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A MONOGRAPH

OF THE

BRITISH PLEISTOCENE MAMMALIA

VOL. I.

BRITISH PLEISTOCENE FELIDÆ.

BY

W. BOYD DAWKINS, M.A., F.R.S.,

AND

W. AYSHFORD SANFORD, F.G.S.

LONDON:
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PART I.

INTRODUCTION.
(Pages i—l.)

BRITISH PLEISTOCENE FELIDÆ.

FELIS SPELÆA, Goldfuss.

(Pages 1—28; Plates I—V.)

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PREFACE.

Since the time when Baron Cuvier published the last edition of his great work, the 'Ossemens Fossiles,' in 1825, the materials for working out, in detail, the British Pleistocene Mammalia, of which Professor Owen had given an admirable outline in 1846, have been steadily and rapidly increasing. Our great National Museum has been supplemented by other public ones in most of the principal towns, in which the past Fauna and Flora of their respective districts are carefully preserved. The zeal of private collectors also has added very largely to the heap of accumulated facts, which only have to be compared and brought to a focus to enable us to realise, in all their varieties of size and form, the animals that lived upon that portion of the Pleistocene continent which now forms Great Britain and Ireland. Zoology also has made great strides, and, armed with a more perfect knowledge of the present order of things, we are daily becoming more fitted to investigate profitably the past. In undertaking to bring the Mammalogy of the Pleistocene up to the requirements of the day, we are conscious of our own shortcomings and of the magnitude of the task. We propose, by adopting the form of a series of Monographs upon each species, and by not commencing a second species until we have exhausted all the attainable information upon the one we may have in hand, to leave the work in such a state that it may be continued by any successors without alteration of plan.

We do not pledge ourselves to bring out the Monographs in zoological order, but just as our materials may admit of the complete description of any Pleistocene genus. This arrangement, as each Monograph will be distinct from the rest, like those composing M. de Blainville's 'Ostéographie et Odontographie,' will not affect their being bound up in their proper order on the completion of the work.

For any information as to the remains of Pleistocene Mammals in private cabinets, or anywhere else in Great Britain or Ireland, we shall be extremely obliged, as we wish to give the distribution and relative numbers of every fossil Pleistocene species.

W. BOYD DAWKINS.
W. AYSHFORD SANFORD.

February, 1866.

CONTENTS OF INTRODUCTION.

BRITISH PLEISTOCENE FELIDÆ.

Felis spelæa, Goldfuss.[1]

When simply numbers are placed at the commencement of the lines of the Tables of Measurement, they invariably signify—

1. Extreme length or antero-posterior measurement in inches.
2. Minimum circumference.
3. Maximum transverse measurement of proximal articulation.
4. Vertical ditto ditto.
5. Maximum transverse measurement of distal articulation.
6. Vertical ditto ditto.

DESIDERATA FOR THE COMPLETION OF THE MONOGRAPH ON *FELIS SPELÆA*.

British specimens of nasal and internal bones of the cranium; vertebræ; atlas; axius; sacrum.
,, ,, complete humerus, or proximal end of the bone; distal end of ulna.
,, ,, carpal bones, viz., cuneiform, trapezium, trapezoid, magnum.
,, ,, complete, or proximal end of femur.
,, ,, complete, or proximal end of fibula.

Bones of any other species of Felis or Machairodus from the British Pleistocene. The species at present known to exist in Britain are *Machairodus latidens, Felis pardus, F. catus.* But the lynx and, perhaps, the serval might be expected. The authors of this Monograph would be glad of the opportunity of examining any bones or teeth of Carnivora; and the utmost care will be taken of bones, addressed either to W. BOYD DAWKINS, Esq., Geological Survey, Jermyn Street, or to W. A. SANFORD, Esq., Nynehead Court, Wellington, Somerset. Or should the possessors not wish to send them, the authors would be glad of the opportunity of simple examination.

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[1] Unfortunately we have been unable, from want of time, to publish the Plates and Descriptions of the Bones of *Felis spelæa* in the order in which they should naturally appear. We trust that this may be rectified in our future Monographs.

INTRODUCTION.

§ 1. In going backward in time from the historical period in Britain, we find ourselves landed in the realms of archæology without any guide to absolute date, and without any connected record of events previous to the first landing of Julius Cæsar upon our shores. The investigation of the contents of peat-mosses, of alluvia of rivers, and of a large number of caverns occupies our attention; and while the remains of man are widely spread, we miss the larger Carnivora, the Pachydermata, and others of the Pleistocene Mammalia. For this period, as embracing the deposits more usually termed *recent,* and extending from the Pleistocene down to the beginning of history, we adopt the name Prehistoric. It is eminently the field of the archæologist, who subdivides it, according to the traces of man that it contains, into the iron, bronze, polished stone, rude unpolished stone, and flint periods.[1] From his point of view we have nothing to do with it; but for the sake of showing the relation of the Pleistocene fauna to that now living in Britain, we are obliged to treat it zoologically. It forms a distinct zoological period, separable from the Pleistocene, but passing insensibly into the Historic period.

§ 2, A. *Prehistoric caverns.*—Caverns, as affording shelter from the weather, have been the resort of man and wild animals in all times, from the Pleistocene to the present day. Hence, very frequently in the same cave remains of different epochs are found. In Kent's Hole, for instance, overlying the mass of bones dragged in by hyænas in Pleistocene times, and in parts hermetically sealed by stalagmite, there was a stratum of dark earth containing the remains of the feasts and fires of some early people—bone implements, chert and flint arrowheads, "a hatchet of syenite," sandstone spindles, shells of mussel, limpet, and oyster, a palate of *Scarus,* and numerous fragments of pottery. This last "is of the rudest description, made of coarse gritty earth, not turned on a lathe, and sun-baked; on its external margin it bears zigzag indentations, not unlike those from the barrows of Wilts." Its ornamentation and texture are like those of the rude pottery obtained

[1] See Sir John Lubbock's 'Prehistoric Man,' 8vo, 1865. London.

by the Earl of Enniskillen, F.R.S., from the Bears' Den of Kühloch, and that from the Pile-dwellings of Switzerland in the collection of the late Mr. H. Christy. In some places the stalagmite had been broken through, apparently for purposes of sculpture; and human bones, and flints of all forms, "from the rounded pebble, as it came out of the chalk, to the instruments fabricated from them, as the arrow- and spear-heads, and hatchets, were confusedly disseminated through the earth, and the whole agglutinated together by stalagmite. Flint cores were lying by the sides of the flakes struck from them."[1] The remains also of the wild boar, red deer, fox, rabbit, and rodentia, were obtained from the same layer, and are in part preserved in the Museums of London and Oxford. The metatarsals and -carpals in the Oxford Museum, obtained from the upper portions of the contents of the cavern in association with charcoal, belong to the small short-horn *Bos longifrons*.

To the absolute date of these remains there is at present no clue; but that the cave was inhabited after, to the disappearance of the characteristic Pleistocene mammalia found in the cavern, by savages closely allied to those whose remains are found in hut-circles and tumuli, there can be no doubt. The careful exploration now being conducted by the British Association will doubtless throw great light upon the relative age of the various layers, and possibly the absolute age of some of the superior ones.

§ 2, B. The Paviland cave, described by Dr. Buckland, affords another instance of the mixture of Pleistocene and Prehistoric remains. To the one period belong the elephant, rhinoceros, horse, and hyæna; to the other, the human skeleton (which equals in size the largest male skeleton in the Oxford Museum), the bones of ox and sheep, the whelk, limpet, littorina, and trochus, that had been introduced for food. Certain small ivory ornaments found along with the skeletons Dr. Buckland considers to have been made from the tusks of the mammoth in the same cavern, and he justly remarks—"As they must have been cut to their present shape at a time when the ivory was hard, and not crumbling to pieces, as it is at present on the slightest touch, we may from this circumstance assume for them a very high antiquity."[2] May we not also infer from the fact of the manufactured ivory, and the tusks from which it was cut, being in precisely the same state of decomposition, that the tusks were preserved from decay during the Pleistocene times by precisely the same agency as those now found perfect in the Polar regions—by the intense cold; that long after the mammoth had become extinct the tusks thus preserved were used by some race that has passed away; and that at some time subsequent to the interment of the ornaments with the corpse a great climatal change has taken place, by which the temperature in England, France, and Germany has been raised, and decomposition set in in the organic remains that up to that time had remained for ages in their natural condition? The presence of the remains of sheep under-

[1] 'Cavern Researches,' by the late Rev. J. MacEnery, F.G.S., edited by E. Vivian, Esq., 4to, 1859 (the larger edition).

[2] Buckland, 'Reliquiæ Diluvianæ,' 4to, 2nd edit., 1824, p. 90.

neath the bones of elephant, bear, and other animals, coupled with the state of the cave-earth, which had been disturbed anterior to Dr. Buckland's examination of the cave, would prove that the interment was not of Pleistocene date. No traces of sheep or goat have as yet been afforded by any Pleistocene deposit of Britain, France, or Germany.

§ 2, C. These two instances of the presence of remains of Pleistocene and Prehistoric age in the same cavern are two out of a large number in which a similar mixture of organic remains are met with. Instances also may be multiplied of caverns containing remains of Prehistoric age alone without others. Thus, Professor Owen quotes a cave at Arnside Knott, near Kendal, that yielded wild boar (*Sus scrofa*), brown bear (*Ursus arctos*), and other existing species of Mammalia.[1]

§ 2, D. During our explorations of caverns in Somersetshire we explored three of Prehistoric age. In 1859 a small cave at the head of Cheddar Pass yielded a large quantity of bones. Prior to our examination, on its first discovery, some of the remains were deposited in the Museums of Bristol and Oxford. The list of Mammalia comprises, besides man, the wolf, fox, badger, wild boar, goat, roebuck, *Bos longifrons*, and horse. A human skull from this cave, preserved in the Oxford Museum, is very well developed,[2] and may have belonged to a person of considerable capacity.

