FEBRUARY 4, 1863.

William Babington, Esq., and Clement Le Neve Foster, Esq., Geological Survey of Great Britain, 28 Jermyn Street, S.W., were elected Fellows.

The following communications were read :—

1. *On a* HYÆNA-DEN *at* WOOKEY HOLE, *near* WELLS. No. II. By W. BOYD DAWKINS, Esq., B.A. Oxon., F.G.S., of the Geological Survey of Great Britain.

CONTENTS.

§ I. *Introduction.*

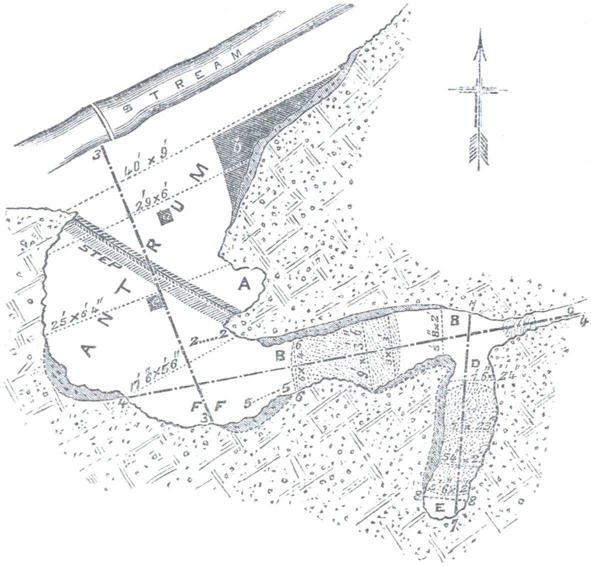
FEELING certain that the results of my former imperfect excavation of the Wookey Hole Hyæna-den, already brought before the Society*, were but the earnest of further discoveries, I, together with Mr. James Parker, of Oxford, and Mr. Henry Catt, of Brighton, determined to explore the cave thoroughly, and to convey its contents completely out. This we were enabled to do in April and May last, by the courtesy of its owner, Mr. Hodgekinson.

§ II. *Excavation of the Cave.*

1. *The Antrum.*—We commenced by completely clearing out the large antrum or entrance-hall (see fig. 1). On the left-hand side, and near the entrance, we discovered teeth of *Ursus spelæus*, Mammoth, *Hyæna spelæa*, and especially of *Rhinoceros tichorhinus*, which greatly predominated over the rest. Associated with these were numerous implements and a few ashes of bone. The area where these were found is represented in the ground-plan (*a*, fig. 1). As we dug our way towards the vertical passage F (see figs. 1 and 3), we found that the cave extended between it and the left lateral branch A. Here a tusk of *Elephas primigenius* was discovered, about 2 feet 5 inches in length, and greatly incurved. Its position is shown by the transverse section (fig. 2).

* Quart. Journ. Geol. Soc. vol. xviii. p. 115.

Fig. 1.—*Ground-plan of the Hyæna-den at Wookey Hole.*



Dolomitic conglomerate. Position of the traces of man.

Undisturbed red earth. Bone-bed *.

A. Upward-tending Branch.
B. Left lateral Passage.
C. Upward-tending Branch.
D. Right-hand Branch of B.
E. Vertical Passage.
F. Vertical Fissure.

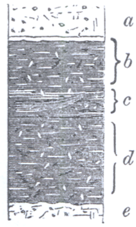
—— . —— . ——. The numbers attached to these lines of section correspond with those of the figures in which the sections are given.

- - - - - - - - - - - -. The figures attached to these lines give the breadth and height of the cave in feet and inches.

*** These explanations also refer to the same symbols, where they occur, in the following figures.**

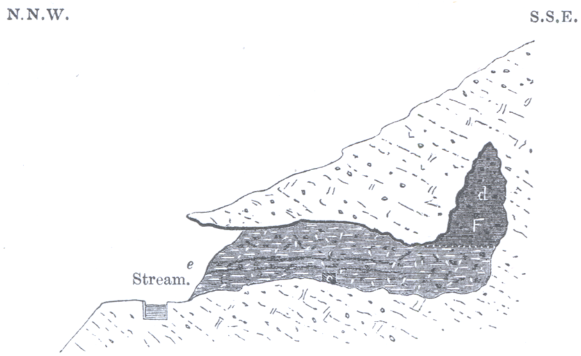
Fig. 2.—*Transverse Section in the Antrum of Wookey Hole.*

a. Roof.
b. Red earth, containing a large quantity of stones, and but few organic remains, 2 feet in thickness, and extending within 1 or 2 inches of the roof.
c. Red earth, with irregular layers of album græcum and peroxide of manganese, and containing the Elephant's tusk, together with teeth, and numerous splinters of bone; 7 to 8 inches.
d. Red earth, containing stones and a few organic remains; 4 feet.
e. Floor, worn by water and corroded by carbonic acid.



