of muscular impressions are visible, excepting those on both sides of the elongated median ridge, and probably the narrow impressions going from the exterior margin of the adductors towards the margins of the valves. It is also possible that muscles were attached in the apical corners of the ventral valve.

If, however, *Trimerella*, by reason of the structure of its median muscular impressions, is related to the *Lingulidæ*, it is widely separated from them in another respect, as its dorsal valve is provided with a large tongue-shaped process (possibly the *processus cardinalis*?), by means of which it is articulated to the ventral valve. This process fits into a semilunar groove below the area of the ventral valve, and this area is formed by the lamellæ, that one by one have been secreted above the semilunar groove (Pl. XX. Fig. 7).

Another anomaly of which I have not seen any homology amongst the *Brachiopoda*, is that the lateral margins of both valves are grooved by a furrow, shallow at the ends and deepest in the centre. These furrows encircle the opposite margins, and make the valves close more tightly.

The valves attain a thickness of 15 millimètres, and consist in their perfect state of calcareous spar, and show no traces of any organic structure.

EXPLANATION OF PLATE XX.

- FIG. 1. Interior of ventral valve restored.
 „ 2, 3. Casts of both valves.
 „ 4. Cast of dorsal valve of *Obolus* ? *Davidsoni*, Salter (Gotland).
 „ 5. Section of ventral valve at the openings of the siphons.
 „ 6. Section of the same showing the concentric calcareous secretions around the siphons.
 „ 7. Cardinal process of dorsal valve fixed in the ventral valve.
 „ 8. Side view of dorsal valve.
 „ 9. Section of ventral valve at the apex.
 „ 10. Interior of the dorsal valve of *Obolus*, sp. from a cast in gutta-percha.

II. — ON SOME CAVITIES IN THE GRAVEL OF THE VALLEY OF THE LITTLE OUSE, IN NORFOLK.¹

By JOHN EVANS, F.R.S., F.S.A., Sec. Geol. Soc.

A FEW months ago both geologists and archæologists, and especially the latter, were surprised to hear of the discovery in the valley of the Little Ouse, between Thetford and Brandon, of certain cavities in beds of gravel, in which flint implements of the forms peculiar to the Palæolithic or river gravel were found, and which it seemed possible might have been the habitations of the early race of men who formed these implements.

An account of this discovery was communicated to the Norwich Geological Society, and also to the Norfolk and Norwich Archæological Society, by Mr. Sheriff Fitch, F.S.A., F.G.S., to whom the credit of first observing these cavities is due, and who I was in hopes would have made a communication on the subject instead of leaving it for me to do.

¹ Read before Section C. of the British Association, Norwich, August 23rd, 1868.

From Mr. Fitch's account it appears that at Santon Downham and Broom Hill, two of the places where gravel is dug between Thetford and Brandon, holes or excavations occur in the beds of gravel at about ten feet from the surface. The beds of gravel in the immediate neighbourhood of these cavities are said to be disturbed, so that the workmen know when they are approaching them, and the implements were said by the workmen to be found lying at the bottom of these holes.

Mr. Fitch had an opportunity of seeing one of these cavities opened in the pit near Santon Downham. It was large enough to allow him to stand inside, a layer of dark clay lined the bottom of the hole, and this formed a basin-shaped floor. Its roof was beautifully rounded and smooth, and had all the appearance of design, and on excavating at the bottom, a flint implement of a Palæolithic type was found.

The workmen maintained that there was little chance of finding implements, unless when working near, or in similar holes, of which some fifteen have been found within a limited space.

Mr. Fitch, while contenting himself with stating bare facts, and without trusting himself to any theory, could not but say that the appearances presented were exceedingly suggestive. He adds that "one cannot help thinking that it looks very much like a colony, and if these holes are of human handiwork, it must bring the age of the flint implements considerably nearer to the Historic epoch than has been usually attributed to them, for the excavation of the holes must necessarily be of later date than the gravel beds in which they occur.

"Elsewhere, as at Brixham, Torquay, and other localities in England and on the continent, caves in the solid rocks have yielded implements, and the occurrence of wrought holes in the hard gravels indicate a similarity of habit as regards the choice of dwelling-places, for we must allow that even these primitive men needed shelter from the inclement climate of that distant period.