§ 2, E. In 1863 we examined a second cave, also in the Mountain Limestone of the Mendip range, in Burrington Combe, and named it from its discoverer Whitcombe's Hole. It was very nearly blocked up with earth mingled with charcoal, and contained a large quantity of the remains of ox, red deer, goat, wolf, fox, badger, rabbit, and hare. In the lower portion of the cave, where the floor dips downwards, we disinterred fragments of a rude unornamented urn of the coarsest black ware, with the rim turned at right angles, and an angle iron which more closely resembled those found strengthening the angles of wooden chests in the Roman graves on the banks of the Somme than anything else we have seen. The accumulation of bones and charcoal proves that the cave was in-

[1] 'British Fossil Mammals,' 8vo, 1846, p. 429.

[2] We are indebted to Professor Phillips, M.A., LL.D., F.R.S., for the following note upon this skull:—"The cranium is dolicho-cephalic, elevated in the parietal region, very narrow behind, with a very distinct occipito-parietal slope, narrow and evenly convex in the front; substance thin; individual young, probably female. This cranium most nearly resembles one from the cave at Llandebie (now in the Oxford Museum), which is filled with stalagmite, and was accompanied by bones of elk, bear, and *Bos longifrons*. The dimensions are—

Length	in inches	7·22
Breadth, parietal . .	„	5·32
„ frontal . .	„	3·75

"The last measurement is taken along the supraciliary line, for it is hardly a crest in this individual.

"Do you ask what race of men this belonged to? I answer that I have seen plenty of men and women with such crania in the south of England and South Wales."—*Oxford, Sept.* 1, 1865.

habited by man for some considerable time, like those of Perigord.[1] The interment is clearly of a later date than the occupation, because it is made in the mass of earth, bones, and charcoal, which resulted from the latter. The interval between the two is of doubtful length.

§ 2, F. In the same year we explored the cave, Plumley's Den, like the preceding in Burrington Combe. It consists of two large chambers, connected together by two small passages, not more than a few inches high. The natural entrance, but a little larger than a fox-hole, was in the roof of the first chamber, and through this we had to drop down into the cave. Subsequently we blasted a second entrance. The first chamber was at least half-full of broken rocks, forming a talus immediately below the natural entrance, through which in part they may have been introduced. They were covered with a mortar-like mass of decomposing stalagmite. Underneath them we found a group of four skulls, more or less crushed and fractured. One of these belonged to a small variety of the *Bos taurus*, probably that variety so abundant in deposits of Prehistoric age, *Bos longifrons*. Two others belonged to a species of the goat tribe, and approach more closely to the *Ægoceros Caucasica*[2] of Asia than any recent species with which we are acquainted, the horncores being oval, in section, very nearly parallel, and slightly recurved. We have met with a similar form in a deposit of bones at Richmond, in Yorkshire ; but in the absence of the necessary materials for comparison from the Museums of London, Oxford, and Paris, we do not feel justified in imposing a new specific name. The fourth skull belonged to *Sus scrofa*, and had a round hole in the frontals, about the size of a crown-piece, which had the appearance of being made by human hands. The presence of the lower jaws by the side of their respective skulls indicates that they were deposited in the cave while the ligaments still bound them together. They were all more or less covered with decaying stalagmite. Between the interstices of the stones covering the floor were numerous bones and teeth of wolf, fox, mole, arvicolæ, badger, bat, the metacarpal of red deer, the radius of Bos, and the remains of birds. The outer chamber was remarkable for the absence of earth of any kind, except underneath the natural entrance, where there was a thin coating. The lower chamber, on the other hand, running in the same slope as the outer, has its lower end entirely stopped up with a fine red earth, deposited by a stream, traces of the flow of which, during heavy rains, were evident. How the animal remains were introduced—for there were no marks of gnawing upon them, and no fragments of charcoal in the cave—is altogether a matter of conjecture. But the fact of finding the skulls grouped together, coupled with the presence of the hole in the frontals of the *Sus scrofa*, inclines us to believe that they may have been introduced by the hand of man. The entrance was far too small to admit of an ox falling into the cave by accident, and scarcely large enough to admit of a goat or deer squeezing themselves through.

[1] 'Revue Archéologique,' 1864.

[2] Gray, 'Cat. of Bones of Mammals in British Museum,' 8vo, 1862, p. 249.

§ 2, G. From a cave in the limestone cliffs at Uphill, near Weston-super-Mare, Mr. James Parker obtained the following remains:—Human crania and bones, accompanied with rude pottery and charcoal, the bones of wild cat, wolf, fox, badger, *Bos longifrons*, and a second species ox of larger size; the red deer, *Sus scrofa*, and water-rat. A large percentage of these belong to young animals, and some are gnawed by dogs, wolves, or foxes. This must not be confounded with the cavern at Uphill from which Messrs. Beard and Williams obtained Pleistocene Mammals.

§ 2, H. The Heathery Burn Cave, in Yorkshire, explored by Mr. John Elliot, yielded, besides the remains of man, those of the otter, badger, goat, roedeer, hog, and water-rat. With reference to the human remains, Professor Huxley observes—"I see no reason for believing them to be of older date than the river-bed skulls," *i. e.* those found in the valley of the Trent, associated with *Bos longifrons*, goat, red deer, wolf, and dog.[1]

We have selected these as examples of Prehistoric caverns, and as representing the fauna of the vague interval between the Pleistocene and our own times.

§ 3. In the alluvia of rivers and in peat-bogs the remains of animals of Prehistoric age are found in large numbers, and correspond remarkably with those of the caverns. Thus, the Manea Fen, in Cambridgeshire, has yielded *Ursus arctos;* the peaty mud near Newbury the beaver, wild boar, roedeer, red deer, wolf, goat, horse, otter, water-rat, bear, *Bos longifrons*, and *B. primigenius;* the peat and the marly beds below of Ireland the *Megaceros*, associated with the *Bos longifrons*, the red deer, and the reindeer (*C. tarandus*). The peat of Hilgay, in Norfolk, has furnished the beaver and Irish elk, while that of Ross-shire the traces of the reindeer, in an antler presented by Sir P. Malpas de Grey Egerton, Bart., to the British Museum. The reindeer also is described by Professor Owen[2] as occurring beneath a peat-moss near East Dereham, in Norfolk. The remains of *Bos longifrons* are most universally found with red deer, roedeer, wild boars, otters, and beavers. The marl underneath the peat of Scotland has also yielded the gigantic skulls of the great Urus, *Bos primigenius*. From the very recent character of the osseous substances of these, Professor Owen infers that this animal may have maintained its ground longer in Scotland that in England.

"In the Museum of the Natural History at Newcastle is a remarkably fine shed antler of the true elk, *Alces malchis*. It was found in Chirdon Burn, near the bottom of the recent peat-formation, resting partially on the coarse gritty marl formed by the weathering of the subjacent strata."[3] It measured, when perfect, from tip to tip, 2 feet 10 inches; from burr to extreme end, 2 feet 10 inches; round the burr, 10 inches; and round the beam nearly 8 inches. The *gisement* of the fossil stamps it as being of the same relative

[1] 'Geologist,' 1862.

[2] Op. cit.

[3] 'Trans. of Tyneside Naturalists Field Club,' vol. v, part ii, p. 111. Paper by Mr. Richard House, 1861.

Prehistoric age as the Urus of Scotland and the Megaceros of Ireland, found in the marl at the bottom of the peat. It is worthy of remark that this animal was eaten by the dwellers in the Lake-villages of Moosedorf, Wauwyl, Meilen, Robenhausen, Concise, and Bienne, according to Professor Rütimeyer.

In digging the foundations of the large works at Crossness Point for the southern outfall of the metropolitan sewage a most interesting collection of Prehistoric Mammalia was made from the peat and silt. We identified red deer, *Bos longifrons,* goat, beaver, horse; and among the remains forwarded to the British Museum is a remarkably fine antler of reindeer (*Cervus tarandus),* which Mr. Houghton, the engineer, informs us came from the bottom of the peat at a depth of fifteen feet below the surface. A large number of cases of similar discoveries may be quoted, as in the estuarine mud of Selsea, of the hind and fore legs of *Bos longifrons,* with all the bones, to the smallest sesamoids, in place, or in a silted-up river-bed at Waterbeach Mills, near Cambridge, of the same animal, associated with the red deer, goat, horse, and wolf.

§ 4. The following list, which probably will be largely increased, represents the mammalia derived from the Prehistoric deposits, and includes those species that began to live in the Pleistocene, and are living in Britain at the present day, and which therefore must have lived in the Prehistoric Period, although their remains have not yet been discovered in it. The latter are marked with an asterisk. It consists of thirty-four species.

Homo sapiens, *Lin.*
Rhinolophus Ferrum Equinum, *Leach.*
Vespertilio noctula, *Geoff.*
Talpa Europæa, *Lin.*
Sorex vulgaris,* *Lin.*
Felis catus ferus, *Schreb.*
Canis familiaris, *Lin.*
„ vulpes, *Lin.*
„ lupus, *Lin.*
Mustela erminea,* *Lin.*
„ martes,* *Lin.*
„ putorius,* *Lin.*
Lutra vulgaris, *Erxl.*
Meles taxus, *Schreb.*
Ursus arctos, *Lin.*
Mus musculus, *Lin.*
Castor fiber, *Lin.*
Arvicola amphibia, *Desm.*
„ pratensis,* *Bell.*
„ agrestis,* *Pall.*
Lepus timidus, *Fabr.*
„ cuniculus, *Lin.*
Equus caballus, *Lin.*
Alces malchis, *Gray.*
Megaceros Hibernicus, *Owen.*
Cervus Tarandus, *Lin.*
„ elaphus, *Lin.*
„ capreolus, *Lin.*
Ovis aries, *Lin.*
Capra ægagrus, *Gmel.*
„ hircus, *Gmel.*
Bos longifrons, *Owen.*
„ Urus, *Cæsar* (= B. primigenius, *Boj.*)
Sus scrofa, *Lin.*

The absence of the squirrel and dormouse from this list may, perhaps, be owing to their arboreal habits, which would render the chances of their bones being found in caverns or river-deposits very remote. Both genera and perhaps both the English species occur in the French Pliocene strata.