On the right-hand side of the cave we found some more implements, at the spot marked *c* in fig. 1, underlying layers of peroxide of manganese and comminuted bone, as in the case of those which I described in my former paper.

Fig. 3.—*Longitudinal Section in the Antrum of Wookey Hole.*



d. Grey clay, containing stones, but no bones *. *e*. Red earth, containing stones and bones.

The longitudinal section (fig. 3), taken along the line marked 3—3 in the ground-plan (fig. 1), shows the relation which the flints of area *c* held to the contents of the cave—the scattered bones and stones,—the complete filling-up of the cave to its roof, and the change in the colour of the sediment in, and the absence of organic remains from, the vertical passage F, described in my former paper.

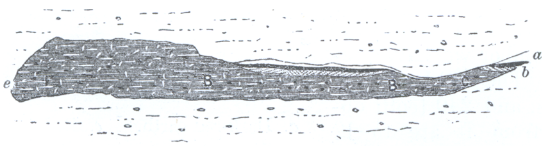
We had now cleared out every portion of the antrum except that between A and F, and had found that the contents extended up to the roof everywhere except in this latter locality, where there was an interval of from three to four inches. This interval was traversed by stalactites, which formed in some places a smooth undulating drapery with stony tassels, in others miniature pillars extending down to the débris and, as it were, propping up the roof. Their pedestals, as they gradually expanded upon the débris, formed round plates of stalagmite, and, where they met, became a continuous

* These explanations also refer to the same symbols in the following figures.

crust—the "pie-crust" of Dr. Buckland. In this interval were hazel-nuts, bearing tooth-marks of Rodents, together with the bones of recent Frogs. With this exception, the section was the same as the transverse section, fig. 2. The layers of album græcum contained round balls, as at Kirkdale. The splinters of bone at this point began to increase in size, and became also, proportionately, more numerous than the teeth. In places an infiltration of carbonate of lime had cemented organic remains, stones, and matrix into one hard mass. In one fragment of this breccia, now in the Brighton Museum, are a tusk and a carpal of *Elephas primigenius*, the coronoid process of the right ulna of *Rhinoceros tichorhinus*, and the base of the antler of *Cervus Guettardi* *; in another, the shaft of the radius of a *Rhinoceros*, side by side with the antler of *Cervus Bucklandi*—a second variety of Reindeer; in a third, two scapulæ, an ilium, and ischium of *Rhinoceros tichorhinus*, together with a coprolite and the lower jaw of *Hyæna spelæa*. The vertical passage F now took the form of an oblique fissure, which presented every appearance of being connected with some rabbit-burrows vertically above it.

2. *The Passage* B.—We were now at the entrance of the small constricted passage B (see figs. 1 and 4), which branches off almost

Fig. 4.—*Longitudinal Section of the Passage* B.



a. Dark-red earth.
b. Bone-bed.
e. Red earth, containing stones and a few bones.

at right angles to the antrum. A spot a little to its right gave the following section, fig. 5.

Fig. 5.—*Transverse Section of the Passage* B.

a. Roof.
b. Red earth, containing stones and but few bones, 1 foot 8 inches in thickness, at a distance of from 4 to 5 inches from the roof, and under a crust of stalagmite.
c. A mass of conglomerate fallen from the roof.
d. Red earth, with irregular layers of album græcum and large stones, which are a continuation of those mentioned in the previous section.
e. Red earth, full of stones, and containing but few bones.
f. Floor.

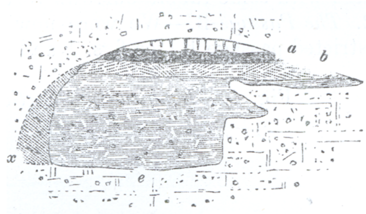
As we dug our way deeper inwards, the stalagmitic crusts became

* I have retained this term for a variety of *C. tarandus*, as sanctioned by the usage of Dr. Falconer, in his paper on the Gower Caves, Quart. Journ. Geol. Soc. vol. vi. p. 489.

more and more intermittent, until they were reduced to a few rounded pedestals. At this point began the bone-bed, a layer of matted bones, teeth, and coprolites, in all stages of decay; some perfectly sound, others too much decomposed to be handled (see figs. 1 and 4). Its relation to the other members of the same section is as follows:—Immediately upon the water-worn and acid-worn conglomerate-floor was red earth (*e*, figs. 4 and 6), 2 feet in thickness, and, as usual, containing few organic remains, but numerous stones; upon this lay the bone-bed (*b*), from 3 to 4 inches thick, with the junction-line rather irregular, and containing a few stones in its lower part; next came a layer of dark-red earth (*a*), from 3 to 4 inches thick, very loose and friable, and having upon the surface a few rounded stalagmites, and a few stalactitic pillars extending through the interval of from 3 to 4 inches, which separated it from the roof.

