THE BONE CAVES OF THE PLYMOUTH DISTRICT.

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(Read February 29th, 1879.)

I HAVE to invite attention to the bone-bearing caverns of the limestone of Plymouth. Cave-hunting is a purely modern branch of science. For hundreds of years the bones of extinct animals have been found at frequent intervals in cavern and allied deposits; but it is only in our own time that they have been really understood. Nearly all the stories of buried giants can be traced to the discovery of the bones of a mammoth, or of one of its huge allies. And even when comparative anatomy began to be developed, the lesson these remains had to teach remained unread. Elephant bones found in England were assigned to animals brought over in the army of Julius Cæsar. Relics of the rhinoceros, tiger, bear, and hyæna, were traced to the losses sustained by travelling menageries. And when their quantity utterly disposed of such random hypotheses, it was suggested that the animals were borne hither on the wave of the deluge. Anything seemed preferable to the simple truth-that herds of elephants once roamed the wastes of Britain; that the hippopotamus dwelt in its rivers; that the rhinoceros lurked in its swamps; that its woods and jungles were peopled by the lion and hyæna, and by that still more terrible beast, Machairodus latidens, the great sabre-toothed tiger; that bears haunted its mountains; that its plains were covered with droves of gigantic cattle, the urus and the aurochs, with the stately Irish elk ; that even the reindeer found fitting quarters ; and that in the midst of this strange wealth of animal life man maintained a precarious existence, notwithstanding the seemingly unequal conflict forced upon him by his dangers and his needs.

That such were the denizens of our land down to a time when it received the main outlines of its present contour, we have learnt from the cavern researches of the present century, commencing in Devon, here at Oreston, and illustrated most cogently by the revelations of Kent's Hole and Brixham. But we have lost much. Long before they attracted scientific notice, and in too many cases since, the contents of bone caverns met with no better fate than that of being turned to road-mending, thrown into limekilns, or sold at so much per pound to the marine store dealer.

Because our district holds such an important relation to this branch of science, and because the latest bone cavern of the locality came under my own investigation, I have been led to direct attention to this subject. Nearly all that had been written about the Oreston caves up to 1872, was published by Mr. Pengelly, F.R.S., F.G.S., in the *Transactions of the Devonshire Association* for that year;^{*} but the Oreston, though the principal, are not the only ossiferous deposits of the Plymouth linestone; and it is my present aim to present a complete consecutive history of all the bone caves of Plymouth, including therein my own observations.

The Plymouth limestone forms a band averaging above half a mile in width, and extending six miles from the Dockyard on the west to West Sherford on the east. It has an average height of one hundred feet above mean sea level; and its beds have a general southerly dip. A more constant feature than its bedding is the regularity of its divisional planes, those approximately perpendicular joints or divisions which cut the rock at right angles to the bedding in two great series, in a northerly and southerly, and casterly and westerly direction, and may be seen traversing the face of the quarries from top to bottom. These planes are the result of causes subsequent to the formation of the rock, which, with the aid of the bedding, they break into rhomboidal masses, suggesting a rude kind of crystallization. In these joints the caverns originate. Water charged with carbonic acid exercises a chemically solvent power over limestone. Finding its way into the joints from the surface, it eats away by slow degrees the rock-faces exposed to its action. Hence the caves. Give the water time, and it will work wonders. When the water is overcharged with lime redeposition is set up, and stalactite and stalagmite result. Where the underground current is most persistent and extensive there most work will be done. The caverns commonly run with the joints and across the bedding. At one point of Cattedown, and again immediately opposite at Oreston, there is a continuous line of cavities

* Vol. v. part i , pp. 249-316.

midway in the face of the eliff. These reveal the existence in former days of a considerable subterranean waterflow; and, as a natural drainage level, show that during their formation there was little change in the relative positions of land and sea—marking the point where the waters percolated to their outlet in the open channel. A distinction has been drawn between fissure and tunnel caverns, convenient for descriptive purposes, but non-essential. A tunnel cavern eroded until the roof gives way becomes a fissure cavern; while should the fissure be closed by breecia cemented by stalagmite, the tunnel phenomena would be reproduced. Every cavern—fissure and tunnel—must during its formation have possessed some surface communication, though the opening may have been subsequently closed.

Interest in cave-hunting began to be shown early in the present century. When Mr. Whidbey was appointed superintendent of the Breakwater Quarries, in 1812, he was requested by Sir Joseph Banks to examine any caverns he might meet with, and have any bones or other fossil contents carefully preserved.^{*} We are not told what was the originating cause of this request; but so far back as 1786, at Kirkby, in Yorkshire, bones † had been discovered in limestone fissures, and used for road-mending. Possibly the loss of this opportunity prompted the action taken with regard to Oreston. Nor was the attention given without result. In 1816 an ossiferous fissure was discovered at Oreston; and this was the first bone cave in England which was made the object of scientific enquiry.

In November of that year a number of bones of the rhinoceros, portions of the skeletons of three distinct animals, in a perfect state of preservation, were found embedded in clay in a cavern near the base of the cliff. The cavern was 160 feet in the hill from the original edge of the cliff, and was reached after blasting away 60 feet of the rock horizontally (100 feet having been previously removed). The face of the rock was 74 feet perpendicular above high-water mark. The bones were found at a depth from the sur-

* Sir Everard Home, "Phil. Trans.," 1817, part i. pp. 176-182. Cited "Devon. Assoc. Trans." vol. v. part i. p. 249. As Mr. Pengelly's valuable resume of the Oreston cave literature is generally available, while the original authorities are not, I give in each case the double reference.

† They were human. Vide Col. Hamilton Smith's "Nat. Hist. Human Species," pp. 94, 453.

face of 70 feet, and 3 feet above the bottom of the cavern, which was wholly filled with elay. It was the opinion of Mr. Whidbey and of the workmen that the cavern was entirely enclosed in the solid rock. Many caverns had previously been met with, but this was the first which had contained bones. It was 15 feet wide, 45 feet long, taking the direction into the cliff, and 12 feet deep. The bones were 6 molars, and parts of 2 vertebre, 1 radius, 1 scapula, 2 ulne, 3 humeri, 3 femurs, 2 phalanges, 1 carpus, and 1 metacarpus.*

Four years later another bone cave was discovered, and the contents forwarded by Mr. Whidbey, as in the former instance, to the Royal Society. These bones Mr. Whidbey, writing on the 11th November, 1820, to Sir Everard Home, † stated had then been "lately found in a cavern 1 foot high, 18 feet wide, and 20 feet long, lying on a thin bed of dry clay at the bottom." Sir Everard described them as consisting of one molar of rhinoceros-single-horned; teeth and bones of the black or brown bear, ‡ two portions of bone of an animal of the deer kind, and portions of bone of some animal the size of a bear. The cervine remains were found in a cavity near to but distinct from that containing the remainder. This cavern also Mr. Whidbey described as entirely surrounded by compact rock. It was about 8 feet above high-water mark, 55 below the surface, and 174 yards from the original face of the cliff, the quarries having been worked inwards about 120 yards in that direction from the cavern of 1816.

So far the quantity of bones discovered had been small, though their importance was great. The next find was of much larger magnitude. Continuing to work into the hill, at a distance of 201 yards from the commencement of the quarry, and 180 yards in a western direction from the cave of 1816, the first of five other caves or chambers was discovered, communicating by passages and associated with galleries. The top of the cliff here was 93 feet above high-water springs; and while the bottom of the lower cave was about 30 feet above high-water, the roof of the

^{*} Sir E. Home, op. cit. Cited "Devon. Assoc. Trans.," vol. v. part I. p. 250.

^{+ &}quot;Phil. Trans.," 1821, part i. pp. 133-5. Cited "Devon. Assoc. Trans., vol. v. part i. pp. 251-2.