All these animals are still living in Britain at the present moment, except the Irish elk (*Megaceros Hibernicus*), which is entirely extinct; the reindeer and moose (*Alces malchis*), which are now confined to the colder regions of Northern Europe, Asia, and America; and the *Bos longifrons*, and *B. primigenius*, the beaver, the wolf, the wild boar, and the *Ursus arctos*, which lived on these into the Historical period. The *Bos longifrons* —which, in our opinion, will ultimately be found to be specifically identical with *Bos taurus*—was the variety that supplied the Roman legionaries in Britain with beef;[1] the *Ursus arctos* was probably, from an allusion of Martial,[2] exported to Rome for the sports in the theatre; and the beaver was still living in the river Teivy, in Cardiganshire, when in 1188, Giraldus Cambrensis accompanied Archbishop Baldwin on his tour through Wales to collect volunteers for the First Crusade. This latter animal, according to Boethius, lingered on in Loch Ness till the fifteenth century. The wolves, sufficiently abundant in the Andreads Wold to eat up the corpses of the Saxons left on the field by Duke William[3] after the Battle of Hastings, lingered on in England till 1306, in Scotland till 1680, and in Ireland, protected by the uncultivated wilds and the misrule of the country, until the year 1710. The last wild boar was destroyed in the reign of Charles I.

The Irish elk (*Megaceros Hibernicus*), whose remains are so very abundant in the Pleistocene deposits, is the only species that can be proved to have become extinct in the Prehistoric period.

Whether or no the great *Urus* and the small short-horn (*Bos longifrons*) be extinct, or live, the one in the larger domestic cattle of Europe, as the Flemish oxen,[4] and those of Holstein and Friesland, the other in the smaller breeds, has not yet been satisfactorily decided.

In the Prehistoric period the dog, the goat, and the sheep, make their appearance for the first time in the world's history. *Bos longifrons* also has not yet been proved to have lived in the preceding period, the evidence for its coexistence with the extinct Pleistocene mammalia being founded on some remains cast up by the sea at Clacton and Walton, which therefore may have been derived from a much later deposit than the Preglacial Forest-bed.

The remains of the Irish elk and the reindeer may, perhaps, indicate an earlier division of the Prehistoric period, but upon this point we must be content to wait for more evidence. The occurrence of the latter animal in Prehistoric deposits proves that in Britain, as in the

[1] See Boyd Dawkins, 'Sussex Archæological Collections,' vol. xvi.

[2] "Nuda Caledonio sic pectora præbuit urso
Non falsâ pendens in cruce Laureolus."

[3] 'De bello Hastingensi Carmen,' by Guido, Bishop of Amiens, who died in 1075.

"Lustravit campum, tollens et cæsa suorum,
Corpora, Dux, terræ condidit in gremio;
Vermibus atque *lupis* avibus canibusque voranda,
Deserit Anglorum corpora strata solo."

[4] As Professors Nilsson and Rütimeyer suggest 'Ann. and Mag. Nat. Hist.,' 1849; 'Fauna der Pfahlbauten,' 4to, Basle.

south of France, it lingered on after the disappearance of its Pleistocene congeners—the lion, the hyæna, and the great pachyderms.

§ 5. *Inferences as to Prehistoric Climate in Britain, &c.*—The evidence of a gradual increase of temperature in France and Germany during the historical period seems to us perfectly incontrovertible. Firstly, the Rhine and the Danube[1], during the first four centuries, were frequently frozen over in the winter, so that the barbarians, "who often chose that severe season for their inroads, transported, without apprehension or danger, their numerous armies, their cavalry, and their heavy waggons, over a vast and solid bridge of ice."[2] On the banks of the Danube the wine was frequently frozen into great lumps.[3] Secondly,[4] Cæsar mentions the reindeer as existing in the great Hercynian Forest that overspread Northern Germany, along with the gigantic *Urus* and the elk. This statement of Cæsar is singularly corroborated by the discovery in the peat-bogs of Pomerania[5] of the remains of these three animals, so that there can be no reasonable doubt of his accuracy in this particular case. Modern ages afford no instance of like phenomena. From some cause or other, the temperature has increased on the banks of the Rhine; and in the fact that at the present moment the reindeer[6] cannot live south of the Baltic we may recognise a proof of a diminution of cold in that region since it was inhabited by those lovers of a severe climate. This change of temperature is very generally accounted for by the drainage of morasses and the cutting down of woods; but may it not with more probability be ascribed to a much deeper cause—to a secular change operating throughout Europe, which began in the Pleistocene, and was going on throughout the Prehistoric, and happened incidentally to be noticed in the Historical period? The presence of the reindeer in the Prehistoric deposits of England, Ireland, and Scotland, affords precisely the same evidence as those mentioned by Cæsar. At the time they lived in Britain and Ireland the climate must have been suited for them. On the theory of the gradual modification of climate through the Prehistoric and Historical periods, the fact of the manufactured ivory and the tusk preserved in the *cave-earth* of Paviland, cited above, being in precisely the same state of preservation, is alone explicable. There may have been oscillations of temperature, but the progress on the whole seems to us to have been gradual from the intense cold of the glacial period to the temperate "insular climate" obtaining in Britain at the present day.

§ 6. The term Pleistocene is used in the same sense as Professor Forbes and M.

[1] Diodorus Siculus, i, 5, p. 340, edit. Wesselling. Herodian, i, 6, p. 221.

[2] Gibbon's 'Decline and Fall,' chap. ix.

[3] Ovid, 'Epist. ex Ponto,' Lib. 4, ep. 7, Lin. 9, 10. Virgil, 'Georgic,' Lib. 3, Lin. 355. Zenophon's 'Anabasis,' i, 7.

[4] 'De Bello Gallico,' vi, 23.

[5] Professor Nilsson, "On Extinct and Existing Bovidæ of Scandinavia;" 'Ann. and Mag. Nat. Hist.,' 1849, p. 264.

[6] See Zimmerman, Specimen Zool. Geograph., 4to, 1778, p. 285.

Gervais[1] have used it, as the exact equivalent of the Post-pliocene of Sir Charles Lyell, the Quaternary of the French geologists and Mr. Prestwich, and the Preglacial and Glacial divisions of Professor Phillips. It applies to all formations from the top of the Norwich Crag up to the Prehistoric deposits, comprising the Preglacial Forest-bed, the Glacial drift, the Post-glacial brickearths, loams, gravels, and the contents of the older ossiferous caverns. The discussion of the characteristic mammalia of each of these we must leave to a future day, when we hope to enter fully upon the distribution of the Pleistocene mammalia in Britain and Ireland. In the south of France the ossiferous caverns of Perigord connect it with the Prehistoric deposits, and mark an epoch when a people, probably closely allied to the Esquimaux, lived on the banks of the Dordogne.[2]

§ 7. *Pleistocene caverns and river-deposits.*—The writings of Sir Charles Lyell, Dr. Buckland, Professor Morris, Messrs. Godwin-Austen, Prestwich, Trimmer, MacEnery, Dr. Falconer, Boyd Dawkins, and many others, on the remains derived from Pleistocene caverns and river-deposits are so well known that to enter into details about them would be superfluous in this Introduction. Their concurrent testimony proves that, while the great majority of caverns owe their contents to the falling of animals into open fissures, and the transporting power of water, others have been inhabited for ages by hyænas and other animals, and filled with the remains of their prey, and that the gravels, loams, and brickearths, which are sometimes very high above the level of the nearest stream, were deposited by a river flowing at a far higher level than at present, that has cut down its bed to its present level, and that the remains from the caverns and the river-deposits are, geologically speaking, of the same date. A list of the mammalia of each will be given subsequently.

A short summary of the Pleistocene mammalia will not be out of place in this Introduction, though, no doubt, our views will be altered in many points as our investigations become more extended. The list of species will also probably be increased. Before, however, we enter upon this, we must define what we mean by the determination and identification of a fossil species.

§ 8. Till within the last few years the idea that the succession of life in the rocks is the result of a series of acts of creation and destruction, and that therefore the fauna of any given geological period is insulated from that which has gone before and that which comes after, has insensibly affected[3] most of the palæontologists who have investigated the Pleisto-

[1] Gervais, 'Paléontologie Française,' 4to, 1859.

[2] MM. Ed. Lartet et H. Christy, 'Revue Archéologique,' 1864.

[3] "On considère ordinairement le terrain diluvien comme séparé de l'époque moderne par les charactères aussi tranchés que ceux qui distinguent les trois étages de la période tertiaire . . . . c'est-à-dire qu'à la fin de cette période toutes les espèces ont été anéanties et qu'une nouvelle création a repeuplé la terre à l'origine de l'époque moderne." ('Paléontologie,' par M. Pictet, vol. i, p. 359, first edit.) Professor Pictet

cene fauna. It has led nearly all to give a far higher value in classification to points of difference than to those of agreement, and has left an indelible mark in the terminology of the species—as, for example, in the *Hyæna spelæa* of Goldfuss, and the *Equus fossilis* of Professor Owen, which have not yet been proved to differ specifically from the living spotted hyæna (*H. crocuta*) and the common horse (*Equus caballus*). The first law of the distribution of fossils given by Professor Pictet is—" Les espèces d'animaux d'une époque géologique n'ont vécu ni avant, ni après cette époque ; de sorte que chaque formation à ses fossiles spéciaux, et qu'aucune espèce ne peut être trouvée dans deux terrains d'âge différent" —a law that is capable of disproof by the examination of any series of fossils stratigraphically arranged, We find, on the contrary, that in proportion to the lapse of time between any two formations, so the difference increases between their respective suites of organic remains. If the interval between them be great, there may be no species and no genera in common ; if it be small, a greater or less number of species or genera will be common to both. In the case before us the interval between the Pleistocene times and our own is, geologically speaking, small, and therefore we expect to find a large number of species and genera in common.