The bone-bed extended horizontally across the passage, with an average width of 7 feet and a length of 14 feet, affording, therefore, a square area of 98 feet. The enormous quantity of organic remains present cannot be estimated even by the large number we have preserved. The 243 bones, the 64 jaws, and 240 teeth obtained from it are to be looked upon merely as a small fraction of the whole.

Fig. 6.—*Transverse Section across the Passage* B.



a. Dark-red earth. *e*. Red earth with stones, &c.
b. Bone-bed.
x. Undisturbed red earth.

3. *The Passage* C.—Having now exhausted the bone-bed, as we worked onwards we found that the passage B bifurcated, the smaller branch, C (see fig. 1), going onwards and gently upwards, the larger branch, D, stretching at right angles from it, and having a gentle dip of 6° to the south. In the former we met with a second bone-bed (see figs. 1 and 4), which continued undiminished in thickness until it rested upon the floor, and thinned out at a distance of 5 feet from the bifurcation. At the entrance of C the section was identical with that in B, the red earth (rather more clayey, and containing more stones) resting upon the acid-worn and water-worn floor, and supporting the bone-bed, immediately above which was a thin layer of dark friable earth. This, at the further end, owing to the thinning out of the beds underneath, was superimposed directly upon the floor, until it likewise thinned out. The bone-bed extended through the whole width of C, affording a square area of about 15 feet. Besides bones, it yielded 8 jaws of *Hyæna*, and 46 teeth and 41 bones of various animals. The passage was but 15 or 16 inches high, and about 3 feet in width; it gradually narrowed until, at a distance of 12 feet from the bifurcation, a stalactite, about 6 inches

long, had reached the floor and formed a vertical bar, as if to forbid further ingress. The last portion of this branch, for a distance of about 6 feet, was perfectly free from sediment, and was covered here and there with stalagmitic crusts.

4. *The Passage* D.—Having explored C as far as we could crawl, we commenced clearing out D, and discovered a third layer of organic remains presenting the same section as the former bone-beds, except that the dark layer was absent in places, and the bone-bed was in immediate contact with the roof. Besides an enormous quantity of bones, it yielded 45 jaws and 120 teeth. It occupied the whole of the width of D, and its edge rested on the floor of the eastern side. Its average width was 6 feet, its length 14 feet; and its square area was, therefore, 84 feet (see figs. 1 and 7).

Fig. 7.—*Longitudinal Section of the Passage* D.

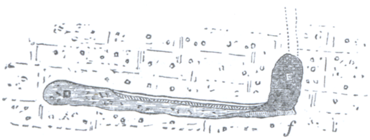
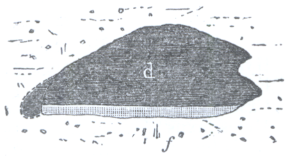


Fig. 8.—*Transverse Section in the Vertical Passage* E.



f. Sand. *d*. Grey clay.

For the explanation of the other symbols see Figs. 2–6.

As we approached the further end of the bone-bed, the red earth became of a paler hue and of greater tenacity; the stones also became larger, and the organic remains more rare. At its further edge was a layer of fine sand (*f*, fig. 7), 4 inches in thickness, underlying grey clay (*d*), full of large stones, and containing a few large bones. This latter extended completely up to the roof (see fig. 7), and was 20 inches in thickness.

5. *The Vertical Passage* E.—From this point up to the vertical passage E (see fig. 7), a distance of 4 feet, there was not the slightest vestige of bones or teeth. The stiff grey clay (*d*, fig. 8) rested upon the horizontal layer of sand on the floor of the cave (*f*). In the former a most beautifully polished piece of chert from the Mountain-limestone was found, which, as its surface is very irregular, appears to owe its polish to friction upon some soft substance. Dr. Buckland would have called it a rubbing-stone*. In the latter, also, there were numerous angular pieces of chert from the Mountain-limestone, associated with peroxide of manganese. The vertical passage took the form of a vault (fig. 7), 6 feet in height and 4 in width, and was represented overhead by an opening, 1 square foot in extent. Here our exploration ended.

* In the bears' dens of Zahnloch and Gailenreuth similar traces of polishing were found, which Dr. Buckland assigns, without hesitation, "to the skin and paws of antediluvian bears" (Reliq. Diluv., second edition, pp. 132, 137).

6. *The Physical Features of the Cave.*—The ground-plan * and sections exhibit the more important features of the cave, namely, the horizontal antrum traversed by a fissure filled with calc-spar, side by side with the "step" of conglomerate; the oblique and but partially filled passage C, similar in these respects also to A; the vertical and completely filled passages E and F, totally devoid of organic remains and full of grey clay; the places where the contents have not been disturbed, and many other phenomena which brevity compels me to pass over.