[‡] Professor Owen afterwards identified the ursine remains as those of both Ursus spelæus and priscus. *Vide* "Brit. Foss. Mam.," pp. 81-5.

uppermost of the series was only 17 feet below the surface.* Of the five chambers the lowest was the largest, and here the bulk of the bones were found. They were "mostly covered with dirt. . . . Part of the bones were lying on the dirt, and in crevices about the caves." + Many of the bones were found in an inner recess. This discovery was made about the middle of 1822. On the 19th August in that year Mr. Whidbey forwarded his find as before to the Royal Society, and the bones were reported on by Mr. Clift, Conservator of the Museum of the Royal College of Surgeons, wherein they were deposited. This collection was not only much larger, but wholly different in character to the preceding. The bones were those of ox, deer, horse, hyæna, wolf, and fox, and they occurred in this curiously separated form : though the cavities communicated "the bones of the different graminivorous animals were found mingled together in the same cavity; but those of the carnivora at a considerable distance from each other; the bones of the hyæna having been discovered in the [second or inner of the two lower] cavern . . . and those of the wolf and fox in the gallery" [a passage described by Mr. Whidbey as leading from the outer cave to the surface of the quarry.] 1

There are two other points to be noted in regard to this collection. A portion of the radius of a young wolf had "the impression of the incisors and canine teeth of some small animal of the size of a weasel." This was the only bone that bore any appearance of having been gnawed or otherwise mutilated.§ Two of the bovine bones unequivocally showed "the effects of ossific inflammation on their surface," and in the lower jaw of a young wolf "an abscess on each side had produced sinuses, and a considerable alteration in its form and texture.

The bovine benes included three horn cores of different individuals, and belonged to more than a dozen animals, varying

* J. Claringbull, "Guide to the Breakwater." Sketch to scale, p. 36.

† Whidbey, "Phil. Trans." 1823, part i. pp. 78-81. Cited "Devon. Assoc. Trans.," vol. i. part i. pp. 254-5.

[‡] Clift, "Phil. Trans.," 1823, part. i. pp. 81-90. Cited "Devon. Assoc. Trans.," vol. v. part. i. pp. 255-260. This separation may be partly accounted for, on the supposition of water carriage, by the difference of the relative bulk of the two sets of animals.

§ Clift, op. cit. Cited "Devon. Assoc. Trans.," vol. v. part i. p. 256.
 Dr. Buckland adds to this the tibia of a horse, and speaks of the wolf's bone as an ulna. "Reliquiæ Diluvianæ." § Ibid. p. 257.

considerably in their age, and of different species. Of smaller ruminants there were imperfect remains apparently of a deer, and others belonging to very young animals, probably of a calf or fawn. Of the horse there were bones and teeth of twelve or more individuals, as if from more than one species, and some from the worn state of the teeth very aged. Five or six individual hyænas of various ages were represented, with a portion of a skull and lower jaw twice as large as that of a full-grown hyæna of the present day. Of the wolf there were the bones of five individuals; of the fox only a few vertebræ and two canines of the lower jaw. Some of these bones were sent up as late as November 9th by Mr. Whidbey, who then stated that they would probably be the last.*

In the interim Oreston had been visited by Dr. Buckland, who had been working at the Kirkdale cavern, discovered in the previous year, and by Mr. Cottle, of Bristol. Dr. Buckland states that Mr. Whidbey had collected fifteen large maund baskets full of bones before his arrival, and that he saw appearances of as many more undisturbed in the upper parts of the cavity whence the others had been taken. They had apparently been "washed down from above at the same time with the mud and fragments of limestone, through which they are dispersed. . . They were entirely without order, and not in entire skeletons; occasionally fractured, but not rolled; apparently drifted, but to a short distance from the spot in which the animals died."[†]

Mr. Cottle made a very large collection, in the course of which he added the lion to the Oreston fauna, by the discovery of two canines of what was then called "tiger." In the following year the other caves of the series were reached. They contained "the remains of the wolf exclusively," the whole of which fell into the hands of Mr. Cottle, who visited Plymouth again that summer. In two days he obtained forty wolf jaws; while he was told by the workmon that before they knew these remains had any value, they had thrown away as much as two cartloads. His general collection, as the result of the two visits, was described by him as consisting of:—500 bones from the tiger to the hare; 1000 fragments without direct character; 250 vertebra; 26 skulls and portions of

* Clift, op. cit. Cited "Devon. Assoc. Trans.," vol. v. part i. pp. 258-9. A few small fragments of shell apparently allied to ostrea, and having a recent aspect, were also found.

+ "Reliquite Diluviana"," p. 69-70. Cited "Devon Assoc Trans.," vol. v. part i. pp. 261, 262.

skulls; 3 horn cores (bull); 80 fragments of osseous breccia; 1 mass of *album grocum*; 147 jaws—2 tiger [lion], 5 hyæna, 86 wolf, 8 fox, 32 horse, 5 bull, 6 deer, 1 boar, 2 hare; 1587 teeth—11 tiger [lion], 35 hyæna, 225 wolf, 6 fox, 800 horse, 400 bull, 100 deer, 5 hare, 2 water-rat, 3 weasel.

There are many fragments of this period in our Museum, besides some bones of more importance. No doubt the collection was once of greater value. There are two cards stating that the bones in certain drawers had been examined and marked by Dr. Buckland,* which is true of those that remain in two or three instance only.

Up to this date, with the exception of the rhinoceros, we have no record of the occurrence of the larger manimals. Mr. J. C. Bellamy stated in 1835, however, that he had seen bones of the elephant and of the hippopotamus which had been discovered at Oreston, † while in 1839 he claimed to have had such specimens in his possession.[†] He had not examined the caves himself; but his words, "I have seen both of these [elephant and hippopotamus], and likewise fragments of the skeleton of rhinoceros from thence, procured in 1822," may be fairly taken to imply that they formed part of that find. Otherwise I should be inclined to assume that they were portions of a more recent discovery; nor on the other supposition is it casy to understand how they could have escaped the trained eyes of Dr. Buckland and Mr. Clift, to say nothing of zealous Mr. Cottle. Of the hippopotamus we have heard nothing since; but the occurrence of the mammoth has been clearly established.§

* Cottle's "Malvern Hills and Essays." Third Essay, on the Oreston Caves. Cited "Devon. Assoc. Trans.," vol. v. part i. pp. 267-281. Mr. Cottle deposited a portion of his collection in the Bristol Museum, where it now remains.

† Writing under the nom de plane of Philophysicus, "South Devon Monthly Museum," vol. vi. p. 221, Cited "Devon. Assoc. Trans.," vol. v. part i. p. 284.
‡ "Nat. Hist. South Devon.," p. 82.

§ Claringbull ("Guide to the Breakwater," p. 37), whose father was government surveyor of the Breakwater, states distinctly that *testk* of the elephant and hippopotamus, with fragments of the skeleton of the rhinoceros, were found in 1822. He wrote in 1840. The collection of Messrs. J. C. and P. F. Bellamy is now deposited in King's College, London. Professor Bentley, Dean of the Medical Faculty, who kindly examined it at my request, has informed me that neither the mammoth nor the hippopotamus is represented. It seems very clear therefore that Mr. Bellamy was in error. Mr. Claringbull evidently in this matter followed him. If, however, a statement in Col. Hamilton Smith's Natural History of the Human Species be strictly accurate, other caves of a notable character must have been discovered between 1823 and the publication of that book in 1848; for he mentions the occurrence of abundant coprolite, which has found no other record before or since. To that point I shall return hereafter. And indeed we do know that some caves were opened in the interim. One was found at Pomphlett in 1839, the contents of which "consisted almost wholly of the teeth of the Horse, but the bulk was undoubtedly lost in blowing away the rock."* Moreover, our own Museum supplies evidence of a discovery at Oreston in 1843, in bones and teeth of horse and ox, duly marked with place and date. Nor does it seem improbable that during the last forty years few have passed without some fossil bones occurring in the Oreston quarries, though as a rule in small quantity.

The next great find was in 1858, and must have approached, if it did not equal in extent, that of 1822-23. It was investigated in 1859 by Mr. Pengelly, who purchased all the specimens he could obtain, and forwarded the bulk of them to the British Museum. Others were deposited in the museum of the Oxford University, and in that at Leeds. I am indebted to Professor L. C. Miall, F.G.S., the curator of the Leeds Museum, for a list of the Oreston species represented in the collection there. They comprise horse, sheep, pig, Bos primigenius, Ursus spelacus, Felis spelacus, Bison priscus, Rhinoceros leptorhinus, and Elephas primigenius.[†] Professor

* "Nat. Hist. South Devon.," p. 440.