In the determination of these we purpose to give the maximum value to variations within the limits of species that may be the result of difference of food, of climate, and the like. But it may be objected that identity of osseous framework does not imply identity of species where colour of the dermal covering is of weight—for example, that the identity of form of the skeleton of *Hyæna spelæa* with the *H. crocuta* does not imply that the former was spotted, or that close agreement between the Pleistocene and living *Ursus Arctos* does not prove that the former was brown or black. To this we say that colour is not, in our opinion, of specific value, changing even in the same individual according to climate, as in the case of the Arctic wolves and many of the Arctic birds. The differences in dermal covering, on the other hand, in all cases that have come before us, are correlated also with differences in the skeleton, as in the recent lion and tiger. If the thick woolly and hairy covering on the carcasses of the mammoth and tichorhine rhinoceros, imbedded in frozen gravel on the shores of Siberia, be contrary to our experience of living species, they were accompanied also by characters in the dentition and skeleton that prove the species to which they severally belong to be extinct. Any argument, therefore, from them to any other Pleistocene mammal, between which and the recent there is no difference in hard parts, as the lion, falls to the ground. The value, indeed, of comparative osteology depends upon the axiom, that *identity of osseous framework and especially of that most important part of the digestive apparatus, the teeth, implies also an identity of species.*

We have purposely omitted to burden this Introduction with references and notes, which will be found in their proper place in the body of the work.

himself disclaims these views of the Pleistocene fauna, and states, as his belief, "Je crois qu' entre le moment ou les ossements des ours ont été enfouis dans les cavernes et le temps actuel, il n'y a point en de création nouvelle, et point d'interruption dans la vie organique."—p. 360.

§ 9. *Pleistocene Mammalia.*—The remains from the British caverns and river-deposits of Pleistocene age, determined according to the principles given above, present us with at least fifty-three species of fossil mammals, of which some are now extinct, some banished to remote parts of the earth, while others still survive in our forests, rivers, and moorlands.

§ 9, A. Bimana, *Homo.*—The presence of man among the Pleistocene fauna is now so universally recognised that there is no necessity for further evidence upon the point being adduced. From the river-gravels of Bedford, Hoxne, the Brick-earth of Fisherton, near Salisbury, and a large number of other places,[1] have been derived the rude flint implements which Messrs. Evans and Prestwich have no hesitation in considering of the same age as the gravels themselves, which frequently contain the remains of mammoth, bear, and other Pleistocene mammalia. The caverns of Brixham, Kent's Hole, Gower, and Tenby, have afforded the rude implements used by the Pleistocene savages in association with the remains of the great carnivora. In the cavern of Wookey Hole also his rude handiwork of flint, chert, and bone, and the ashes of his fires, occurred under circumstances that admit of no doubt upon the subject.

§ 9, B. Cheiroptera.—The remains of bats found in the ossiferous caverns, as Professor Owen[2] very justly remarks, cannot be differentiated from those of the species still inhabiting the districts in which they occur; and from the fact of the species often still inhabiting the caverns in which its remains are found, there is a possibility of the latter not being of the same date as those of the associated mammalia. The same objection applies equally to the remains of the badger and fox, which, beyond all doubt, have been proved to have been Pleistocene mammals. The balance of probability is, on the whole, in favour of the *Cheiroptera* having lived at the same time as the extinct Pleistocene mammalia; but there is no absolute proof. Professor Owen describes *Vespertilio noctula* as occurring in a fissure in a Mendip bone-cavern, and a lower jaw of the Greater Horseshoe Bat (*Rhinolophus ferrum-equinum*) is figured by Scharf among the fossils from Kent's Hole.[3]

§ 9, C. Carnivora. Genus *Machairodus*, Kaup. Species *Machairodus latidens*, Owen. —The fact that, out of all the numerous places in which the remains of Pleistocene mammalia occur in Britain, but one, Kent's Hole Cavern, should have furnished traces of this most remarkable Pliocene carnivore, caused the late Dr. Falconer to consider it of a different date to the other fossil mammalia in the cavern. The condition, however, of the teeth in question, and their intimate association with the other remains,[4] the absence of all traces

[1] 'Quart. Journ. Geol. Soc.,' 1856—65.

[2] Tom. cit., p. 11 et seq.

[3] See the beautful folio plates published in 1859, Torquay.

[4] 'Cavern Researches,' by the late Rev. J. MacEnery, F.G.S.,' edited by E. Vivian, Esq., London, 1859, 8vo, pp. 32-3.—"To enumerate the amount of fossils collected from this spot would be to give the

of watery action on their fine serrate edges incline us to believe that Machairodus ranged down, like *Elephas meridionalis,* from the Pliocene into the Pleistocene period, and was a contemporary of the tichorhine rhinoceros and the spelæan hyæna.

Genus *Felis.* Species *Felis spelæa,* Goldfuss.—The opinion that we propose to advance with reference to this species differs considerably from that of all the authors who have preceded us in their inquiries. The reason for it will be specially detailed in the monograph upon the genus, the first part of which is contained in the present publication. We consider that, although differences may be found in all the parts of the skeleton of *F. spelæa,* which, at first sight, appear to separate it specifically from the lion, that they are not too great to be fairly ascribed to variation within the limits of the species. Remains which can in no way be distinguished from those of the lion occur both in the caverns and river-deposits; and although the larger feline bones show us, as we have said, considerable differences, the examination and comparison of a large series, proves that the characteristics of lions are invariably shown, and very generally in an exaggerated form. We feel obliged, therefore, to consider *Felis spelæa* as a large variety only of the *Felis leo,* that differs far more than the latter from the tiger (*Felis tigris*). The fact of the tiger now having an extended northern range round the sea of Aral, the district of the Altai, and in Northern Tartary, and of its living with some of the Pleistocene species that have survived in those areas has inclined some naturalists, among whom is the late Dr. Falconer and M. Lartet,[1] to consider it identical with *F. spelæa.* Up to the present time there is no evidence that the tiger has ever existed in Britain, or, indeed, in Europe, the fossil remains upon which the European range of the species in Pleistocene times is based bearing, without exception, leonine, and not tigrine characteristics.[2]

A convenient method of classing the remains of the fossil lion is to consider the larger

inventory of half my collection, comprising *all* the genera and their species, *including the Cultridens* (= *Machairodus latidens,* Owen); there were hoards, but I must specify jaws of the elephant, and tusks, with the teeth in the sockets, the bone of which was so bruised that it fell to powder in our endeavour to extract it, a rare instance of the teeth occurring in jaws or gums. The same may be observed of the jaws of the rhinoceros, one portion alone of which was saved, but the teeth of both were numerous and entire. The jaws of the elk (*Megaceros Hibernicus*), horse, and hyæna, were taken out whole. The teeth of the last two were gathered in thousands, and in the midst of all were myriads of rodentia. The earth, as may be expected, was saturated with animal matter; it was, to use the expressive words of my fellow-labourer Walsh, fat with the sinews and marrow of more wild beasts than would have peopled all the menageries in the world."

[1] 'Cavernes du Périgord,' p. 21. Dr. Falconer's opinion, that the tiger of Northern Asia had no community of origin with, or, in other words, differs specifically from, the tiger of Bengal, is by no means confirmed by the description of one killed on the shore of the Sea of Aral, by Commander Bukatoff ('Journ. Geograph. Soc.,' 23rd vol., p. 95).—"A real royal tiger of a beautiful orange colour, with broad black stripes, uncommonly fat, and six feet four inches long from the nose to the beginning of the tail."

[2] The naturalists who consider the lion of Barbary, Senegal, Persia, and India to belong to distinct species, will also consider *F. spelæa,* as specifically distinct from all the living species.

remains, which, besides their size, present also the characters of lion in an exaggerated form as belonging to variety *α*, *Felis spelæa*, while the smaller ones, that exhibit no differences as compared with those of the existing lion, constitute the second variety—var. *β*, *Felis leo.*

Species *Felis antiqua*,[1] Cuvier.—The remains of *Felis antiqua*, first discovered by Cuvier in the bone-breccia, at Nice, in association with remains of the horse and cave-lion have been determined by us[2] in two localities in the Mendip Hills. One canine tooth in the collection of the Earl of Enniskillen, F.R.S., came from Banwell, and two canines and molar teeth in the Taunton Museum were obtained by the late Rev. D. Williams from the cavern either of Sandford Hill or Hutton. We believe also, from drawings shown us by Colonel Wood, that its remains occur also in the cave of Spritsail Tor, in Gower. In Germany the species occurs in the great cave of Gailenreuth; in Belgium, in the caverns of Liège, so ably explored by Dr. Schmerling; and in France it appears to have been described under several names by various authors. In 1864 it was found at Gibraltar by Dr. Falconer and Mr. Busk, by the former of whom it has been identified with the panther, *Felis pardus* of Linnæus.

Species *Felis catus ferus*, Linn.—The remains from Kent's Hole and the Mendip caverns indicate a species slightly larger than the wild cat, that is becoming extinct so fast at the present moment in Britain. The brickearths of Ilford also have furnished a lower jaw, which is figured by Professor Owen, and is in the collection of Mr. Wickham Flower, to whose courtesy we are indebted for its examination.

Genus *Hyæna*. Species *H. spelæa*, Goldfuss.—The Spelæan hyæna, so abundant in the caverns of France and Germany, we consider to be a variety merely of the *H. crocuta* or spotted hyena of South Africa.[3] Full evidence for this view will be given in the monograph upon the genus. Its remains, as we would expect from its habits, are abundant in the caverns, and comparatively rare in the river-deposits. Maidstone, Grays Thurrock, Lawford, Walton, and Fisherton, may be cited as the places where it occurs in river deposits. It exhibits considerable variation in respect to the talon of the lower sectorial molar, which MM. Croizet and Jobert, M. de Serres, Dubrueil, and Jean-Jean consider of specific importance. The two marked varieties in Britain are var. *α*, *H. intermedia* of M. de Serres, and var. *β*, *H. Perrieri* of MM. Croizet and Jobert. They are, in our opinion, mere varieties, as in a large series that has passed through our hands a gradation is evident from the typical to the more unusual forms.

Genus *Canis*. Species *C. lupus*, Linn., *C. vulpes*, Linn.—The wolf (*C. lupus*) and the fox (*C. vulpes*) are indistinguishable from those that are now living in Europe. Their remains are found both in caverns and river-deposits.

Genus *Gulo*. Species *Gulo luscus*, Linn.—The wolverine or glutton (*Gulo luscus*),

[1] 'Oss. Foss.,' 4to, 1825, vol. iv, p. 188, pl. xv, fig. 12.

[2] See Ayshford Sanford, 'Brit. Assoc. Rep.,' 1864.

[3] See Boyd Dawkins "On the Dentition of *Hyæna spelæa*," 'Nat. Hist. Rev.,' 1865.

the great pest of the fur-hunters of North America and Siberia, has left traces of its presence in Britain in Banwell and Bleadon caverns, and also in a cavern at Gower. It is very abundant in the Pleistocene caverns of Liège, and occurs also in the famous Bear's Den at Gailenreuth.