§ III. *Organic Remains.*

A. General Review.

1. *Table showing the Distribution of the Bones in the Cave.*

	Antrum.	Passage B.	Passage C.	Passage D.	Total.
Carnivora.					
Hyæna spelæa	4	4	1	5	14
Felis	1	2	...	3	6
Ursus	...	1	...	...	1
Meles taxus	1	...	...	...	1
Canis lupus	2	...	...	4	6
C. vulpes	3	...	...	...	3
Proboscidea.					
Elephas primigenius...	4	2	1	3	10
Perissodactyla.					
Rhinoceros tichorhinus	32	144	22	38	236
Equus.....................	6	33	3	3	45
Artiodactyla.					
Bos †	12	27	10	17	66
Cervus tarandus ‡	...	...	...	...	...
C. elaphus §	...	...	...	...	...
Cervus†, sp.	8	20	4	9	41
Total..............	73	233	41	82	429

* For many of the measurements in the ground-plan I am indebted to my partner in the work, Mr. James Parker.

† The absolute accuracy of these numbers is not to be depended upon, on account of the great difficulty in discriminating between the carpals and tarsals of the larger Deer and those of the smaller Oxen.

‡ The skull of a Reindeer bearing an antler of *Cervus Guettardi*, in the Taunton Museum, proves that the latter is a variety of the former. *Cervus Bucklandi*, Owen, a species based upon a small fragment of antler, and characterized by the brow-antler being "3½ inches from the lower extremity or base" of the beam [Owen, Foss. Mamm. fig. 200, p. 485], is by no means satisfactorily separated from *C. tarandus*, in which the brow-antler varies greatly even in the same individual (see Coll. Surgeons' Hunt. Cat. 3512). *C. Guettardi* is probably founded on a young, and *C. Bucklandi* on an old antler of the Reindeer.

§ There is no evidence that *Strongyloceros spelæus* is a distinct species from *Cervus elaphus*.

2. *Table showing the Distribution of Jaws and Teeth in the Cave.*

	Antrum.		Passage B.		Passage C.		Passage D.		Total.	
CARNIVORA.	Jaws.	Teeth.	Jaws.	Teeth.	Jaws.	Teeth.	Jaws.	Teeth.	Jaws.	Teeth.
Hyæna spelæa	26	229	46	67	8	7	41	39	121	342
Felis spelæa	...	5	...	2	...	...	...	2	...	9
Felis.........	...	...	...	...	...	...	...	1	...	1
Ursus spelæus	1	13	...	...	...	3	...	8	1	24
Ursus arctos	...	1	...	...	...	...	...	...	...	1
Ursus	1	2	...	...	...	...	...	...	1	2
Canis lupus	1	3	3	...	...	...	...	...	4	3
C. vulpes	3	2	...	...	...	...	...	...	3	2
PROBOSCIDEA.										
Elephas primigenius...	...	13	...	4	...	...	...	13	...	30
PERISSODACTYLA.										
Rhinoceros tichorhinus	3	88	4	63	...	10	...	29	7	190
R. hemitœchus, *Falc*...	...	1	...	...	...	...	...	...	...	1
Equus.....................	...	215	4	95	...	24	...	28	4	362
ARTIODACTYLA.										
Bos primigenius	...	14	...	1	...	1	...	...	...	16
Bos	...	1	...	...	...	...	...	...	...	1
Megaceros hibernicus	2	18	7	4	...	1	3	...	12	23
Cervus tarandus*	2	...	...	...	...	...	...	...	2	...
C. elaphus	...	...	...	...	...	...	...	...	...	...
Cervus, sp................	...	7	...	...	...	...	...	...	...	7
Total..............	39	612	64	236	8	46	44	120	155	1014

3. *Introduction of the Organic Remains into the Cave.*—I shall now briefly consider the method by which the contents of the cave were introduced; and first the organic remains.

The 800 or 1000 bones, including splinters, which we obtained, form no index to the vast quantity that crumbled to pieces on exposure to the air. Table No. 1 shows the distribution of the 429 which I have catalogued; and Table No. 2 shows the distribution of the teeth and jaws in the cave. A glance at them will show that, on the whole, the remains of any given animal, if abundant, are not confined to one spot in the cave, but are pretty evenly distributed, and lie large with small, the more with the less dense, not in the least degree sorted by water. There is no evidence of the Bear succeeding to the Hyæna, or the *Felis* to the Bear, in the occupation of the cave; or that the latter retired hither to die, as in some of the caves of Germany; or that any of the Herbivores fell into the open swallow-holes, and so left their remains, as in the Hutton and Plymouth caves †. On the contrary, the numerous jaws and teeth of *Hyæna*, the marks of those teeth upon every one of the 800 to 1000 bones, upon the 155 jaws, and even upon the great

* *C. Guettardi* and *C. Bucklandi* are merely varieties of *C. tarandus*, under which they are here classed.