† The label attached to the collection is worth quotation: "ORESTON CAVERNS .- During the excavation of a vast body of limestone at Oreston, on the left bank of the Plym, chiefly for the formation of the Plymouth breakwater, several bone caverns were discovered and destroyed. The principal discoveries were made in 1816, 1820, 1822-3, and 1858-9; and though it is to be regretted that no attempts were made to explore the caverns systematically, or under scientific superintendence, the bones and teeth they have yielded have been the subjects of several papers, in which they have been carefully described and many of them figured. Amongst the remains, those of the following animals have been identified : Ursus priscus, U. spelæus, Putorius ermineus, Canis lupus, Vulpes vulgaris, Hyæna spelæa, Felis spelæa, Rhinoceros leptorhinus, Elephas primigenius, Equus fossilis, E. plicidens, Asinus fossilis, Bison minor, Bos longifrons, and Sus. It has been stated that remains of the hippopotamus, sheep or goat, deer, camel, giraffe, and a rodent of the size of a mouse have also been detected. There does not appear to have been any indication of man."

Prestwich, F.R.s., has kindly informed me that the collection in the Oxford Museum includes pieces of bone breccia, and a number of specimens (chiefly horse) labelled Plymouth, but without further specification. The Oreston examples are not displayed, but Mr. Prestwich doubts whether they would add to the published lists. The Oxford Museum possesses the valuable collection of Dr. Buckland from Kirkdale, Kent's Hole, &c., and this is fully set out.

Many specimens of this date found their way into private hands. Our own museum was utterly neglected. Mr. Pengelly describes * this cavern as apparently in the same line as Mr. Whidbey's, "as if the various caverns had been so many enlarged portions of one and the same original line of fracture." + The quarry face was 1090 feet from the quay or river margin, and about 487 feet from Mr. Whidbey's last discovery. The face of the quarry was about sixty feet high, and the cavern, which was ninety feet long. N.N.E. to S.S.W., commenced about eight feet below the top of the cliff and extended to its base, where the bottom was not reached. At the top it was about two feet wide, gradually increasing downwards to a width of ten feet at the bottom. The uppermost eight feet were occupied with angular limestone debris, mixed with a small quantity of sand. The next thirty-two feet in depth contained "similar materials . . . (the sand being somewhat more abundant) with the addition of a considerable quantity of tough, dark, unctuous elay." Beneath this again was a bed of "dark, very tough, unctuous clay." The bones were found in connection with "a nearly vertical brecciated plate, or dyke, which the workmen denominated 'callis,'" stalactitic in origin, containing masses of the fissure breccia, and having a general thickness of about two feet. "The bones were found alike in the 'callis,' and in the mass of heterogeneous materials beside it; in the cemented and uncemented portions of the bed," "as frequently in the pure stalagmite as elsewhere." The roof of the fissure was formed of cemented limestone breecia, and Mr. Pengelly held that the cavern "originally communicated with the

* "Geologist," 1859, pp. 434-444. Cited "Devon. Asssoc. Trans.," vol. v. pp. 295-300.

+ Mr. Pengelly bases this view on the information as to position of an old quarryman; but it is not probable that the caverns of 1816 and 1820 were connected with that of 1858, if those of 1822-3 were, because Mr. Whidbey expressly states that the two earlier caverns were 180 yards to the east of the latter. (See *ante.*)

surface by an opening sufficiently wide to allow the passage of all its contents, and that it was thus filled."

This cave contained the remains of herbivores chiefly, with a few carnivores; the animals represented including the mammoth, rhinoceros, cave lion, cave bear, wolf, horse, ox, deer, and hog. Mr. H. C. Hodge states that the remains of elephants found belonged not merely to very young, but to somewhat mature animals; that there were numerous teeth of elk or deer and ox, but no antlers or horn cores (a fragment of the base of an antler and one small horn core excepted); that the canine of a lion measured $5\frac{3}{4}$ inches in length; that both *Equus plicidens* and *E. fossilis* occurred, with teeth referable to the ass or zebra; that of the carnivores teeth of bears predominated, indicating two species; and that there were no remains of hyænas or their coprolites.

From 1859 until 1878 no further discovery of any importance was made, though a few bones occasionally occurred. Early in June last, however, Mr. J. Goad, of the Phenix Marble Works, informed me that bones had been found in the course of working the Pomphlett Quarry, near Oreston, and that he had directed their preservation. He kindly offered to give whatever might be found to our Museum, and to place the working of this new ossiferous fissure under my care. I at once examined the bones discovered, the most notable object in which was a horn core. To this we are indebted for our knowledge of the deposit. The foreman of the quarry had asked his employer for a horn to give the usual blasting signals; but when he received it said he thought he could have done without, as the core, which he then produced, and which had been found in the interim, might have been made to answer the purpose. Mr. Goad, however, saw the importance of the core in another light, ordered all that might be found to be preserved, and communicated with me.

Two days afterwards we visited the place together. Pomphlett Quarry closely adjoins Pomphlett Creek on the west, and is at the extreme end of the Oreston range of quarries from the point where

* "Geologist," 1860, pp. 26-30, 343-7. Cited "Devon. Assoc. Trans.," vol. v. part i. pp. 300-8. Mr. Hodge also suggests that other teeth belonged to the giraffe and the camel, and a "few hollow conical teeth" to immense reptiles. Ho likewise notes the occurrence of a "small rodent the size of a mouse," and records teeth of sheep or goat, about the genuineness of which he was doubtful. the original discoveries were made. The artificial cliff is nearly ninety feet high, and the floor of the bone-bearing fissure was about twenty feet from the surface, seventy feet therefore above the bottom of the quarry. We had to clamber up by the aid of a rope.

The quarry, which faces north, had been worked in such a way as to leave a kind of rocky promontory, on each side of which the stone had been removed for a varying distance ranging up to fifty feet. The beds had the usual general dip, subject to slight variations, a little west of south at an angle of about 30°. The rock was of a very open character, and the description by Dr. Buckland of the appearances of 1822 applies to it with singular appropriateness.

"There is an artificial eliff ninety feet in height, the face of which is perforated and intersected by large irregular cracks and cavities, which are more or less filled up with loam, sand, or stalactite. These apertures are sections of fissures and caverns that have been laid open in working away the body of the rock, and are disposed in it after the manner of chimney flues in a wall. . . . Some of them have lateral communications with adjacent cavities, others are insulated and single; some rise almost vertically towards the surface, others are tortuous, passing obliquely upwards, downwards, inwards, and in all directions in the most irregular manner through the body of the rock."*

At the foot of the quarry, immediately beneath the cavity, was a talus of earth and elay mingled with fragments of limestone, in the more elayey portions of which were small fragments of bone. On ascending to the cave I found it had the appearance of a shelf. This was due to the fact that the men had opened on it longitudinally, and taken away the western side (it ran with the jointing nearly north and south, a little to the westward), while the eastern wall and the greater portion of the floor remained intact. The cave dipped with the bedding at an angle which would have brought it to the surface some fifty feet north of its northern extremity; but the rock there had long been worked away, and the quarrymen, although they had no doubt the cavern originally "came to grass" in that way, could not speak positively on the point. There was still remaining however tangible evidence of

* "Reliquiæ Diluvianæ," p. 67. Cited "Devon. Assoc. Trans.," vol. v. part i. p. 260.

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surface communication in a perpendicular plane, in an earth-crusted joint face, which extended from the roof of the cave to the top of the quarry. The portion of the cavern which remained was twentyfive feet in length, from four to six feet in height, and it had probably averaged three to four feet in breadth. At its inner extremity it continued downwards, but was there filled with limestone debris mixed with clay. The bones had been found at the innermost point of the cavity, immediately above this downward continuation, embedded in a matrix of very dense, tough, red clay, of that peculiarly fatty character which has been attributed to the decomposition of the fleshy portions of the carcases. Some of this elay remaining *in situ* beneath an overhanging part of the east wall of the cave, was full of fragments of bone, mostly small, while the larger pieces were as a rule so tender that the effort to extract them intact was almost hopeless.