Genus *Mustela.* Species *Mustela erminea,* Linn.—The identification of the ermine or stoat as a British Pleistocene mammal we owe to our great palæontologist, Professor Owen.[1] It has been discovered by Mr. Bartlett in the cave at Berry Head, near Plymouth, and by Mr. MacEnery in Kent's Hole.

Species *Mustela putorius,* Linn.—The skull of the fossil polecat, obtained, like that of the preceding species, from Berry Head, and figured by Professor Owen,[2] is identical with that of the living *Mustela putorius.* Dr. Schmerling has proved the existence of this species in the caverns of Liège.

Species *Mustela martes,* Linn.—In the Williams' collection from the Mendip Caverns is a skull and lower jaw imbedded in breccia which we can by no means differentiate from the marten-cat that is now rapidly becoming extinct in Britain.

No species of this genus has up to this time been found in a river-deposit.

Genus *Lutra.* Species *Lutra vulgaris,* Erxl.—From the aquatic habits of the otter we should naturally expect to find few traces of its presence in the bone-caves, many in the river-deposits. Yet but three cases have come to our knowledge of its occurrence in association with the extinct mammalia—the one in Kent's Hole Cavern, and the second in the brick-earths of Grays Thurrock, in Essex, the third from Banwell, and is preserved in the Taunton Museum. The specimens figured and described by Professor Owen are derived from the Prehistoric marls that underlie the peat of Cambridgeshire.

Genus *Meles.* Species *Meles taxus,* Linn.—No trace of the badger (*Meles taxus*) has been afforded by Pleistocene river-deposits. The caverns of Banwell, Kent's Hole, Berry Head, and Wookey Hole, have furnished ample proof of its presence among the Pleistocene cave-fauna, where, however, it does not seem to have been abundant. In the caverns of Prehistoric age, on the other hand, the occurrence of its remains is the rule rather than the exception. It is indistinguishable in species from that which abounds at the present day in the limestone caves of Somersetshire.

Genus *Ursus.* Species *Ursus spelæus,* Goldfuss.—The remains of the fossil bears have been a fruitful source of dispute among naturalists since the days of Goldfuss. Their variations are so great and marked that to the person who has confined himself to the study of those derived from some one locality there is not the slightest difficulty in dividing them into species, while, on the other hand, those who have compared the French, German, and British specimens gradually realise the fact that the fossil remains of the bears form a graduated series in which all the variations that at first sight appear specific vanish away. In the very large number of bears' skulls from our own caves and those of France

[1] Op. cit. [2] Op. cit.

and Germany that we have examined there are hardly two that are alike. The frontal development, the muscular ridges, the zygomata, the size and even the form of the last upper true molar, present us with points of difference that, perhaps, may be the result of different food, locality, and sex. In the lower jaw, also, the relation of the angle to the coronoid process, the length of the diastema between the canine and premolar 3, the absence or presence of the small monofanged premolars 1, 2, or 3, afford materials for the manufacture of species or varieties according to the views of the naturalist as to their value in classification. Thus, the eminent French palæontologist, M. de Blainville, considers these differences of no specific value, and believes that the specific determination of *U. spelæus* from *U. ferox* and *U. Arctos* to be by no means clearly proved. Professor Owen, on the other hand, considers the spelæan bear to differ in species from both *Ursus ferox* and *U. Arctos,* and endorses the validity of Goldfuss's second species from Gailenreuth—*U. priscus.* Dr. Schmerling divides the remains of the bears he obtained from the caverns of Liège into five species—*U. giganteus* Schm. *U. Leodiensis,* Schm., *U. Arctoideus,* Gold., *U. priscus,* Gold., *U. spelæus,* Gold. To this list of fossil species Marcel de Serres adds *U. Pitorii,* and Mr. Denny, of Leeds, *U. planifrons.* The whole of these, with the exception of *U. priscus,* are probably varieties of *U. spelæus,* dependent upon locality, food, and sex.

In the remains ascribed by Dr. Carte to the Polar bear (*U. maritimus*)[1] from Lough Gur, in Limerick, we can see nothing to differentiate the animal to which they belonged from the spelæan bear. The proportions of the long bones and the position of the third trochanter on the inner side of the femur are points of difference between these remains and the recent Polar bear.

The *Ursus planifrons*[2] of Mr. Denny, A.L.S., is probably a variety of *Ursus spelæus* with small frontal sinuses.

Species *Ursus Arctos,* Linn.—The second group of fossil remains may be considered to belong to *Ursus Arctos,* the living European bear. It is differentiated from the *U. spelæus* by the persistence of the small monofanged premolar one immediately behind the canine, and many other points to be discussed in the article on the Ursidæ. It occurs in Wookey Hole, Oreston, Durdham Down, Hutton, Llandebie, Kent's Hole, and several Welsh caverns, and in the deposits of the Thames Valley at Grays Thurrock, in Essex, and Crayford, in Kent.

The *Ursus priscus* of Dr. Goldfuss is probably a variety of this species.

In conclusion, we are obliged to acknowledge that the evidence afforded by the remains of the fossil bears is most conflicting, and that we consider it by no means impossible that at some future time the interval between the *U. spelæus* on the one hand and *U. Arctos* on the other may be bridged over, and both turn out to be, as M. de Blainville has suggested,

1 'Journal of Royal Dublin Society,' 1863.

2 'Geol. and Polytechnic Soc. of Yorkshire,' 1864.

the extremes of a series ; but at present it is safer to consider them two closely allied species than as varieties of one and the same,

§ 9, D. Insectivora. Genus *Talpa.* Species *Talpa vulgaris.*—The remains of the common mole have been discovered in a raised beach near Plymouth, together with the skull of a polecat, and in the fluviatile clay at Bacton, whence also those of *Hyæna spelæa, Ursus spelæus, Elephas primigenius, Hippopotamus major*, and *Rhinoceros leptorhinus*, have been obtained.[1]

Genus *Sorex.* Species *Sorex moschatus,* Pallas = *Myogalea moschata,* Fischer.—The fluviatile or lacustrine deposit at Ostend, near Bacton, in Norfolk, has afforded the only remains of this the most gigantic of the shrews. In the absence of the means of comparing it with the recent skeleton, Professor Owen named and described it as an extinct species under the name of *Palæospalax magnus.*[2] In 1863 M. Lartet determined its true affinities, and considers it identical in species with the animal described by the eminent Russian zoologist, Dr. Pallas, under the name of *Sorex moschatus,* from the water-shed between the rivers Volga and Don, in Southern Russia.[3]

Species *Sorex vulgaris,* Linn.—The common shrew has been found in Kent's Hole. Its apparent rareness in the caverns is probably the result of its small size. Other remains of shrews from Bacton and Ostend, in Norfolk, are perhaps referable to *Sorex remifer* and *Sorex fodiens,* but "the dentition of the jaws is not in such a complete state as to allow of an unequivocal determination."

§ 9, E. Ruminantia.—Genus *Bos.* Subgenus *Bison.* Species *Bison priscus,* Owen.—Just as at the present day the bison wanders in vast herds over the lower grounds of the North American Continent, from north latitude 33° to 65°, so did the *Bison priscus* or great fossil bison in Pleistocene Europe and Asia north of the Himalayas. Its remains are most abundant in both the river-deposits and in the caves. The gravels of the Thames furnish most unequivocal proof of its presence in the numerous skulls and horncores that have been obtained from Grays Thurrock, Clacton, Ilford, Crayford, and Dartford. In Yorkshire and Scotland also it has been recognised, and in Somersetshire we have detected it in five out of eight ossiferous caverns of the period. It formed the prey of the hyenas of Wookey Hole, and fell into the "swallow-holes and fissures" by which Banwell, Bleadon, Uphill, and Sandford Hill caves were supplied with bones. The horncores present considerable variations in size—one from Sandford Hill measuring 26 inches in length, with a basal circumference of 16 inches, while a second from Banwell measures but 13·5 in length, with a basal circumference of 12·5 inches. The examination of a very large number of horncores and skulls of the fossil bison leads us to endorse Baron

[1] Prof. Owen, op. cit. [2] Op. cit.

[3] 'Revue Archéologique,' 1863.

Cuvier's opinion that the living and the fossil belong to the same species.[1] The smaller varieties are those to which Professor Owen applies the name of *Bison minor*.

Genus *Bos*. Species *Bos primigenius*, Bojanus.—Numerous horncores and skulls and other remains in various parts of Britain attest the former existence of the great Urus (*Bos primigenius*) in Britain during the Pleistocene period. It has been found in Scotland near Edinburgh, and in the gravels of the Avon and Thames, and in a large number of other localities.

Species *Bos longifrons*.[2]—A second species of true ox, the small short-horned *Bos longifrons*, has been described by Professor Owen from the river-deposits of Clacton and Walton, and Kensington, associated with the mammoth (*Elephas primigenius*), and from Bricklingham, in the valley of the Avon, along with *Bison priscus* and *Bos primigenius*. On the other hand, all the smaller Bovine remains of Pleistocene age that we have examined, are proved by the associated horncores to belong to the bison, and not to *Bos longifrons*, many bones of which, from their strong resemblance to those of the former, have been a frequent cause of error in the absence of horncores. We have already spoken of *Bos longifrons* as being probably a variety of *Bos taurus*, of which also *Bos primigenius* is probably a second and extreme variety. Professor Nilsson, of Lund,[3] considers the latter as the ancestor of the large-horned Flemish oxen, and Professor Owen thinks that in all

[1] Op. cit., t. iv, p. 140.