† See Buckland, Rel. Diluv.

majority of the teeth, show that they alone introduced the remains which were found in such abundance.

4. *Position of some of the Remains.*—A glance, however, at the vertical sections will show that some of the remains are not now in the exact position they occupied in the days of the Hyæna. The maximum distance of the bone-layers from the roof is but eight inches, a space manifestly too small to allow of the Hyæna devouring his prey; while in many instances the remains actually touched the roof. This, indeed, has been used as an argument in favour of their having been introduced by water from some unknown repository. On this supposition the introducing current of water must either have passed down the vertical passages or through the horizontal mouth of the antrum. In the former case the three bone-layers would not have been found in the narrow passages, but would have been swept out into the wide antrum, where the force of the hypothetical current must have abated. In the latter case the great bulk of the remains would have been found in the antrum, and not in the smaller passages and innermost crannies of the cave. But, apart from this evidence, the absence of marks of watery action upon the organic remains, and especially of that sorting action which water, as a conveying agent, always manifests, and in no case more remarkably than in the lower jaws of the Stonesfield Mammals, makes the hypothesis of their introduction by water untenable *.

The evidence, indeed, as to the cause of the position of some of the remains is most conflicting. Their condition, their distribution in the cave, and especially the presence of two gnawed rami of the same lower jaw of *Hyæna*, found a few feet apart in the passage B, of two gnawed fragments of the same upper jaw of the Irish Elk, also found apart in the passage D, of the right and left lower molars of the same Elephant, and the right upper and lower molars of a second, also in the passage D, all prove that the organic remains were not introduced by water. On the other hand, the horizontality of the layers, the presence of layers of peroxide of manganese, of the red sediment, and of the sand, show that water certainly was an agent in rearranging and introducing some of the contents of the cave. The only solution of this difficulty that I can hazard is the occurrence of floods during the occupation by the Hyænas, and perhaps for some time afterwards, similar to those which now, from time to time, take place in the caverns of the neighbourhood.

5. *Introduction of the Red Earth.*—A few years ago the outlet of the stream flowing through the great cavern at Wookey Hole was blocked up, and the water rose in it to a height of upwards of sixteen feet, and left a horizontal deposit of red earth similar, in every particular, to that of the Hyæna-den. Now, if we suppose that similar floods were caused by an obstruction in the ravine below the Hyæna-den, it may have been flooded just as the upper galleries

* The caverns of the Liége district, explored by Dr. Schmerling, were filled, without exception, by the action of water, and contain in many cases water-worn bones. Schmerling, Recherches sur les Ossements Fossiles découverts dans les Cavernes de la Province de Liége, vol. i. pp. 18, 19.

of the great cave; and the water, laden with sediment, entering from time to time, might have elevated the layers of matted bone and all the scattered remains on the surface, while the current was insufficient to disturb the stones or to affect, to any extent, the deposit of former floods. The buoyancy of the organic remains is not required to be greater by this hypothesis than is demanded by that of their having been introduced by a current through the swallow-holes.

But if water introduced the red earth, it is certain that it had nothing to do with the introduction of the stones. As the red calcareo-magnesian cement of the dolomitic conglomerate supplied the red earth, so did its imbedded pebbles of limestone supply the latter. Either angular or water-worn, they are in the same state as they were when they formed integral parts of the roof, sides, and floor of the cave, with the exception that they have been worn by carbonic acid, and exhibit a network of calc-spar, stems of Crinoids, and shells of Spirifers in strong relief. It is needless to repeat that, had they been once set in motion, these organic remains must have been ground to powder.

B. Special Description.

1. *Jaws and Teeth of Carnivora.*—I shall pass on now to a brief consideration of the jaws and teeth, omitting, for the sake of brevity, all mention of the bones. Amongst the Carnivora *, *Felis spelæa* is represented by four teeth of the molar series, and six canines. As the difference in the length of the crown of the large upper canine as compared with the largest of the lower ones (1·1 inch) is greater than the difference in an adult tiger (0·4), these teeth may indicate the presence of two species. This difference is, I think, too great to be owing to mere sexual peculiarities. There is no evidence as to whether they belonged to the Lion or the Tiger; for P.M.3, in its size, approaches the corresponding tooth of *Felis tigris*; in the

* *Comparative Measurements of Canines of* Felidæ *and* Ursidæ.