Mr. Goad consented to have the cave, so far as that was practicable, worked out independently; and while this was in progress I visited the quarry, and received the bones, carefully examining also the clay removed. The quantity found, however, after the first day or two was not large, and at last the supply seemed exhausted, the clay having been all worked out, and only coarse, rubbly limestone *débris* remaining. The same care, however, continued to be exercised, and it was eventually rewarded during my absence for a few days by another find—in clay beneath this *débris*—small in quantity, but important in character, and evidently a portion of the same deposit. Altogether bones were then found at intervals for about two months.

The remains are chiefly those of the aurochs, *Bison priscus*, which was not recorded as having occurred previously in the bone caves of Oreston (though its bones had certainly been found there), and which I had therefore the pleasure of definitely adding to our cave fauna. There are other bovine bones (*Bos longifrons*), some of the red deer (*Cervus elaphus*)* and several obscure fragments. All, however, are of the ruminant order, with the exception of a canine of bear, fragments of a second, and a few bones of birds, about the size of those of a duck. The whole are now in our Museum.

* Mr. Davies, F.G.S., of the British Museum, kindly identified a number of the bones which I submitted to bim, including those of the red deer, and a sacrum of a small equal (ass?) found in the Mill quarry adjoining. Of the aurochs we have the horn core mentioned, with pieces of a second, fragments of the skull, portions of the left ramus of the lower jaw with several teeth, a perfect vertebra, portions of pelvic bones, a humerus, an ulna, metacarpal, and metatarsal bones; a number of phalanges, including a perfect ungual phalanx, and the phalanges articulating therewith, sesamoid bones, fragments of ribs, &c., indicating the presence of the entire animal, though the bones were evidently re-deposited.

The horn core ranks among the finest that have been found. Its extreme outer length is 15+ inches, and its girth at the root is 117 inches. The breadth of the longer basal axis is 4 inches, of the shorter $3\frac{1}{4}$ inches. The extreme depth of the cavity is $4\frac{3}{4}$ inches, and the greatest thickness of the shell at the root 1 inch. On the straight its length is 14 inches, and its weight before it was dried was 3 lbs. 15 ounces. When found the tip of the core had been broken off, and these measurements apply to its imperfect condition. A few days later the extremity of the tip turned up. It was $4\frac{1}{2}$ inches in outer length, 33 on the straight, and its width at the point half an inch. In general section the core is an irregular oval, flattened towards the tip. As it is evident that at least three or four inches of the core between the larger and smaller portions are still wanting, the total length of the horn when perfect and coated exceeded two feet. The aurochs to which it belonged, therefore, must have been a formidable beast, its horns spreading from tip to tip, including the frontal breadth of skull, upwards of five feet.

Of *Bos* we have a number of vertebræ, chiefly broken, a humerus, leg bones, some very perfect, phalanges, teeth, and the left ramus of lower jaw.

The remains of *Cervus elaphus* include portions of humerus, ulna, metatarsus, and a fragment of jaw.

The fissure which has been already noticed as continuing the cavern downwards was subsequently to the discovery worked upon, and its clayey contents removed. They yielded nothing, however, in the way of bones from August until March, when the base of **a** canine of bear was discovered.

This brings the history of the Oreston bone caves down to the present date.

And now for a point of special importance. Had the earlier investigators of our bone caverns been true to the claims of science, the question of the antiquity of man would not have been left to be settled by the present generation. Unfortunately, with rare exceptions, they either failed to recognize the importance of the association of human relics with these of the extinct genera of mammals, or, biassed by preconceptions to which they attempted to make the results of their investigations square, they shut their eyes to the evidence on the other side; nay, in certain cases wilfully destroyed it. Something must be forgiven men who suddenly found themselves face to face with facts which upset their most cherished convictions; and had such been content with simple credulity, we might have respected their prodence. But there is no excuse for deliberate falsification, or for the suppression of testimony vital to the settlement of the question in hand.

Mr. Mc Enery found human bones in Kent's Cavern, and was alleged to have concealed the discovery, from an over-anxiety to support the views of Dr. Buckland. Mr. J. C. Bellamy, however, quotes a letter from Mr. Mc Enery, in which he admits the discovery fully and frankly : but sets up a theory intended to deprive it of all special importance. "I have," he says, "found human bones and works of art . . . beneath the stalagmitic crust, and in association with the relics of fossil mammalia; but decidedly under such circumstances as left no doubt on my mind of their having been introduced subsequently to the fossil bones."* He had his theory that man and the mammoth did not coexist, and by it interpreted the phenomena. Systematic observers of later date. free from such preconceptions, have proved that his hypothesis of interment utterly fails to account for the presence in Kent's Hole of many relics of the human frame and handiwork. There, however, for many years the question remained.

In the case of the Oreston caves, the destruction of the evidence of the inosculation of the bones of man and the extinct mammals was wilful; and few are aware that any human remains were over found in them. In a most important passage in his *Natural History of the Human Species*,[†] Col. Hamilton Smith says: "Before that period [1833], and repeatedly since, caves have been opened by quarrymen at Oreston, near Plymouth, several of which

* Nat. Hist. South Devon., pp. 95-96.

 \dagger This is not in Mr. Pengelly's Oreston Cave Literature, but will be found in his "Literature of Kent's Cavern," published in the previous year. "Trans. Devon. Assoc.," vol iv. part ii. p. 483. had bones, such as of Elephant, Rhinoceros, Ox, Horse, Hyæna, and abundant coprolite, denoting that they had been the dens of Carnivora. Among them we detected the upper portion of a humerus of man, which was immediately thrown away upon being pointed out to the possessor." And he adds in a note, "This is not the only instance of the kind. Collectors, in the plenitude of ignorance and prepossession, determined that human bones were of no consequence."*

Who this scientific heathen was Col. Smith does not say; but the event must have happened before 1848, when the book was published. Mr. Bellamy and Mr. Cottle both aver distinctly, that up to the time when they wrote no human bones had ever been discovered in this connection.

We now come to the Hoe. It is doubtful whether, in the ordinary acceptation of the phrase, the Hoe linestone has any ossiferous caverns of consequence. Caves have occurred on the Western Hoe, the most important of which was described by the Rev. R. Hennah in a communication to the Geological Society. He spoke of it as abounding in stalactites; but as containing no bones of importance.

There are connected with the Hoe two forms of recent deposits —one occurring in fissures, the other lying on water-worn shelves in the sea-face of the cliff. The first is clearly alluvial, due to the action of water which formerly flowed over the plateau.⁺ It varies in character between clay, sand, and pebbly gravel, and is in the main clearly a detritus of Dartmoor origin. It is found on the very summit of the plateau, and in some of the fissures extends to an unknown depth. The other deposit,[±] now in the main removed, though doubt has been cast upon its character through a confusion of the two, was clearly a raised beach, and occurred at an average elevation above sea-level of about thirty feet. The contents of the fissures, and the materials of the raised beaches, have really nothing in common beyond certain casual exterior resemblances; but these

* pp. 95-96.

† Fide my descriptions: "Devon. Assoc. Trans.," vol. vii. pp. 150-3; "Plym. Inst. Trans.," vol. v. pp. 472-4; "Quar. Jour. Geo. Soc.," Aug. 1876, p. 237.

[‡] Described and figured by Mr. Bellamy, "Nat. Hist. South Devon.," pp. 114-119. It contained marine shells, and the shells of pholades still remained in their borings on the shelf.

resemblances and their contiguity have frequently caused them to be confounded.*

The first palaeontological discovery recorded in connection with the Hoe was in 1808, when there was found in a bed of fine sand in a fissure, "at least fifty feet above high-water mark," unconnected with the raised beach, "one side of the jaw of some nondescript animal. The teeth, of which there is a double row, are each nearly two inches long, and the jaw about eighteen inches, and evidently carnivorous." A vertebra was also discovered 91 inches diameter by 41 inches deep. "There is no perpendicular hole for the spine; but three holes pass horizontally through the centre."⁺ Mr. Busk, to whom this description was submitted by Mr. Pengelly, can only suggest that the animal might have been a large saurian of some kind; while the vertebra, if the neural arch were not broken or worn off, "must have been a caudal one, and belonging to a creature bigger than a large whale." Mr. Busk adds, "On the whole I think the mystery, from the given data, is to me inserutable." Though the word "side" should indicate that only one ramus was found, it may be that the term was loosely used here to indicate the lower jaw as opposed to the upper, in which case the animal might very well have belonged to one of the cave series. The assumed vertebra may not have been a vertebra at all; but a description which baffled Mr. Busk must be very far beyond me.