"It seems to me, that if we are to discover human bones at all, these caves are the likeliest spots to look for them.

"At Broom Hill, bones are frequently found in the made earth or 'trail,' but not in the underlying gravels.

"The caves have had some communication one with another, for we are safe in presuming that wherever man lived, he was always a gregarious or social being."

Like many others, I was of course much interested in this report, though I could not regard the question in the same light as those who had personally witnessed the phenomena. I at once wrote to Mr. Fitch, suggesting a possible cause for the existence of such cavities, and requesting him to give me notice of the next occasion on which one of them was found capable of examination.

In the meantime, my friend, Mr. J. W. Flower, came down to Norwich, and on his way back to London, he stopped at Brandon, and found that in the Broom Hill pit, about a mile and a half from Brandon station, the workmen had come across one of these cavities,

which, however, with the exception of a small opening in it, was left entirely undisturbed. On hearing of this discovery I immediately arranged to go down and examine into the phenomena, and accordingly, on the 8th of July, Mr. Flower, Mr. Fitch, and I met upon the spot. We found a face of gravel and sand exposed, about 24 feet in height from the chalk at its base to the superficial soil at the summit. The upper part of the section showed sand with a few gravelly seams, about eight or ten feet in thickness; at the base of this occurred a dark band of ferruginous argillaceous sand a few inches in thickness, then some eight or nine feet of ochreous gravel, with a red sandy matrix, which was separated by a band of grey sand from the lower beds of gravel which contained a very large percentage of rolled Chalk and seams of chalky sand.

The opening into the cavity was not much more than a foot in diameter, and was about the middle of the bed of ochreous gravel. It was soon sufficiently enlarged to enable one of us to creep in, and by the aid of a candle to examine the cavity. It was slightly irregular in form, and seemed about three feet in diameter and about five feet in height, but we did not take any accurate measurements, as we were in constant fear, and not without reason, of the face of the cliff of gravel falling in upon us. The bottom of the cavity had some sand upon it, which had fallen from the roof, the cavity extending upwards through the gravel, so that its ceiling was formed by the base of the sands above. The axis of the cavity was not quite perpendicular. Having examined it as far as was consistent with safety, we next commenced cutting a vertical groove in the face of the gravel below, with a view of ascertaining whether, as I had suspected, there was not a sandpipe below, the absorption of the gravel into which was the primary cause of the cavity. The second blow of the pickaxe broke through the wall of gravel and at once revealed a sandpipe, thus proving my view to have been correct.

We at once proceeded to clear it out as far as was consistent with safety, and found that at about three feet above the base of the gravel the pipe was about two feet in diameter and nearly circular, but whether it descended into the Chalk we were unable to see, and before we left the pit the face of the gravel cliff gave way, and the scene of our operations was buried under a mass many tons in weight. During our examination of the pipe, and while we were speaking of the occurrence of flint implements in these cavities, one of the pointed form was found under our eyes by one of the workmen among the gravel he was clearing out of the pipe.

The existence of this sandpipe below the cavity, similar in character to the pipes so frequently occurring in sands and gravels overlying calcareous strata, at once proved that these cavities were of natural and not of artificial origin. As, however, such cavities are of extremely rare occurrence, and have not, I believe, been previously noticed except by Mr. Fitch, who did not enter into the question of their origin, it will be well to devote a short time to a consideration of the causes to which they are due.

Mr. Prestwich was, I think, the first to point out that such pipes

in the Chalk are due to the percolation of water charged with the carbonic acid derived from the decomposition of vegetable matter, which dissolves the calcareous portion of the Chalk, leaving any argillaceous particles behind, with which (and with the superincumbent gravel, sand, or clay, which descends as the calcareous matter beneath is removed,) the pipes are usually filled. The arrangement of the matter enclosed in the pipes and of the bands of flints through which they sometimes pass, proves the correctness of Mr. Prestwich's views. The general action of the carbonated water on calcareous strata is evinced by similar pipes occurring in Oolitic beds, such for instance as the celebrated natural wells near Poitiers and in the Coralline Crag of Suffolk, which in some places, as in a pit not far from the Railway Station at Aldeburgh, is absolutely riddled with such pipes. And not only have such pipes been formed in this manner, but the whole upper surface of the Chalk, where covered by beds of gravel, appears in many instances to have been so eroded that the beds which would seem to have been originally laid out horizontally on an approximately smooth base, now rest upon a rough and irregular surface full of peaks and hollows. Where, as is sometimes the case, the gravel in pits has been cleared away completely, so as to leave the upper surface of the Chalk bare, a sort of model of a mountainous country is presented to our eyes.