[2] It is a remarkable fact that out of all the localities in Europe where Pleistocene mammals occur those given in the "British Fossil Mammals" should alone furnish proofs of the coexistence with the extinct mammalia of an ox that subsequently was brought under the rule of man, and kept in great herds in France, Britain, and Switzerland, in Prehistoric and Historic times. With respect to the remains of *Bos longifrons* washed up along with *Elephas antiquus* and rhinoceros on the coast at Walton and Clacton; a parallel case at Selsea, on the Sussex sea-board, inclines me to hesitate in inferring their contemporaneity from the fact of their having been washed up together. While engaged in the Geological Survey of the latter district in 1863, I found that there were two deposits of widely different age, lying side by side at the mouth of Pagham Harbour; the one Preglacial, underlying the Boulder-clay, containing *Elephas antiquus* and the mammoth, the other estuarine, of comparatively recent formation, and containing *Bos longifrons*, and red deer. The latter is deposited on the same Eocene plateau as the former, the ancient estuary having worn away the Preglacial forest-bed, the Boulder-clay, and the Preglacial river-deposits. The remains from both these deposits, washed out by the waves, were precisely in the same mineralogical condition, and both were stained of the same dark colour, and had I not been able to trace the remains of *Bos longifrons* to the estuarine mud, where one hind and one fore extremity of the animal remained in *situ*, with every bone in place, I should have been compelled to believe that the *Bos longifrons* of Pagham coexisted with the *Elephas antiquus* of the forest-bed. May not the similar association of the remains on the shores of Walton and Clacton be accounted for in some such manner? While paying all possible deference to the views of our most eminent comparative anatomist upon the contemporaneity of *Bos longifrons* with the Preglacial mammalia, the evidence seems to be of such a nature as to leave the question of the existence of the animal in Pleistocene times entirely open. With reference to the other localities, where this species is alleged to occur, Kensington and Bricklingham, satisfactory evidence of its association with Pleistocene mammals seems to me to be wanting.—W. B. D.

[3] Tom. cit. (1849).

probability the small Scottish and Welsh cattle are descendants of the former. If these views be correct, and we accept, as we are bound to do, interbreeding as a test of species, then both the urus and the short-horn belong to the same species, because their descendants breed freely together. Since, however, there is a great and persistent contrast between the size and form of the two in Pleistocene and Postpleistocene times, not only in England but throughout Germany, France, and Switzerland, we think that in classification they more conveniently fall under the head of closely allied species than of varieties. The views, moreover, of their being the ancestors of our present varieties of cattle may possibly turn out to be false in after years.

The evidence for the existence of *Bos longifrons* in Pleistocene times appears to us to be of such a nature as not to warrant the insertion of the animal in the list of species.

Genus *Ovibos*. Species *Ovibos moschatus*, Blainv.—One of the more curious of the North American herbivores is the *Ovibos moschatus*, or musk-sheep, generally from its size called the musk-ox.[1] Its affinities, as M. Lartet[2] and M. de Blainville[3] have shown, are all with the *Ovidæ* and *Capridæ*. Its former existence in the West of England is proved by portions of two skulls found in the gravels of the Avon, near the Somerset and Wilts border. Messrs, Lubbock and Kingsley have also found it in the river-deposit near Maidenhead, on the banks of the Thames.[4] A fragment of a cranium and a portion of a pelvis of this animal have also been found at Green Street Green, in Kent, and are preserved in the British Museum. It has not as yet been found in any of the British bone-caves.

Genus *Capra*. Species *Capra hircus*, Gmelin.—The discovery of the skull, figured by Professor Owen, and lower jaw of *Capra hircus* on the Walton shore, is by no means conclusive of the contemporaneity of the genus with the extinct mammalia, the remains of which are washed up on the same shore. The case indeed, cited by Professor Owen, stands alone, no instance being on record of the occurrence of the genus in any of the numerous Pleistocene deposits on the Continent. The remains found by Mr. Brown, of Stanway, on the Walton coast, may have been washed up from some other and later formation, as in the instance cited in the note upon *Bos longifrons* of the association of remains on the Selsea shore. Further evidence is still required to prove that any of the *Ovidæ* or *Capridæ* coexisted with the mammoth, rhinoceros, and other Pleistocene mammalia.

Genus *Alces*. Species *Alces malchis*, Gray.—We have already mentioned the characteristic broad palmated antler of the true elk of Norway, or moose-deer of the Canadians, found in the neighbourhood of Newcastle, in our list of Prehistoric mammalia; the proof that the same species inhabited South Wales in Pleistocene times is furnished by the lower

1 *Bubalus moschatus*, Owen. 'Quart. Geol. Journ.,' 1856.

2 'Comptes Rendus,' lviii, 26.

3 'Bull. Soc. Philom.,' 1816, p. 81.

4 'Quart. Geol. Journ.,' 1856.

jaw detected by M. Lartet among the remains from the cave of Llandebie, in the Oxford Museum.[1] It was associated with remains of *Ursus arctos.*

Genus *Megaceros.* Species *Megaceros hibernicus,* Owen.—More closely allied to the preceding than to any of the existing mammalia is the great extinct Irish elk—the most gigantic of the deer tribe, generally found not only in the caverns and gravels of the Pleistocene, but also in the lacustrine marls of the Prehistoric period.

Genus *Cervus.* Species *Cervus tarandus,* Linn.—On the borders of "the Barren Grounds" in North America, Sir John Richardson tells us "there are two varieties of reindeer, the larger inhabiting the woods and living upon grass as well as lichens, the smaller living entirely on lichens, and ranging into the extreme northern latitudes." In our caverns and river-deposits there are traces of reindeer, also of two sizes. The hyænas of Wookey Hole and of Kirkdale preyed upon both the larger and the smaller deer. The fossil antlers, like the recent, vary to such a degree in size and form, and in the position of the brow-antler, that scarcely any two can be found alike. They may however, roughly, be divided into two classes by their size. On the larger series is based the variety *C. Bucklandi,* of Professor Owen; on the smaller *C. Guettardi,* of Baron Cuvier. The antlers from Banwell are all of the large variety. The remains of reindeer are so incredibly numerous in some caverns that Colonel Wood obtained upwards of 1000 antlers in one cave in Pembrokeshire.

Species *Cervus elaphus,* Linn.—Two varieties of red deer, a large and a small, are found both in the caverns and in the river-deposits. Professor Owen terms the larger—from the large size of its antlers—*Strongyloceros spelæus.* It is probably the Pleistocene representative of the large variety of red deer (*Waipiti*), now ranging on both sides of the Rocky Mountains, from the Columbia River at least as far north as the Saskatchewan, from North latitude 45° to 55°. It is a very curious fact that in tracing the red deer (*C. elaphus*) from the Pleistocene times down to the present in Western Europe, there is, from some unknown cause, a diminution of the size of the antlers. Thus, those of the variety *Strongyloceros spelæus,* are vastly larger than those of the Prehistoric period, while the latter greatly surpass in size the red deer now living on the Scotch moors. That the large Prehistoric variety lived on in Britain into the times of history, is proved by its discovery near Worcester, in 1844, in association with the remains of *Bos longifrons*[2]—"fragments of Roman urns and pans of red earth, and a piece of Samian ware." A coin of Marcus Aurelius was also found that would bring the date of the whole deposit to some time posterior to the year A.D. 161. The increase of population, and the encroachment of the cultivated lands on the lower grounds, more favorable in climate and food for the support of the deer, by forcing them to take refuge in higher and inhospitable districts where the herbage is scanty, were the probable causes of this diminution in size.

[1] 'Revue Archéologique,' 1864.

[2] Brit. Foss. Mam. p. 475.

Species *Cervus capreolus*, Linn.—The presence of a small deer, undistinguishable from the roe (*C. capreolus*), among the Pleistocene mammals, is proved by five jaws, numerous teeth, and some antlers associated with *Elephas antiquus*, reindeer, red deer, bisons, and others, derived from Bleadon Cave, its antlers from that of Brixham, and other remains from the lacustrine deposit of Ostend, accompanied by *Elephas antiquus*.

Species *Cervus dicranios*, Nesti.—The Rev. S. W. King has called our attention to the Cervine remains obtained in the forest-bed of Cromer, and preserved in his splendid collection of Mammalia. Of these, one portion of skull with bases of antlers attached proves that the *Cervus dicranios* of the Italian Pliocenes is to be ranked among the British Pre-glacial Mammalia.

§ 9, F. ARTIO-DACTYLA. — Genus *Sus*. Species *Sus scrofa ferus*. — The wild boar (*Sus scrofa ferus*) has left traces of its presence in the West of England, in the caverns of Bleadon, Uphill, and Hutton. One of its small incisors and a molar was obtained also from Wookey Hole Hyæna-den. It occurs also in the river-gravels of Ilminster, as well as those of the Thames Valley at Ilford and Brentford.

Genus *Hippopotamus*.—Species *Hippopotamus major*, Owen. The remains of the hippopotamus have only been found in four bone-caverns in this country—in that at Durdham Down near Bristol, by Mr. Stutchbury, in association with *Elephas antiquus* and *Rhinoceros leptorhinus* and other remains; and in that of Kirkdale, along with the same two species of mammalia; in Kent's Hole cavern; and in the Ravenscliff cave in Gower. In the river-deposits, also, it is, contrary to what one might expect from its habits, comparatively rare. Its remains are found at Grays and Ilford associated with the tichorhine, leptorhine, and megarhine rhinoceroses; at Walton and Folkestone with *Elephas antiquus*; at Peckham with *E. antiquus* and *E. primigenius*; at Bedford with *E. antiquus*, the tichorhine rhinoceros, and the reindeer, and at Bacton with the leptorhine rhinoceros; and the mammoth. Brentford, Cromer, Burfield, Overton, Alconbury, and Cropthorne, are the principal localities in Britain, which up to the present day have yielded the remains of this member of a tropical group of mammals. Its occurrence so far north in association with the reindeer, bison, and other members of a northern fauna, has led Sir Charles Lyell, Bart., Mr. Prestwich, and other eminent authorities, to infer that it was defended from the cold by long hair and fur, similar to that which the discoveries in Siberia have made known on the mammoth and tichorhine rhinoceros. And this inference is probably true, because in existing nature we know of no animal that is exposed to a severe or even temperate climate without some protection against the cold. The difference between the dentition of *H. major* as compared with the closely allied species *H. amphibius* (Linn.) is very small. The former, however, is characterised by its larger size, by the shortness of its cranium, the posterior position of its orbits, the great elevation of the sagittal and occipital crests, and especially of the upper margin of the orbits above the plane of the brow.[1]

§ 9, G. Perisso-dactyla. Genus *Equus*. Species *Equus fossilis*, Von Meyer.—The prairies of Pleistocene Europe must have been as plentifully stocked with the wild horse as those of America by the half-wild horses introduced by the early settlers, Nearly every Pleistocene bone-cavern in England has yielded their remains, and in the river-deposits their presence is the rule rather than the exception. In the forest-bed at Cromer, it is found associated with the remains of mammoth, hippopotamus, rhinoceros, and trogontherium. In Wookey Hole Hyæna-den, in conjunction with the tichorhine rhinoceros it formed the chief food of the hyænas.