The most important discovery of ossiferous remains on the Hoe took place about forty years (1838 ?) ago. The facts were recorded by Dr. Moore. The bones were found ten feet beneath the soil, on the top of the raised beach, which at its base was thirty-five feet above high water springs. The remains specially enumerated are " a molar and part of the jaw of a young elephant; a femur of a rhinoceros, maxillary bones of a bear, with the molar and palatine processes, and two teeth in each; an entire right lower ramus with teeth and tusks, the latter much worn; four separate tusks; several frag-

• Mr. J. H. Collins, F.G.S., in a paper read before the British Association in Plymouth (Report 1877, Trans. Sec., p. 68), came to the conclusion that the deposits he examined were not raised beaches. And here I agree with him; for most of the raised beach has long been worked out.

+ "Monthly Mag.," vol. xxvi. p. 191; "Devon. Assoc. Trans.," vol. ix. p. 428.

‡ "Devon, Assoc. Trans.," vol. ix. p. 430.

ments of long bones; fragments of jaws of the horse containing teeth; numerous loose teeth; portions of long bones, and two caudal vertebrae; likewise portions of a deer's jaw containing teeth. . . The vertebra of a whale much rounded were also discovered, with undeterminable portions of ribs."* "The quantity of fragments of leg bones amounted to several bushels, being exceedingly fragile, and deprived of their animal matter; the whale's vertebra and bear's tusks appeared much worn, as if by long-continued friction in water."[†]

Now it is clear that the bulk of the bones could not have been roughly used after deposition, however much some of the examples might have been. It is clear also that as the bones were found onthe beach and not in it, they were placed there subsequently to the origin of that marine deposit. How can they be accounted for more simply than by the hypothesis that they came from a pre-existing ossiferous fissure or fissures, precisely analogous in character to those at Oreston ? Dr. Moore speaks of "nearly the entire collection of bones" as "similar to those formerly obtained from the limestone caverns of Oreston, Yealm Bridge, Kitley, and Kent's Hole,"§ He does not mention the hyæna, but it is included among the specimens from the Hoe deposited in our Museum by him; and as some bones in the collection were labelled "from the Hoe fissures," it seems probable that there were other discoveries beside those of the raised beach, though in all likelihood at much the same date.

That bones should find their way from the fissures to the ancient beach is nothing wonderful. The tooth of a rhinoceros was found by Mr. Hearder on the present beach "at the entrance of the cave under the Hoe . . . rounded by its exposure to the tide which now flows into it." [[] Mammoth teeth have been found here under similar conditions.

The most interesting discovery in direct connection with the

• "Proc. Geo. Soc." vol. viii. pp. 589-90; "Devon. Assoc. Trans.," vol. ix. p. 427.

+ "Rep. Brit. Assoc.," 1841, Trans. Sec., pp. 62-63; "Devon. Assoc. Trans.," vol. ix. p. 426.

[‡] This is a point on which Mr. Pengelly and myself hold differing views. Vide "Devon. Assoc. Trans.," vol. ix. pp. 425-431; vol. x. pp. 404-410.

§ "Rep. Brit. Assoc.," 1841, Trans. Sec. p. 63. "Devon. Assoc. Trans.," vol. ix. p. 426.

|| "Nat. Hist. South Devon," p. 439.

Hoe fissures was made about the year 1844 by Mr. Edyvean. Observing about twenty feet above the path under the Hoe, close to the wall which divides the Hoe from the quarry, something pointed projecting from the soil, he took steps to dig it out, and uncarthed two elephant tusks. One in the process of removal crumbled into cubical fragments. The other broke into three parts, but otherwise continued intact. One of these sections, retained by Mr. Edyvean, fell to pieces, however, while being dried for the purpose of being coated with a preservative composition. This tusk was six feet two or three inches in length, and two feet nine inches in girth at the base.

Ossiferous caves have been discovered at Stonehouse, but the information concerning the earlier is very scanty. The first was opened somewhere about 1835.* Another is said to have been discovered while the works of the Great Western Docks were in progress; but there is no trustworthy record of what either contained. About 1865 a cavern in the quarry above the Docks, on the Battery Hill, near the old Yacht Club house, was also found to be ossiferous, and some of the contents, obtained by Mr. C. Spence Bate, F.R.S., are deposited in our Museum. They include remains of rhinoceros, horse, ox, and deer. Of Equus two species are represented, one probably asinus. Of ox there are bones of the Bos longifrons. Of deer there are two species at least. The most remarkable bones of this series are the remains of antlers of red. deer, Cervus elaphus, of great size, and part of the skull, with stumps of horus attached. The complete series was presented by Mr. Spence Bate to our Museum.

Within the past few weeks (February, 1879) the resumption of the quarrying operations at this point has resulted in the finding of other bones in the remaining portion of the same cave. These were kindly brought under my notice by Mr. F. Brent, who has presented them to our Museum. The quantity is small, but the collection includes the tip of an antler (probably of *Cervus cluphus*), a fragment of a rhinoceros bone, and a calcaneum of horse.

Caverns are much less frequent towards the western extremity of the limestone, and no ossiferous deposits therein have hitherto been recorded. I learn, however, that in 1861, while operations were in progress for the construction of the battery adjoining the grounds of the General's house, Mount Wise, part of the rock was

* "Nat. Hist. South Devon," p. 440.

hewn away, revealing fissures in which bones in small quantity were found. The remains included those of deer (*Cervus elaphus*) and horse. Some of the bones were obtained by Mr. Codnor, of Morice Town, and a cervine tooth, found by him, has been presented to our Museum by the Rev. W. Sharman.

The fissures at Cattedown have yielded bones, but only occasionally and in small quantity. We have in our Museum a fragment found sixty feet deep, in clay, presented by Mr. Sparrow.

The accompaniments and investments of the bones have varied greatly. Few have been found in what may be regarded, in the special sense of that term, as cave earth. Mr. Whidbey's first find was imbedded in solid clay; his second lay on a thin bed of dry clay in the bottom of the cavern; some of the third adhered to the walls of the cavity, others were covered with dirt, and part were lying on the dirt and in crevices; to which Mr. Clift adds: "Some of the bones . . . which lay on and near the surface of the clay have acquired a thin crust of stalagmite . . . the greater number were imbedded in the stiff clay, which adhered so firmly to them that many were broken by the workmen in separating them from the matrix."* Dr. Buckland + describes the bones of 1822 as "lodged in irregular heaps in the lowest pits [of a "deep hole nearly perpendicular"], and in cavities along the lateral enlargements of this hole, and mixed with mud, pebbles, and fragments of limestone;" while Mr. Cottle, referring to the discoveries of the following year, mentions that in two days forty jaws of the wolf were found imbedded in clay, while in another cave without clay two hundred phalanges of the wolf were found "in parallel rows," beneath a large stone which had fallen from the roof; the remaining bones in this particular cavity having been united by stalagmitic matter with limestone fragments into a breecia. However, in the principal cave, where the bottom was covered with a stratum of red clay, "the greater portion of the bones lay promiscuously scattered over the surface of the clay, or had but partly sunk into it."; The Rev. R. Hennah says the bones of 1822 were "enveloped in a mass of apparently black mould and clay," and in some cases brecciated. The bones of

* Op. cit. Cited "Devon. Assoc. Trans.," vol. v. part i. pp. 254-256.

† Op. eit. Cited "Devon. Assoc. Trans ," vol. v. part i. p. 264.

† Op. cit. Cited "Devon Assoc. Trans.," vol. v. part i. pp. 269-270.

§ "Lime Rocks of Plymouth." Cited "Devon Assoc. Trans.," vol. v. part i. p. 282.

