituent was, however, the Triassic trap of Cawsand Bay. This is equally true of the larger pebbles and of the finer material classed as sand. The granitic sand spoken of by Dr. Moore was nowhere visible, and he was probably there in error. There were some granules of quartz, but of no more importance than the quartz pebbles and fragments to be found in every modern beach in the neighbourhood.

Now the only actual beach in the locality that presents any likeness to this ancient beach is that at Cawsand, two miles distant across the Sound, and in constitution the two may be regarded as practically identical. But this fact suggests a somewhat difficult problem.

Undoubtedly the materials of the Raised Beach were carried to the Hoe from Cawsand Bay, round the eastern point of Drake's Island; for a boulder of upwards of 2 cwt., derived from an exposure of peculiar trap rock which occurs only in the island in this immediate locality, was found in the basement bed. What is now the island then formed part of the main peninsula of Mount Edgecumbe. The drift to its eastern end was thus along shore, and easily explicable. But how did the materials cross the channel between the island and the Hoe? It is true the distance is only half a mile, but for a couple of hundred yards the interval is occupied by a portion of the deep water-trough, which reaches from near Mount Batten to Saltash Bridge; and the present low-water depth

here is 15 fathoms. It is quite clear that considerable modifications in the relations of land and sea have taken place since the Raised Beach era.

Among the shells yielded by the Beach are those of whelk, limpet, oyster, cockle, and periwinkle; and a few nodules of umber, evidently the result of limestone decomposition, were mixed with the pebbles.

The points at which Submerged Forests have been recorded in the neighbourhood of Plymouth are Sandycove—a spot now obliterated on the eastern side of Millbay, near the pontoon—and Bovisand. I have been unable to detect any traces of a peat bed or allied deposit elsewhere in Millbay, or in the recent excavations made in what was anciently the Surpool area; but that a forest growth extended up the valley of the Plym is clear. Mr. J. C. Bellamy¹ notes its occurrence in the bed of the Laira; and there is a piece of wood in our Museum dug from this locality at a depth of thirty feet from the surface. What is especially important here is that the same writer records—“A piece of oak *bearing marks of the axe* was taken up some years ago in sinking a shaft in the bed of the Laira, at a considerable depth. It may be seen in my brother's museum, Plymouth.”²

The Bovisand submerged forest is now mainly represented by a peat bed which extends some distance from the beach up the little valley beneath the soil. Beyond trunks of trees (sometimes seen *in situ* beneath the water after storms) no discoveries of note appear to have been made here; but I have observed in the peat diminutive patches of earthy blue iron ore, or vivianite—phosphate of iron—which curiously enough is also associated with the forest deposits of Pentuan.

Our most interesting local example of submerged forest growth is put upon record for the first time to-night, although discovered some forty years ago.

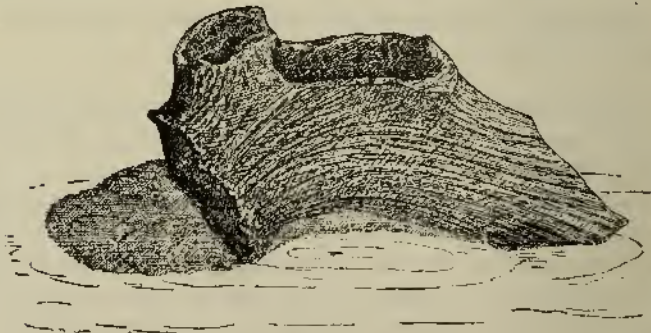
The Museum of our colleague, Mr. Brent, contains a fine implement made of the horn of the red deer, which was found in the course of excavating for the formation of the Keyham Docks. Having seen this as a child, in an exhibition held in connection with the Devonport Mechanics' Institute, I had some recollection

¹ *Natural Hist. of S. Devon*, p. 108.

² *Ibid.*, p. 124.