Professor Owen considers that the solidungulate remains indicate the coexistence of three distinct species in Pleistocene Britain ;—*Equus fossilis*, a species distinct from the living *E. caballus*, *Equus plicidens*, based on molar teeth from Oreston, and *Asinus fossilis* from Chatham, Oreston, Thorpe, and Kessingland. These last two may turn out to be varieties of *Equus fossilis*, and that species we can determine by no special mark except by the smaller transverse measurement of the teeth, from the living *Equus caballus*. It is possible that the smaller remains ascribed to *Asinus fossilis* may have belonged to the ass, but at least it is equally possible that they may have belonged to a small variety of horse.[2]

Genus *Rhinoceros*. The remains of the fossil rhinoceros have perhaps a wider range than those of any other fossil quadruped except *Machairodus* and *Elephas*. From the shores of Siberia in latitude 72°, southwards as far as the Sivalik Hills they are found in greater or less abundance, from east to west the genus ranges from the banks of the Lena to the Straits of Gibraltar. Its range in time is as great as its range in space—from the Miocene as far down as the later division of the Pleistocene, when the 'low-level' gravels and brick-earths of Mr. Prestwich were being deposited. The British Pleistocene species are four in number.

Species *Rhinoceros tichorhinus*, Cuv.—The tichorhine is the most widely spread and the best known of the British species of rhinoceros. Its remains are found from the Pyrenees and Alps, throughout France, Germany, and Russia, as far north as the shores

[1] Dr. Falconer's letter in Dr. Morton's paper, "On a new living species of Hippopotamus," etc., 'Journ. Acad. Nat. Sci.,' Philadelphia, vol. i, 2nd series.

[2] Cuvier comes to the same conclusion, after a careful study of the remains of horses: "La même resemblance paroît avoir eu lieu de l'espèce fossile aux espèces vivantes. J'ai choisi des os de cheval fossiles bien entiers, et que je savois certainement avoir été trouvés pêle-mêle avec des os d'éléphans, rhinocéros, ou d'hippotames, qui devoient donc être provenus de chevaux de cette ancien monde, ayant vécu avec tous ces grands pachydermes et j'en ai fait une comparaison soignée avec mes squelettes. Par example, une fémur de cette caverne de Breugues ou il y avoit des os de rhinocéros etoit parfaitement semblable, à un fémur de cheval de taille moyenne," etc., etc. Op. cit., tom. ii, pp. 111, 112.

of the great Arctic Sea. Cuvier also mentions it as having been found in Italy;[1] but his determination is, in our opinion, open to considerable doubt. In Britain, Professor Owen[2] describes its remains as occurring in the forest-bed of Cromer; and in the caverns and river-deposits its bones and teeth are very generally found. In Ireland no remains of any of the four species have as yet been determined, nor could we detect any trace of them in the Museums, on a journey for that express purpose. The species is characterised by the possession of two horns; an osseous septum between its nares, that *completely* divides the one from the other; by the presence of the *anterior combing-plate* in the permanent upper molar series and of *two costæ* on the anterior area of the lower,[3] by the stoutness of its bones and a very great many other points to be found in the essays of Professors Brandt,[4] Owen,[5] Mr. Dawkins,[6] and M. de Christol.[7] Defended from the cold by hair, and with a hide entirely without those hideous wrinkles that disfigure the living species, this animal ranged throughout the regions of the great Pleistocene continent north of a line passing through the Pyrennees eastwards through Switzerland to the northern end of the Caspian, thence along the watershed of the River Irtish through Lake Baikal as far as the Jablonoi and Stanovoi Mountains, and most probably up to Behring's Straits.

Species *Rhinoceros leptorhinus*, Owen.[8]—The remains of the non-tichorhine species of rhinoceros remained in the greatest confusion up to the year 1835. Baron Cuvier, so far back as the year 1812, had divided the non-tichorhine rhinoceros into three species, *R. leptorhinus*, *R. minutus*, and *R. incisivus*. The *R. leptorhinus*, with which alone we have to do, he based upon a skull found in the Pliocene of the Val d'Arno, of which he had a drawing sent him by Professor Cortesi, which he gives in the first edition of the "Ossemens Fossiles." In this drawing, the osseous septum between the nares was absent, and from its absence,[9] coupled with the slenderness of certain long bones found in the same deposit, and with different proportions of the skull as compared with the tichorhine species, he inferred the existence of a second species, *R. leptorhinus* or "*rhinocéros à narines non-cloisonnées*." This determination was accepted without question by the scientific world until the year 1835, when M. de Christol proved that the very skull described as *à narines non-cloisonnées*[10] possessed the osseous septum between the nares, and that therefore Baron

[1] Op. cit., tom. ii, p. 73, pl. ix, fig. 10.

[2] Op. cit., p. 347.

[3] 'Nat. Hist. Rev.,' (1863) xii, p. 552.

[4] "De Rhinocerotis Antiquitatis seu Tichorhini seu Pallasii structurâ." 'Trans. de St.-Pétersbürg, vol. vii, pt. 2. 4to, 1849.

[5] Op. cit., p. 325.

[6] 'Nat. Hist. Rev.,' 1863.

[7] 'Ann. de Sci. Nat.,' 2e série, t. 4, 1835.

[8] Op. cit., 356.

[9] Op. cit., tom. ii, pp. 71-2, pl. ix, fig. 7.

[10] It is indeed very hard to reconcile the figure given by M. de Christol (op. cit., pl. ii, fig. 4) with an incidental remark of Dr. Falconer. In his masterly "Treatise on the Mastodon and Elephant," ('Quart.

Cuvier's definition of the species was wrong. In the year 1846, Professor Owen, on the discovery of a non-tichorhine skull and lower jaws at Clacton in Essex, inferred from the correspondence of the latter with those from the Val d'Arno described by Cuvier, that the rhinoceros of Clacton and that of Italy belonged to one and the same species. And as the skull found at the former place presented traces of a partial septum between the nares he proposed that Cuvier's definition of "*R. à narines non-cloisonnées*" should be altered into "*R. à narines demi-cloisonnées.*" Whether the lower jaws from Italy, by which Professor Owen connects his species with that of the great anatomist, belong to the leptorhine as defined by the latter or not may be an open question; but as the assemblage of remains of rhinoceros from Clacton has been truly and accurately defined by Professor Owen as belonging to *R. leptorhinus,* under which name they have been in the catalogues of British Fossils for the last 18 years, the specific name as imposed by Professor Owen ought to be maintained. The *Rhinoceros leptorhinus* then, or *R. à narines demi-cloisonnées* of Professor Owen,[1] the equivalent of *R. hemitœchus* of Dr. Falconer is the second species of fossil rhinoceros found in Britain. Like the tichorhine species it was bicorn; but probably from the partial ossification of the anterior continuation of the vomer, the anterior horn was much smaller than in the latter. The head and the bones were much more slender, the *anterior combing-plate* is invariably absent from the upper permanent molar series, and a very large number of other differences are observable which it is superfluous to mention here without the aid of figures. It occurs in the brick-earths and gravel-pits of the "lower terrace" of the Thames Valley at Clacton, Ilford, Crayford, and Peckham. It is one of the species that fell a prey to the hyænas of Kirkdale and Wookey Hole, and its teeth and skulls have been found in the ossiferous caverns of Gower and of Durdham Down near Clifton. Both upper and lower jaws associated with the *Hippopotamus major* and *Elephas antiquus* have been obtained from the river deposits at Lexden near Colchester.

Species *Rhinoceros megarhinus,* De Christol.[2]—Out of the confusion which the non-tichorhine continental species were involved, M. de Christol determined in 1835, one valid species, *Rhinoceros megarhinus,* so called from the large size of its nasals. In the type

Geol. Journ.,' 1865, p. 285) he says of a skull of *Elephas meridionalis,* "It was found at no great distance from the classic cranium of Monte Zago, upon which Cuvier founded his *Rhinoceros leptorhinus,* as an extinct species devoid of any bony partition between the nostrils. Both specimens are now preserved in the Natural History Museum of Milan, and, by the permission of Dr. Emilio Cornalia, I had an opportunity of examining them minutely .... The skull of the rhinoceros is exactly as Cuvier in the first instance, and Dr. Cornalia subsequently, described it, *i. e.,* without a trace of an external nasal septum."

[1] It is probably the same species as that described by Aymard, as *R. mesotropus* (Pictêt, Paléontologie, 1856, t. 1, p. 298); *R. leptorhinus* du Puy., by Gervaise, (Zool. et Pal. Fran., 1st edit. t. 1, p. 48); and as *R. Aymardi,* by Pomel. ('Cat. Méthod.,' p. 78, 1854.) Gervaise describes this fossil species as being ona "dont les narines sont séparées par une demi-cloison osseuse.'

[2] Op. cit.

specimen from Montpellier the septum between the nares is absent. It is closely allied to the *R. leptorhinus* of Professor Owen, but differs materially in its larger size, and in a great many other points. Its existence in Britain was first satisfactorily determined by Mr. Boyd Dawkins,[1] in the spring of 1865. The remains belonging to this species have been obtained from three localities in the valley of the Thames, at Grays Thurrock, Crayford, and Ilford, and are preserved for the most part in the British Museum. In the cabinets also of Dr. Spurrell and Mr. Grantham are some upper molars from the south bank of the Thames near Crayford, in Kent; while in the beautiful collection of mammalia from Ilford, in Essex, on the north bank, made by Dr. Cotton, F.G.S., are two molar teeth. A single worn and mutilated tooth, obtained by Mr. Prestwich from the railway-cutting near Bedford, may possible belong to this species; but its condition renders a precise determination impossible. The Rev. J. Gunn, F.G.S., has a fine upper premolar of this species in his collection from the forest-bed of Norfolk, where, as in Italy, it is associated with *Elephas antiquus, E. meridionalis*, and *E. priscus*.