	Length of tooth, measured anteriorly.	Basal circumference of crown.	Length of crown, measured anteriorly.	Length of fang, measured anteriorly.	Maximum circumference of fang.	
	in.	in.	in.	in.	in.	
Felis spelæa. Upper canine	5·5	3·4	2·5	3·0	3·9	maximum.
Felis, sp. Lower canine	4·2	2·4	1·4	2·8	2·7	minimum.
Ursus spelæus. Upper canine	6·0	3·3	1·7	4·3	4·3	maximum.
" " Lower canine	5·6	3·2	1·4	4·2	3·7	maximum.
U. Leodensis (*Schmerling*). Lower canine	4·9	2·2	1·4	3·5	2·7	
U. arctos. Lower canine	4·4	2·1	1·3	3·1	2·5	

The upper canine of *Felis spelæa* has the apex of its fang truncated as in a corresponding tooth of *Felis tigris* in the Museum of the Royal College of Surgeons (4535 of Cat.) and as another in the Oxford Museum.

narrowness of its anterior as compared with its posterior talon, it approximates to *Felis leo*.

The 121 jaws and 342 teeth of *Hyæna spelæa*, the normal inhabitant of the den, show how numerous those animals were, and for how long a time they inhabited the cave. A selected set of rami shows all the changes in their dentition, from youth to old age. The two oldest have each lost one of their two bone-crushers: the one has lost P.M.4, and its alveolus is partially filled up; the other has lost P.M.3, and its alveolus is completely obliterated by osseous tissue. In the three youngest jaws are seen the stages by which the small deciduous molars were replaced by the large and perfect permanent dentition—the most admirable for crushing bone that could be desired. In one lower jaw of a Hyæna in its prime the perfect dentition of the right ramus is preserved; both rami were found some feet apart in the bone-layer in the passage B. In a second ramus of an older animal the angle and the greater part of the coronoid process are preserved—the only instance of their having escaped the teeth of the Hyæna. In a third, covered with tooth-marks, the broken M.1 has been partially thrust out of its alveolus by the teeth of the animal that devoured its possessor. As, however, it was fortunately exposed on the floor to the calcareous dripping from the roof, it is firmly cemented in its place by stalagmite. Of the upper jaws, also arranged according to age, one shows the perfect premolar series, a second the small true molar which disappears early in the *Hyænidæ*, a third the diseased stump of P.M.4. The inflammation resulting from the fracture of the latter has greatly constricted the supraorbital foramen.

The *Canidæ* are represented by *Canis lupus* and *C. vulpes*. The three jaws and two teeth of the latter indicate a size similar to that of the existing species, while the four jaws and three teeth of the former indicate a superiority of size.

The *Melidæ* are represented by *Meles taxus*, of which one humerus only was found. This may be of a date far posterior to that of the other remains.

Of the *Ursidæ* twenty-seven teeth and two jaws were discovered, the larger canines equalling, if not surpassing, in size the largest from Germany; and the molar teeth, of which one upper molar is larger than any from Gailenreuth or Quinger, in the Bucklandian Collection, belong to the gigantic Cave-bear, *Ursus spelæus*. A lower canine also indicates the presence of a second species of Bear, *U. arctos**. Of the equivocal remains, one jaw is closely allied to that from Bacton in the British Museum†; and a canine with a thin compressed fang is identical with that figured by Dr. Schmerling as *Ursus leodensis*‡, though slightly larger in every dimension.

* Comp. Schmerling, *op. cit.* vol. i. pl. 8. p. 8. In the collection of my friend Dr. Spurrell I recognized a lower canine of *U. arctos*, from the Crayford gravel-pits.

† Comp. Owen, Brit. Foss. Mamm. fig. 35 B, p. 106.

‡ Comp. Schmerling, *op. cit.* vol. i. p. 94, pl. 8. fig. 8. Whether *U. leodensis* is a valid species or not, I can offer no opinion.

The tooth-marks upon the remains of the Carnivores prove that they were preyed upon by the Hyænas.

2. *Perissodactyla*.—Of the Perissodactyle Herbivores, the solidungulate division is represented by *Equus fossilis*, of which four jaws and 362 teeth were found, while the multungulate division contains *Rhinoceros tichorhinus* and *R. hemitœchus*. Seven jaws and 190 teeth belong to the former of these. The molars present points of great interest. One series of $\underline{\text{M.3}}$ shows the inconstant size and form of the posterior column ($\overline{Collis}$ *tertius* of Brandt), which, rudimentary in some, passes gradually to the summit of the crown in others, and finally, in an abnormal specimen, circumscribes a second deep cavity on its posterior aspect. One of the $\underline{\text{M.2}}$ is also abnormal. In it the entrance of the principal valley is closed up, leaving the valley so characteristic of *Rhinoceros* as an insulated cavity in the middle of the tooth. The upper milk-molars are remarkable for a cusp at the wide entrance of the valley, quoted by Professor Owen as one of the characteristics of *R. leptorhinus*. The lower jaws prove that in no stage of the dentition was the first premolar developed. The jaws from Lawford and Thame, figured and described by Professor Owen (Brit. Foss. Mamm.) as containing the premolar dentition, are really young jaws with the deciduous dentition. The first milk-molar in the Lawford specimen is mistaken for the first premolar, which, as yet, has not been proved to exist*. Of *R. hemitœchus* but one fragment of a left upper milk-molar was found, for the identification of which I am indebted to Dr. Falconer.