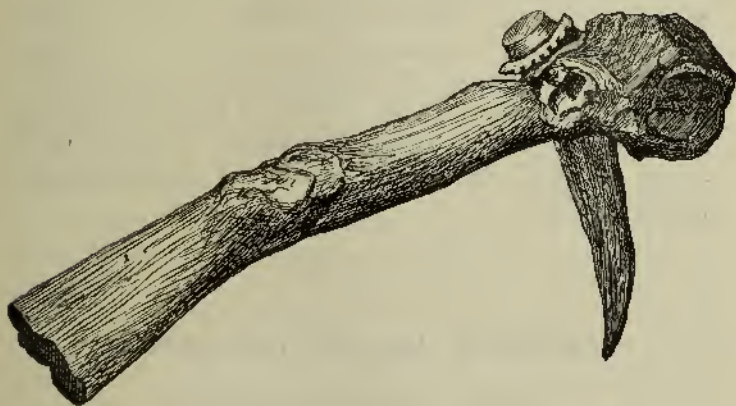
of having heard that other horns and trunks of trees were found at the same time ; and a few weeks since applied to our late townsman, Mr. Alexander Hubbard, by whose firm the excavation for the docks was carried out, for any information he might be able to give. Fortunately he had the information needed ; and he very kindly sent me not only a statement of what he recollected of the facts, but a sketch of the site before the works commenced. The original water-line ran at an angle with the Saltash Road, in such a manner that the whole of what is now the South Basin, and all except the north-eastern corner of the North Basin, were below high-water mark. Where the tide flowed the slate rock of the locality was covered with mud, and at the south-western corner of the South Basin the rock was fifty feet below high-water springs, and buried in mud to the depth of twenty-five feet. At the north-western corner of the North Basin the rock was about eighteen feet below high-water springs, with very little mud covering it ; in fact, at extreme low tides the rock was visible. The mud was of a fatty, alluvial character ; and (I quote here Mr. Hubbard's own words) "there was scarcely any vegetable remains or anything like a peat bed, *except* in one place, where there was nearly one foot of it and an old trunk of a tree blackened, somewhere near the centre, between the two basins." The evidence therefore is ample, that although the extent of the portion left could not have been large, the remains of a true submerged forest in the estuary of the Tamar were discovered when the Keyham Docks were made.

And the chief interest to us here is that this ancient forest bed, like those in Barnstaple, Bridgwater, and Tor Bays, and those



KEYHAM PICK.

at Carnon and Pentuan, yielded unmistakable evidence of the presence of forest man. The deer horn implement to which I refer bears the original label: "Horn found about seven feet below the surface in excavating for the North Basin, Keyham." Its extreme length is eight inches, and its largest circumference the same; while the base of the antler is three inches across. A mortise hole is driven in it $2\frac{1}{8}$ inch long, by $1\frac{1}{8}$ inch wide. The part of the horn which I assume formed the digging part of the implement has broken, but shows signs of subsequent wear. This tool naturally connects itself with the kindred implements found at Torbay and at Carnon. Opinions have differed as to whether we have in it a portion of a pick, or the haft of a celt or stone axe; but I have no doubt myself it is the former. The ancient flint workings at Brandon, in Suffolk, have yielded many examples of the natural deer horn used for digging purposes; the main stem of the antler being the shaft, and a tine the pick proper. Similar implements have been found in the mines of Cornwall; but one unearthed in the Carnon stream works at a depth of forty feet displays a marked advance; for a mortise has been cut in the main shaft of the antler, and a tine inserted in the aperture in such a way as to produce a far stronger and more effective tool than the adaptation of a portion of a horn in its natural state could possibly supply.



CARNON PICK.

Now this is much what was done in the case of the Keyham pick. The more massive portion of the antler has been pierced; but in this case for the reception of the haft, and not of the tine—the complete implement being partly of wood (the shaft) and partly of bone (the head). We have thus what we may call the third stage in the evolution of the pick. First there is the natural antler, as at Brandon; then the mortised and adapted antler, as at Carnon; and lastly, the antler ceases to supply both shaft and prong, and a far more formidable and effective tool is made by turning the antler itself, and not merely a tine, to full account by hafting it with wood.

THE TRINITY CORPORATIONS.

SYLLABUS OF PAPER BY F. J. WEBB, F.G.S.

(Read January 29th, 1885.)

INTRODUCTORY notice of growth of the Naval and Mercantile Marine of this country. Chaucer's *Schipman*. Hull in Chaucer's time. Sketch of the history of the Hull Trinity Corporation. Its constitution. The benefits conferred by the Corporation upon the Mercantile Marine. Sketch of the history of the Newcastle Trinity Corporation. The transference of certain of its functions to other bodies. Sketch of the history of the Leith Trinity Corporation. Its benefit societies. Sketch of Deptford, commonly known as the London Trinity Corporation. Substance of its several charters. Its gradual growth and development, and present position.

PAUPERISM AND ITS PREVENTION.

LECTURE BY REV. CANON BLACKLEY.

(Read February 5th, 1885.)