1859 are described by Mr. Pengelly as associated with a mass of hoterogenous materials, consisting of limestone $d\acute{e}bris$, sand, and "tough, dark, unctuous clay," partially cemented by stalactite, and "in the cemented and uncemented portions of the bed.^{*}

Mr. H. C. Hodge, writing of the discoveries of the same date, implies that the bones were generally found on or in a soft, dark-red, tenacious clay.⁺ The bones in the Pomphlett cave of 1878 were invested by a dark-red, tough, greasy clay, which where the bones were thickest at once—as already noted—suggested the value of the hypothesis of Sir II. De la Beche, that some clay observed at Oreston by him was "apparently impregnated with animal matter."[‡] The bones found at Cattedown were in clay; on the Hoe they have been associated with sand and gravel. Those found on the raised heach are of course out of our present purview.

But there are other points to be noted in these fissure deposits beyond this variation in character. Dr. Buckland says, that in one cavern at Oreston, "where the quantity of diluvium was very great, it was stratified, or rather sorted and divided into laminæ of sand, earth, and clay, varying in fineness, but all referable to the diluvial washings of the adjacent country. It is often partially interspersed with small fragments of clay-slate, and quartz." § I have elsewhere noted associated phenomena in connection with the alluvial deposits on the Hoe. At Deadman's Bay there are the remains of a huge pocket deposit of similar character, chiefly consisting of white clay. At Long Room I have recently found quartz pebbles in the earthy filling of small fissures in the limestone there. At Yealm Bridge there are caverns containing waterworn debris identical in character with the materials of the river bed many feet below. Similar appearances have presented themselves in connection with the fissures at Billacombe.

Since I first directed attention to the Hoe deposits, they, with others at Deadman's Bay and Mount Batten, have been examined by Mr. J. H. Collins, who found therein pebbles of quartz, limestone, schorl rock, greenstone, grit, clay-slate, tourmaline schist, granite, elvan, flint, chert, all of which he considered had been

^{*} Op. cit. Cited "Devon Assoc. Trans.," vol. v. part i. p. 298.

[†] Op. eit. Cited "Devon, Assoc. Trans.," vol. v. part i. p. 303.

[‡] "Rep. Geo. Cornwall, Devon, and West Somerset," p. 413. Cited "Devon. Assoc. Trans.," vol. v. part i. p. 285.

[§] Op. cit. pp. 82, 83. Cited "Devon. Assoc. Trans.," vol. v. part i. p. 261.

derived from the rocks of the neighbourhood, and thus confirmed my views on this point, though we differ upon some others.*

Now the fact that amidst all those differences there were still some connecting links of similarity, led me to assume on investigation a common origin for at least the bulk of our ossiferous deposits. In all we have evidence of transportation by water. Either the bones are mixed with sand or clay, which may (as in the case of the red elay derived from the roddish earth of the limestone area) occasionally be of local origin, but must frequently have been transported for some distance; or the remains are so placed and mingled that there is clear evidence of their removal after decay. Or we have the concurrence of both conditions.

Finding that the variations in the phenomena of the different bone caverns at Oreston were as wide as those between the ossiferous deposits of Oreston generally and the deposits of the Hoe, while they were yet associated in the manner already described, **I** was led to suggest that "the caverns were in the main contemporaneous with the surface formations [of the Hoe], and date back to a time when the limestone rocks which enclose the fissures were but slightly raised above the waters, and when therefore nothing was easier than the introduction into the caverns of bodies of animals swept down the stream, probably in times of flood, just as they are commonly swept down the rivers of tropical countries in the present day." †

This was the first attempt at the definite correlation of our most important and typical series of Quaternary deposits; and my conviction that the solution of the problem here propounded is the true one remains unshaken.[‡] Perhaps its bearing and importance will be best indicated by reference to the rival hypotheses. §

I know of only three authorities for the opinion that any of the Oreston caves were dens; that is, were used as the homes of carnivora.

The Rev. R. Hennah, writing in 1822, supports the conjecture

* "Brit. Assoc. Rep.," 1877, Trans. Sec., p. 68.

† Geology of Plymouth, "Plymouth Inst Trans.," vol. v. p. 475. "Quar. Jour. Geo. Soc.," Aug. 1876, p. 237.

‡ Vide "Devon. Assoc. Trans.," vol. ix. pp. 436-440; vol. x. pp. 404-410.

§ Mr. Collins comes to the same conclusion that "gravels, fissure deposits, and cave deposits are of the same age," and "that they belong to the mammoth period."—" Brit. Assoc. Rep.," 1877, Trans. Sec., p. 68. "by the shattered appearance of the ends of many of the bones, and the sharp splinters, which are in great numbers, and seem as if they had been gnawed, and broken by the teeth of some animal." *

Mr. Cottle mentions the discovery of one mass of album gracum. +

Col. Hamilton Smith speaks of several of the caves as having "bones, such as of Elephant, Rhinoceros, Ox, Horse, Hyæna, and abundant coprolite, denoting that they had been the dens of Carnivora.[‡] This must have been before 1848.

That Mr. Hennah was wrong in his conclusion here we may safely assume, from the strongly expressed opinion to the contrary on these very bones by Dr. Buckland and Mr. Clift. Bones may be shattered and splintered without the agency of carnivora; and there was no evidence whatever of contemporary gnawing.

Nor is Mr. Cottle's discovery of any moment. A few coprolites or masses of *album gracum* might very well occur where the bodies of animals had been deposited while intact.

Col. Hamilton Smith's statement is not so easily met. It would be conclusive if he also mentioned gnawed bones; but as it stands there is the possibility of other things having been mistaken for coprolital matters, probably clay balls, such as those noted by Mr. Pengelly in 1859. In any case however the reference is to a cave on which we have absolutely no other information; and there is nothing at all improbable in the supposition that Oreston may have had its den as well as Yealmpton and Torquay. I have always recognized the possibility of this; but if so the case was exceptional, and does not affect the general issue. Were all, or even the majority, of the Oreston bone caves dens the question would stand upon a different footing.

Dismissing then the hypothesis of the introduction of the remains into the fissures by carnivora as unsupported by facts, and practically irrelevant, we have to deal with the phenomena on a mechanical basis. At one time or other every cavity had its comnunication with the surface, approximately perpendicular, as in the case of the fissure caves, approximately horizontal, as in the case of the tunnel caverns, but either way open to the action of running water.

Dr. Buckland's hypothesis was that "the animals had fallen

- * Op. cit. p. 67.
- † Op. cit. "Devon. Assoc. Trans., vol. v. part i. p. 273.
- ‡ "Nat Hist. Human Species," p. 96.

during the autediluvian period into the open fissures, and there perishing, had remained undisturbed in the spot on which they died, till drifted forwards by the diluvian waters to their present place in the lowest vaultings with which these fissures had communication." *

Mr. Cottle (if I rightly understand him) suggested that the animals rushed headlong into a horizontal passage communicating with the main chambers, to escape the waters of the deluge, and were drowned in the trap into which they were thus precipitated,⁺

I shall not enter upon the discussion of the deluge theory, though it has been recently revived by Mr. Howard, F.R.S. The evidence is utterly opposed to the action of *any* agency of a cataclysmal character.

Mr. Pengelly held in 1859 that the eavern of 1858 "originally communicated with the surface by an opening sufficiently wide to allow the passage of all its contents, and that it was thus filled; but whether animals fell or were dragged in, or whether the bones found there were wholly or partially the disjointed remnants of dead animals washed in, I will not undertake to say."‡ In 1877, however, Mr. Pengelly's views were more definitely expressed, as he did not see "the least occasion for supposing anything more than a series of gaping fissures, traversing a table-land, above the reach of flooded rivers—though not necessarily or probably of great elevation—into which some animals fell and were killed, and others retired to die; where, perhaps, a few were dragged or pursued by beasts of prey; whilst the rains of Devonshire washed in at least some of the bones of those which died near at hand on the adjacent plateau."§

The intimate association and order of many of the bones proves that at the time of deposition these were partially united by ligaments, if not invested with flesh; while the manner of admixture of the remains of various animals in some cases shows that with them at least there was redeposition after decay. That water played some part in the production of the phenomena is admitted on all hands; and that the carrying force of this water must have been considerable is proved by the magnitude of the

§ "Trans. Devon. Assoc.," vol. ix. p. 440.

^{*} Op. cit. Cited "Devon. Assoc. Trans.," vol. v. part i. p. 265.

[†] Op. cit. Cited "Devon. Assoc. Trans," vol v. part i. p. 274.