3. *Artiodactyla*.—The Artiodactyle division of Herbivores is largely represented. Sixteen teeth attest the presence of *Bos primigenius*, while one upper molar, smaller in every dimension than the rest, may possibly belong to a second species of the *Bovidæ*.

Twenty-three teeth and twelve jaws are preserved of *Megaceros hibernicus*. One specimen of a right lower ramus shows, besides the perfect molar series, a curious freak of nature. P.M. 2, instead of being in its natural position, has come up hind foremost, the anterior part occupying the place of the posterior, the inner side that of the outer. The fragments of the upper jaw containing M. 1, 2, 3 were found dissociated in the passage D.

Cervus Guettardi, *C. tarandus*, and *C. Bucklandi* are represented by antlers, some of which have been torn violently from the skull, and not shed by necrosis, as are all those found at Kirkdale. The fact that in the Williams Collection, at Taunton, there is a skull of *Cervus tarandus*, bearing on the left side an antler† of *C. Guettardi*,

* Pallas, indeed, and Fischer doubt the existence of the first premolar. Brandt comes to the conclusion that it is absent from the adult. On the other hand, Cuvier, without ever having seen it, states that it exists, on the authority of Adrian Casper; and Blainville (Ostéographie, p. 107) ascribes four premolars to *R. tichorhinus*.

† Comparative measurements :—

	Right side.	Left side.
Burr to bez-antler	6 4‴	0 0‴
Burr to brow-antler	0 5‴	2 0‴
Circumference above burr	3 2	2 8
Circumference of brow-antler at base	1 8	1 8

and on the right its own normal antler, shows that the latter is but a variety of the former, consequent upon the irregular position of the brow-antler. The correspondence also of the antler-basements of a skull belonging to the former with the bases of necrosed antlers of *C. Bucklandi* may indicate that this is a second variety of the same species, consequent on varying age. Antlers also indicated the presence of *Cervus elaphus*. Some of the teeth also correspond with those of *C. elaphus*; but I cannot affirm without hesitation that they undoubtedly belonged to that animal.

4. *Proboscidea*.—The twenty-four molars and six tusks of *Elephas primigenius* belonged in the main to young individuals. The longest tusk was 2 feet 5 inches in length; the oldest molar was composed of seventeen plates, four of which were supported by the anterior fang.

IV. *Results of the Excavations.*

1. *The Ancient Physical Geography of the District*.—The group of animals just noticed throws great light upon the physical geography of the district in the days of the Hyæna. In the absence of the Beaver and the Otter, of the Water-rat and the Hippopotamus, we may see that then, as now, there was no river in the immediate vicinity. The great preponderance of the Horse and Rhinoceros is very remarkable. The great number of the former, compared with the few in the Kirkdale Hyæna-den, may perhaps show that they were more numerous in the west than in the north of England*. Both indicate the existence of an extensive plain in the neighbourhood; while the various species of *Cervidæ* point to woodlands on the flanks of the Mendips, and encroaching on the plain at their base. But this evidence does not stand alone. The physical configuration of the west coast of Somerset, the mammalian remains found at low water at St. Audries, the jaws of *Rhinoceros tichorhinus* at Taunton, associated with oak, ash, and alder, prove that a level district extended in those days, with but little interruption, from the Mendips to the Devonian range of the Quantocks, and advanced westwards into the British Channel, and possibly into the Atlantic. The higher grounds of South Wales, in the Mountain-limestone of which bone-caves are so numerous, probably formed its northern boundary.

The Mountain-limestone borders of this great plain would obviously be most favourable for the habitation of the large numbers of Carnivores—the Hyænas, the three, if not four, species of Bear, the two species of *Felis*, the Foxes, and the Wolves. We should naturally expect to find them here in greater variety and numbers than in any less favourable place.

Subsequently to this came a great depression of the district, followed by a gradual upheaval, the evidences of which time does not permit me to bring forward. In neither the marine deposits of the one, nor the lacustrine deposits of the other, have I detected any of the fauna of the bone-cave, with the exception of the Fox, the Irish Elk, and the Red Deer. Thus the palæontology of the district shows that the date of the cave was prior to a submergence of the immediate

* See List of Remains from Kirkdale, 'Reliquiæ Diluvianæ.'

vicinity, while *Rhinoceros hemitœchus* here, as at Kirkdale, associated with *R. tichorhinus*, may perhaps refer it to the earlier part of the newer Pliocene period*.