We have seen that in nearly all cases the pipes that have been thus gradually eroded, have been filled by the superincumbent beds gradually following down, but we can readily conceive instances in which some one or other of the upper beds might be so tenacious as not to subside into the hollow beneath until a large superficial area was left unsupported. The result in such a case would be a cavern of greater or less magnitude, from the bottom of which proceeded a pipe passing through calcareous rock, and filled with the remains of the less tenacious beds underlying the more unyielding bed, which would form the ceiling of the cavern. These conditions were fulfilled in the cavity in the Broom Hill Pit, where the tenacious bed was the sand with the compact argillaceous band at its base, the incoherent beds which filled the pipe were the ochreous gravel and sands, and the pipe was eroded through the calcareous gravel, and probably into the Chalk itself. Since then, in fact within the last few days, I have had another opportunity of visiting the pits at Santon Downham, of there inspecting one of the caves, which, however, it was not possible thoroughly to investigate. Only the upper part of the cavity was visible, of a regular vaulted form, the sides being formed of coarse incoherent gravel, while the roof or ceiling consisted of a much finer gravel, with a more coherent matrix of red sand. The bottom of the cavity was at the time filled with coarse gravel fallen in from the sides, and there was no opportunity of observing whether there was any sandpipe at the bottom, though no doubt such was the case. In the wall of gravel close by, there were two sandpipes in which the upper beds had followed down in the usual manner.

With regard to the supposed almost exclusive occurrence of the

flint implements in connection with these cavities, it is to be observed—1st. That the evidence of such being the case is not susceptible of cross-examination, and moreover that one of the workmen remarked to Mr. Fitch and me on what he regarded as a singular fact, that no implements were found in these holes; and, 2ndly, that if the pits were found in the proportion of 12 or 15 to an area of a few score square yards, as has been stated, and implements were found at all, it would be singular indeed if they were not found either near or in the cavities, with which too the workmen would naturally associate them. As a matter of fact, however, the implements do occur in other parts of the gravel than in or near the cavities, and some of those at Broom Hill have occurred in the lower gravel with the calcareous matrix.

It is, however, *a priori* improbable that such a gravel, a great part of the constituents of which appears to have been derived from the destruction of some river bluff, should contain so many relics of human handiwork as gravels derived from the washing away of some once-inhabited surface.

If, however, it be true, as is generally believed and asserted, that the flint implements occur in most abundance at the base of these fluviatile gravels with a sandy nature, there is a reason why they should be found not unfrequently in the pipes into which, of course these lower beds of the gravel would be let down. I have known instances at Thetford where the gravel has been extracted from pot-holes running down into the Chalk, and in which implements have been found at a considerable depth. The celebrated pit at Drucat, in the valley of the Somme, affords another instance of implements occurring in these pipes.

Mr. Prestwich has already, in his valuable memoir communicated to the Royal Society, suggested that these pipes may eventually afford some means of estimating the antiquity of the beds in which they occur. It is, however, extremely difficult to ascertain the exact amount of carbonic acid which, on an average of years, the percolating water of each year would contain. Could we, however, ascertain the exact drainage area of one of these pipes, I think that some sort of calculation might be made. For we know by experiment the number of inches of rain which, with our present climate, percolate annually to the springs in a Chalk district, while we also know the quantity of chalk in solution held by each gallon of the spring water. It must, however, be borne in mind that in all probability the maximum quantity of carbonate of lime in solution is not attained until after the water has percolated a considerable distance through the Chalk. But without entering into any such calculation, I think it must be evident that a cavity large enough "to hold a cart inside," eroded by the carbonic acid of vegetable matter decaying on the surface, and carried down by the rain, implies a lapse of time for its erosion such as is quite in accordance with the antiquity which from other considerations must be assigned to these beds, containing as they do the undoubted handiwork of our barbaric forefathers.—Reprinted from the *Norfolk News*, August 25th, 1868.