¹ Op. cit. Cited " Devon, Assoc. Trans.," vol. v. p. i. pp. 299-300.

bodies transported, and by the character and quantity of the materials of the associated deposits.^{*} These facts seem to indicate the existence of a more definite agency than the casual entrapments of open fissures; a more powerful one than the downpour of even a tropical thunderstorm.

While quite admitting the possibility of some animals having dropped into ancient pitfalls, and the equal possibility that some of the cavities may have been the occasional resort of beasts of prey, the evidence then seems to be conclusive that the great bulk of the deposits must have had the fluviatile origin suggested; and that we have in them the local equivalent of the ancient river gravels which have elsewhere been found so rich in the relics of the mammoth and its associates, preserved in the cavities of the limestone from the denuding influences which have removed it elsewhere. To distinguish the cavern deposits from the fissure—using these terms in their most distinctive sense, seems to involve the conclusion that in the same locality two similar results were produced simultaneously by two wholly different sets of causes.

The materials at command are not adequate to the tabulation of the various "finds" in chronological order of origin. Assuming the correctness of the fluviatile hypothesis, they may still be spread over a considerable period; and if any of the caves were "dens," the time-range must have been long enough to have placed the cavities so occupied above the general reach of the waters, while the character of the fauna remained practically unchanged. Nay, it is quite possible that when the deposits originated, some of the caverns into which portions have since found their way had no adequate surface communication.

As to the general date of the period to which these remains belong. It was certainly sufficiently remote to allow of the production of a present change of some 100 feet in the relative local positions of land and water, and beyond that of a pause of sufficient duration for the formation of the raised beach, with the time occupied in the continued elevation and subsequent depression of the submerged forest.[†] I cannot express the interval in any more

† Vide Geology of Plymouth, "Plym. Inst. Trans.," vol. v. p. 468.

^{*} If it is safe to argue out the main question from the recorded phenomena of 1822 and 1878, when the ossiferous deposits were found in the southern ends of the cavities, the inference would be that the current came from the northward, *i.e.* more in the line of the Tamar than the Plym.

positive way. One step further is, however, possible. The lowest deposits in Kent's Cavern, known as the Ursine beds, have yielded no remains of hyæna; and Mr. Pengelly argues thence that the hyæna did not reach this country until after the Ursine period, when Britain was in its last continental state.* As our ossiferous deposits are referable to one epoch, and include the hyæna, they must therefore have originated either during the continuance of, or subsequent to, that final continental condition.

Professor Boyd Dawkins, F.R.S., in his Treatise on the British Pleistocene Mammalia, points out that "the present wild animals of Europe are merely the survivors of a large and varied group that lived on the Pleistocene continent.+ Between the Pleistocene period and our own time lie his Prehistoric and Historic periods, the latter commencing for every country with its first authentic record, and the former filling up the interval between it and the Pleistocene. "It is characterized by the advent of the swine, dog, sheep, goat, and the domestic horse and oxen into Europe under the care of man." We have scant information concerning the date of extinction of our wild animals of Pleistocene times. Professor Dawkins holds it to be probable that the wolf was exterminated in England and Wales before the end of the fourteenth century, ‡ while Pennant says that the last in Scotland was killed by Sir Ewan Cameron in 1680. According to tradition the last wolf in Cornwall was killed in the parish of Ludgvan somewhat earlier. The wild boar became extinct before the reign of Charles L; the beaver was hunted for its fur in Wales in the twelfth century; the bear existed in England during the Roman occupation; the reindeer lingered on in Caithness until the twelfth century, and died out about the same time as the beaver. All the other extinct representatives of our Pleistocene fauna had disappeared before historic times; but there is nothing, unless it be the doubtful inosculation of the sheep, to indicate whether our cave deposits belong to the Pleistocene period as distinguished from the Prehistoric or not.§

In conclusion I have to present a tabular statement of our local cavern fauna, in which uncertain are distinguished from specific identifications, and the fauna of every "find" shown independently.

^{*} See "Rep. Brit. Assoc.," 1877, Trans. Sec., p. 65, for a valuable comparative chronological table of the Kent's Cavern periods, by Mr. Pengelly. † "Palseontographical Society," 1878, p. vi.

⁺ Ibid. pp. vi., vii. ‡ Ibid. pp. x., xi. § Dawkins, op. cit. p. xi., xii.

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	QRESTON.					Hor.		STONE- HOUSE,		fouwr Wise,	ATTS- DOWN.		
	1816.	1820.	1622-3,	Year uncertain.	1643.	IB58-9.	1878-9.	IB38 (i)	Year uncertain.	1865.	1679.	1861.	
HomoMan Elephas primigeniusMammoth Rhinoceros , tichorhinus , leptorhinus Hippopotamus Felis spelecaCave lion Ursus-Bear , priscus-Great cave bear , spelecus-Great cave bear Hyæna spelæaCave hyæna Canis lupusWolf Vulpes vulgarisFox Putorius ermineusWeasel Equus-Horse forsilisFossil horse	*	*	oto: **********	*		* *	*	* * *	**	*	*	*	
, plicidens-Plicated toothed horse Asinus fossilis-Fossil ass or zebra Bos-Ox , primigenius Bison priscus-Aurochs , minor-Lesser bison Bos longifrons-Long-fronted ox Cervus-Deer , -Large or elk , -Small , elaphus-Red deer Sus-Hog Ovis-Sheep (or Capra, goat) Lepus timidus-Hare Arvicola aquatica-Water rat Rodent, size of mouse Aves-Birds		***	** * * *	A.	*	** **	* *	*		*	*	*	*2

The authorities for this table are for the most part already given; but it is desirable to add a few notes by way of further elucidation.

The mammoth has had a very remarkable range in space and time. Professor Boyd Dawkins, in a paper read before the Geological Society in London in November last, "expressed his opinion that the result of the evidence collected since the death of Dr. Falconer has been to establish the view of that palæontologist as to the mammoth having appeared in Britain before the glacial epoch. In 1858 remains belonging to *E. primigenius* were found by Prof. Prestwich under boulder-clay in Hertfordshire. In Scotland remains of *E. primigenius* have been found under boulder-clay;

but whether under the oldest boulder-clay is uncertain. In 1878 a portion of a molar was brought up from a depth of sixty-live feet near Northwich. It was in a sand beneath boulder-clay, which the author considered to be undoubtedly the older boulder-clay." Prof. Boyd Dawkins "now assents to Dr. Falconer's opinion (which he formerly doubted) that E. primigenius was a member of the Cromer forest-bed fauna. It is also clear that it was living in the southern and central parts of England in postglacial times. It has not been found north of Yorkshire on the cast, and Holyhead on the west, probably because Scotland and north-west England were long occupied by glaciers. Its remains have been found" in Europe "as far south as Naples, and as far north as Hamburgh; but not in Scandinavia. Its remains, as is well known, abound in Siberia, and it ranged over North America from Eschecholtz Bay to the Isthmus of Darien, E. columbi, E. americanus, and E. Jacksoni being only varieties."

Professor Owen assigned the rhinoceros remains of 1816 to the tichorhine species; Mr. Busk identifies them as the leptorhine, which has never been found in cavern deposits elsewhere, except in the Victoria Cave, Settle. Dr. Falconer held that the earlier rhinoceros remains belonged to *R. hemittechus.* "They are quite unlike *R. tichorhinus*, and I believe that they agree with *R. hemittechus.*"* Mr. Pengelly lodged relics of the tichorhine species in the British Museum in 1859,† and Mr. Miall informs me that the Leeds Museum has bones of the leptorhine.

Like the ascription of the mammoth and rhinoceros to the 1822 find, the occurrence of the hippopotamus, which likewise rests on Mr. Bellamy's sole authority, is more than doubtful. Professor Owen cites it from Kent's Hole, ‡ Mr. Pengelly has "never met with satisfactory evidence of its occurrence in Devonshire."§ We have, however, in our Museum two fragments of jaw so assigned by Mr. Northmore, part of the results of that gentleman's Kent Hole investigations.

Some of the hovine bones of 1820 appear to have belonged to Bos longifrons. Though the remains of deer have been of frequent

§ Address, Sec. C. Brit. Assoc, 1877; Trans. Sec., p. 57.