2. *Evidences of Human Occupation.*—Let us now pass on to the evidences of human occupation. All the ashes and implements were found in positions, near the mouth of the cave, where man himself may have placed them (see figs. 1 to 8), with the exception of an ash of bone imbedded in the earthy matrix between the canine tooth and a coprolite of the Hyæna, and cemented to a fragment of dolomitic conglomerate. This was found far in the cave, either at the entrance of the passage B or in the middle of the passage D. The latter passage yielded the only rolled flint without traces of man's handiwork. The materials out of which the implements were made were used pretty equally. All the spear-heads were of flint; all the sling-stones of chert from the Upper Greensand; while the flakes consisted of both, used indifferently. Besides these three typical forms, which were most abundant, is a fourth, in form roughly pyramidal, with a smooth and flat base, and a cutting edge all round. Of these we found but two examples, both consisting of chert. In form they are exactly similar to some hundreds found in a Celtic village at Stanlake, and to others I discovered in a cemetery of the same date at Yarnton, near Oxford. They strongly resemble a cast I have of one found by M. Lartet in the cave of Aurignac. Were it not for this similarity, I should look upon them as accidental forms. The rest are mere splinters, irregular in form, and probably made in the manufacture of the various flint and chert implements. All the flint implements have been strangely altered in colour and structure, either by heat or, as is more probable, by some chemical action. Without exception, the old surfaces present a waxy lustre (by the absence of which forgeries are easily detected), the colour is of a uniform milk-white, and the ordinary conchoidal fracture is replaced by that of porcelain. Some are not harder than chalk. I have obtained weathered and calcined flints from Sussex in which similar changes are observable, and in which the difference in the results of chemical action and heat can hardly be detected. The chert implements, on the other hand, show no traces of any such changes, but are similar in colour and structure to the rocks from which they came—the Upper Greensand of the Blackdown Hills.

The inferiority of workmanship, on comparison with the implements of Amiens and Abbeville, and of Hoxne, may possibly indicate a higher antiquity, and certainly shows that the Wookey Hole savages were of a lower order than the Flint-folk of the valley of the Somme, or of Suffolk. If also the complete whitening and the total absence of conchoidal fracture in these implements, as compared with the fracture and natural colour of those from the above well-known localities, in which the decomposition is but skin-deep, and causes but a waxy lustre, be any evidence of antiquity, the former are of a far earlier date than the latter.

* Comp. Dr. Falconer, "On the Ossiferous Caves of the Peninsula of Gower," Quart. Journ. Geol. Soc. vol. xvi. p. 491.

All the fragments of calcined bone, with the exception of one already mentioned, were found near the entrance (see fig. 1), and in a place more suitable for a fire than any other in the cave. I can identify none of them as human. The coarse texture, the structure, and the thickness of one indicate a fragment of a long bone of *Rhinoceros* *. All resemble many splinters strewn about in other parts of the cave, which are not calcined, but were evidently introduced by the Hyænas. The calcination may therefore be due to the accident of their lying upon the surface at the time the fire was kindled. The presence of the ashes indicates the occupation of the cave by man.

3. *Conclusion.*—The whole body of evidence † tends to prove that man, in one of the earlier stages of his being, dwelt in this cave; that in it he manufactured his implements out of flint from the chalk-downs of Wilts, and from the less fragile chert from the Greensand of the Blackdown Hills, and arrow-heads out of the chert and the more easily fashioned bone; and that, beyond all doubt, he was a contemporary with the extinct fauna found, with the traces of his existence, in the cave. Then after an interval, in which much of the fauna became extinct, and in which the whole of the district was considerably depressed, we again meet with traces of man in the coarse pottery and the human teeth found by Dr. Buckland in the great Wookey Hole cavern ‡. And, lastly, the discovery of coins of Allectus, Comes littoris Saxonici, together with skeletons near the Hyæna-den, brings us down to the fourth or fifth century after Christ. Thus Palæontology shades off into Archæology, and that into History, and each, taking up the thread where the other dropped it, shows the intimate relation between sciences formerly considered to have little or no bearing upon each other. Until, however, there are data for estimating the magnitude of the breaks in the succession, it is impossible to reduce the interval between ourselves and the Flint-folk to the scale of time used in history. The supplanting of one species by another, and the oscillations in the level of the surface, prove that the lapse of time was enormous, but they do not warrant us in reducing it to any definite number of years.

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2. *On the* Discovery *of* Paradoxides *in* Britain.

By J. W. Salter, Esq., F.G.S., A.L.S.

During a few days' holiday in South Pembrokeshire last summer, I went to the neighbourhood of St. David's. I wished to see the Cambrian and Lower Silurian beds recently mapped by Mr. T. Aveline, and to learn if they presented the same characters as the corre-

* Possibly it may have belonged to *Elephas*, but its coarse texture seems to me to indicate *Rhinoceros*.

† For arguments on the relation of the traces of man to the organic remains, see Quart. Journ. Geol. Soc. vol. xviii. p. 119.

‡ See Rel. Diluv. p. 165.