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^{* &}quot;Palaeontological Memoirs and Notes of the late Hugh Falconer," vol. ii p. 309. Cited "Devon. Assoc. Trans.," vol. v. part i. p. 309.

^{+ &}quot;Trans. Devon. Assoc.," vol. ix. p. 424.

t "Brit Foss Mam.," p. 410.

occurrence, no attempt at their specific identification appears to have made until Mr. Davies, of the British Museum, kindly examined those found by me at Pomphlett, and pronounced them to belong to the red deer—*Cervus elaphus*. It is, however, quite certain, from the manner in which previous cervine remains are described, that other species were represented—*Cervus megaceros* (the Irish elk), and *Cervus tarandus* (the reindeer)—which have occurred in Kent's Hole and at Brixham, almost certainly, and not improbably *Cervus capreolus* (the roedeer). A sacrum of horse found in 1878 (in the Mill Quarry) was identified by Mr. Davies as that of a small species of *Equus*, possibly *Equus asinus*, though Mr. Davies declines positively so to pronounce it.

A human skull in the possession of Mr. Hodge is stated to have been found in a crevice of the rock at Turnchapel. There is however nothing by which it can be definitely associated with the cavern fauna, and I have not included it in the table. Mr. Hodge considers that some of the teeth of the 1858–9 "find" belong to the giraffe and others to the camel, no relies of either of which have, however, been found in the country elsewhere.

Mr. Hodge expresses a doubt of the genuineness of the sheep remains from Oreston. Mr. Bellamy had none with regard to those that fell into his hands. The probability is however that they were of more recent date.

The remains of hare, water-rat, the rodent mentioned by Mr. Hodge, and the weasel, may be of later origin than the general cave fauna. I am inclined to the same belief with regard to the birds' bones found by myself at Pomphlett, and which are the first of the kind recorded from the Oreston district.

Professor Owen mentions the bones of shrew-mice (*Sorex vulgaris*) as having been found "in the raised beaches near Plymouth." He also describes the hare of Kent's Hole and Kirkdale as having a rather shorter head than the common hare.*

The Plymouth cave fauna is smaller than that of Kent's Cavern, the most important particulars of difference being the yield by the latter and not by the former of *Machairodus latidens*, badger, beaver, and glutton; and that Oreston has given us the *leptorhine* rhinoceros as well as the *tichorhine*, the lesser bison, and three species of *Equus*—fossilis, plicidens, and asinus—against one, caballus. Though the balance is still somewhat in favour of Kent's

* "Brit. Fos. Mam.," p. 28. Ibid., p. 211.

Hole, that cavern excepted, no others in Devon can show so rich and varied a fauna as those of our own district. The annexed table gives a comparative view of the fauna of the various caves of South Devon :

			1					
	Oreston.	Hoe.	Stonehouse.	Yealmpton,	Kent's Hole,	Ash Hole.	Windmill Hill, Brixham,	Chudleigh.
Man	*	1	i		*			
Elephant		*			*	*	*	2
Bhinoceros, tichorhine	*	*	+	*	*		*	÷
Rhinoceros, leptorhine	*	1		1				
Hippopotamus .	22	!		1	. ?			2
Cave lion	*				*			•
Brown bear		bear	1	bear	*		*	
Grizzly bear	*				*		*	
Cave bear					*		*	
Cave hvæna	*	*		+	*		*	2
Wolf	*			÷	- #i			Ť
Fox	*			×	*		*	
Weasel	*			*			*	
Machairodus	ĺ				*			
Fossil horse	٠	*	*	horse				
Plicated toothed horse	٠	1						
Fossil ass	*		*					
Modern horse ,					*		*	
Great fossil ox	*		•	ax	*		*	ox
Aurochs	*	-			*			
Lesser bison	*			1				
Long fronted ox	*						*	
Irish elk	2	deer		deer	*			
Reindeer,					*	*	*	
Red deer	*		*		*		*	*
Roe deer							*	
Hog	*			±±	*			
Sheep or goat	8	*		*	goat		•	*
Badger					*	*		
Glutton				*	*			
Hare					*		*	
Dog					*			
Rabbit				*	*	7 47		
Seal					*			
Cave Pika					*			
Voles				*	*			
Birds	*			*	*	*		
Beaver					*			
Mouse	rodent			*	1			
Polecat							•	
Stoat						*		
Shrew ,							•	

The Kent's Hole fanna, in addition to the animals specified, probably includes also Lynx cervaria, Canis isatis, and the wild cat.

With the single important exception of the Brixham Windmill Hill cave, almost all the bone caverns of the county are represented in the Museum of the Plymouth Institution, and the following is an outline of the leading features of this part of the collection. Most of the older bones from Oreston are mere fragments, the relics of what was once a fine collection. The bones in the Museum generally are either marked in full or with initials indicating their origin—O., Oreston; P., Pomphlett; H., Hoe; S., Stonehouse; Y., YeaImpton; C., Chudleigh. The Ash Hole (except the smaller) and Kent's Cavern bones are for the most part marked in full.

ORESTON, including Pomphlett.—Remains of mammoth, wolf, hyæna, bear, rhinoceros, aurochs, great fossil ox, long-fronted ox, red deer, horse (fossil and plicated toothed), ass, birds, &c. The later additions presented by Mr. R. Bayly and Mr. J. Goad.

HOE.—Mammoth, whale, hyæna, &c. Presented by Mr. J. Gill and Dr. E. Moore.

STONEHOUSE.—Rhinoceros, red deer, great fossil ox, horse, ass, &c. Presented by Mr. C. Spence Bate and Mr. F. Brent.

MOUNT WISE .- Deer. Presented by Rev. W. Sharman,

YEALMPTON.—Hyæna, wolf, ox, badger, fox, sheep, birds. Presented by Mr. J. C. Bellamy.

AsH HoLE, Brixham.-Badger, fox, raven, arvicolæ, &c.

CHUDLEIGH.-Bear, sheep, &c. Presented by Mr. J. F. Webb.

KENT'S CAVERN.—From this cave there are two collections, each interesting not only in itself, but also historically. The first was presented by Mr. Northmore about 1824–5, and includes bones of rhinoeeros, bear, hyæna, deer, ox, horse, and two fragments assigned by him to hippopotamus.* The other collection is the gift of the Rev. J. Mc Enery, and from its peculiar interest, I annex a copy of the original memorandum relating thereto:

"Organic Remains from Kent's Cave.—No. 1. Tooth of the superior jaw of Rhinoeeros worned down by use. 2. Molar of Inferior Jaw of Rhinoeeros. 3. Molar of infr^{*} jaw of Elk. 4. Molar of sup^{*} jaw of Horse. 5. Molar of infr^{*} jaw of Horse. 6. Canine of Horse. 7. Canine of the Ursus Spelæus. 8. Incisor of do. *9. Breecia. 10. Sup^{*} Jaw of the Hyæna. 11. Inf^{*} do. 12. Canine do. 13. Pæt^{*} Molar of inf. jaw of the Hyæna. 14.

* See *ante*. Mr. H. C. Hodge tells me the Museum once contained undoubted examples of hippopotamus teeth, though he has no knowledge of the locality. These teeth have disappeared.

Bones broken and gnawed by the Hyaena in the state they were dug up. *15. Graecum of the Hyaena. *16. Mass of the bones of Rodentia. *17. Astragalus of Rhinoceros gnawed. 18. Tibía of Rhin^s broken and gnawed to its actual state by the Hyæna. This collection was presented by Mr. J. Mc'Enery, of Torquay, on Nov. 23rd, 1829."

The specimens to which an asterisk is prefixed are *not* in the Museum. The remainder bear the original numerals as above.

THE CRUSTACEA TAKEN DURING THE CRUISE OF H.M.S. CHALLENGER.

SYLLABUS OF PAPER BY MR. C. SPENCE BATE, F.R.S.

(Read February 27th, 1879.

SPECIAL object of the *Challenger* expedition. The route and course pursued. Crustacea taken during the cruise. Their position in the animal kingdom. Their classification. The order under review. General structure of the animal. Nervous system. Organs of respiration. Organs of sense. Form and character of the young. Geographical distribution of some of the more known species in depth and area.