The occurrence of these Pliocene species, the remains of which in the marine sands of Montpellier were found in association with *Mastodon brevirostris*, and *Halitherium Serresii*, in the lower part of the Thames Valley, is a very curious and interesting fact, especially as at Grays Thurrock it is associated with the *Elephas priscus*, Falc., of the Pliocenes of the Val d'Arno. It may perhaps attach a higher antiquity to the Pleistocene river-deposits in which it is found than those from which it is absent.

Species *Rhinoceros etruscus*, Falc.—In the collections of the Rev. J. Gunn, F.G.S., and of the Rev. S. W. King, F.G.S., Dr. Falconer, identified also the remains of a second species of Pliocene rhinoceros derived from the Preglacial deposits on the Norfolk shore. It is a species found very abundantly in the deposits of the Val d'Arno, near Florence. The upper true molars from the latter place differ from those of the tichorhine rhinoceros in all points of difference presented by the megarhine and leptorhine species. In size and general form they are more closely allied to the latter of these two species. From both they differ in their small size, coupled with the lowness of the crowns of the upper molars and basal excavation of the *external lamina*. A second upper true molar in the cabinet of the Rev. J. Gunn, F.G.S., presents also a cusp at the valley-entrance.

§ 9, H. Proboscidea.—Genus *Elephas*.—The proper classification of the genus *Elephas* we owe to the cosmopolitan researches of the late Dr. Falconer, brought before the Geological Society of London in 1857, and published in the 'Quarterly Journal' for 1865.[2] Beginning with the mastodons he traces, in a most masterly way, the gradual passage through the various existing and extinct species into the *Elephas Indicus* and the

[1] 'Nat. Hist. Rev.' (1865), No. xix, p. 99.

[2] This short abstract of Dr. Falconer's papers, we give, merely that our readers may be in possession of the facts.

mammoth (*E. primigenius*). His classification is based upon that most important part of the digestive series—the dentition.

A. *Stegodon.*—The remarkable deposits in the Sivalik hills yield the first indication of a passage from mastodon into elephas in the presence of three species—*Elephas* (*Stegodon*) *bombifrons*, *insignis*, and *ganesa*. *E.* (*Stegodon*) *Clifii*, Falc., found by Mr. Crawford in Ava, constitutes the nearest approach to Mastodon in the limited number of ridges (six) of which its intermediate[1] teeth are composed. *E. bombifrons* and *E. insignis* present the next stage in departing from the mastodontic type in the presence of seven, eight, or even nine ridges in their intermediate molars. The Stegodons are differentiated from the mastodons by the number of ridges on the crown; by the convex outline of each unworn ridge, by the absence of the longitudinal line of division along the middle of the crown; by the valleys being filled with cement; by "the pronounced arc of a circle described by the molars as we trace them forwards in the jaw;" and by the inner side of the upper teeth and the outer side of the lower being the higher, besides many other less obvious points. A longitudinal and vertical section of the stegodon tooth showing "a series of chevron-shaped ridges, of which the height does not much exceed the base, and assimilating closely to the true mastodons," differentiates this group from the succeeding ones.

This group is confined to tropical Asia, and is now extinct.

B. The next stage in departing from the mastodons is shown by the species of the group *Loxodon*, that comprises the extinct *Elephas planifrons*, Falc., of the Sivalik Hills; *Elephas priscus*, Falc., and *E. meridionalis*, Nesti, of Europe; and the living *Elephas Africanus*. Its essential character "is that the ridges while closely corresponding" with the former group, "in regard of number, are considerably more elevated and compressed," showing, in a longitudinal and vertical section a series of elongated wedge-shaped processes of enamel, intermediate in thickness between *Stegodon* and *Euelephas*.

C. The third and last group, the most aberrant from the mastodontic type, is the group of the *Euelephas*, comprising the living Indian elephant (*E. Indicus*), and the extinct *E. antiquus*, Falc., and mammoth (*E. primigenius*), Blum., and some other species. It is characterised by the number and thinness of the ridges or lamellæ forming the crown, and the flattened ellipse afforded by their sections on its worn surface, by the small quill-shaped digitations that they present in the unworn tooth, and by the thinness and the minute folds on the enamel.

[1] *i. e.* The last milk molar and ante-penultimate and penultimate true molars. See Falc., 'Quarterly Journ. Geological Society' (1857), No. 52, p. 315.

Such is a brief summary of the results of Dr. Falconer's classification. Previous to this the elephants were divided into three species—*E. Indicus*, *E. Africanus*, and, lastly, the fossil species *E. primigenius*. Under the head of the latter all the remains of the fossil elephants were described by Baron Cuvier, M. de Blainville,[1] and Professor Owen, and considered to be merely varieties by MM. Gervais, Pictet, and other palæontologists.

The species of elephant that lived in Britain during the Pleistocene period are four in number—*Elephas* (*Loxodon*) *priscus*, Goldfuss; *E.* (*Loxodon*) *meridionalis*, Nesti; *E.* (*Euelephas*) *antiquus*, Falc., and *E.* (*Euelephas*) *primigenius*, Blum.

1. Species *Elephas* (*Loxodon*) *priscus*, Goldfuss.—The sections of the ridges on the worn surface of the crown present a lozenge-shaped outline and a mesial expansion. Teeth bearing this characteristic have been identified by Dr. Falconer from the Pleistocene brick-earths of Grays Thurrock, in Essex, and from an uncertain locality in the Thames Valley, and from the Norfolk coast, between Cromer and Lowestoft, near Happisburgh.[2] The latter was probably derived from the horizon of the Forest Bed. The species occurs in Italy in the Pliocene strata of the Romagna, and possibly in central France.

2. Species *Elephas* (*Loxodon*) *meridionalis*, Nesti.—This species of elephant, first of all named by Nesti, from the rich deposit in the Val d'Arno, and accurately defined by Dr. Falconer in the essay above cited, is characterised by the possession of the following ridge formula, exclusive of talons :—

Milk Molars.	True Molars.
$\frac{3 + 6 + 8}{3 + 6 + 8}$	$\frac{8 + (8 - 9) + 13}{8 + (8 - 9) + 13 - 15}$

The enamel composing the ridges or lamellæ of the teeth is thick and plaited, and the ridges themselves are very thick as compared with those of the group Euelephas, and present a mesial angular expansion. The crown is very wide and belongs to the eury-coronine, just as the preceding *E. priscus* belongs to the steneo-coronine, or narrow-crowned species of the group Loxodon. The tusks are *simply* curved, and the skull presents a large number of characters, that it would be out of place to mention here. The remains of *Elephas meridionalis* have been found only in the horizon of the Forest Bed at Bacton, Mundesley, and Happisburgh, in deposits of Pleistocene age. They occur also in the Norwich Beds and the Red Crag below them. The species is essentially a Pliocene one, that lingered on into the early part of the Pleistocene, where its range in Britain is restricted to the area of Norfolk and Suffolk, which it inhabited also in the Pliocene times.

[1] Ostéographie, Article 'Elephas.'

[2] 'Quart. Geol. Journ.' (1865), lxxxii, p. 269, et seq.

3. Species *Elephas* (*Euelephas*) *antiquus*, Falconer.—The *Elephas antiquus*, like the preceding species found in vast numbers in the Val d'Arno deposits is characterised by the possession of narrow-crowned (steneo-coronine) molars. The enamel is crimped, and the ridges in the worn crown surface present a certain amount of mesial rhomboidal expansion. The tusks are nearly straight. Its remains are found both in the bone-caverns and in river-deposits. In the West of England the caverns of Bleadon and Durdham Down have furnished unequivocal proofs of its coexistence in the one with the cave-bear, cave-lion, and mammoth, in the other with the hippopotamus and leptorhine rhinoceros. In South Wales those of Gower yielded it in association with the reindeer, and the hippopotamus, and the same species of rhinoceros; and in Yorkshire, that of Kirkdale, with the three last species and the cave-hyæna, and the bison. Along the coast of Norfolk, southwards round the coast of Kent and Sussex, the detached molars are frequently dredged up, and between high and low water-mark on the Selsea shore the greater part of a skeleton was found in association with the stumps of trees that constitute the Forest Bed of the south coast. The skull, ribs, teeth, tusks, and gigantic leg bones are preserved in the Chichester Museum. It is found abundantly in the low-level deposits of the Thames Valley, as at Ilford, Brentford, Grays Thurrock, and Crayford. Clacton, Walton, Lexden, Ostend, Happisburgh, and Thorpe, have also afforded its remains. In the Bedford Gravels it is found associated with the tichorhine rhinoceros, the hippopotamus, and reindeer, and in those of Folkestone with the Irish elk, the red deer, and the bison.

4. Species *E.* (*Euelephas*) *primigenius*, Blum.—The mammoth is differentiated from the other fossil species of the genus by the possession of the same ridge-formula as the Indian elephant—

Milk Molars.	True Molars.
$\frac{4 + 8 + 12}{4 + 8 + 12}$	$\frac{12 + 16 + 24}{12 + 16 + (24 - 27)}$

exhibiting a progression by successive increments of four ridges. The tusks are curved spirally, in which point they contrast greatly with those of the preceding species. The enamel is very thin and uncrimped—a point of difference between the mammoth and the *E. Indicus*—and the ridges are very much compressed. This species is most abundantly found in all the British Pleistocene deposits from the Forest Bed of Norfolk upwards. In Wookey Hole Cavern it was associated with the leptorhine and tichorhine rhinoceroses, and in the Thames Valley with *E. antiquus*, and *Rhinoceros megarhinus*. It is one of the few Pleistocene species that have been found in Ireland. The animal must have lived in Britain in vast numbers, and for a long time, as its remains are so universally found. Its range was greater than any other fossil mammal—throughout Europe, north and east of the Pyrenees, through France, Germany, Russia, and Siberia (where its frozen carcase was found), across Behrings Straits into Russian America, and down southwards as far as the river Ohio, where its remains occur associated with the mastodon at "Big-bone Lick." In the College of Surgeons there are some very characteristic remains from this latter locality.

§ 9, 1. Glires.—Genus *Castor.* Species *Castor trogontherium,* Cuvier.—Jaws and numerous isolated teeth from the Forest Bed of Bacton and Mundesley, and the blue clay of Cromer, prove the former existence of the great extinct species of beaver first found by M. Fischer on the sandy borders of the Sea of Azof, at the beginning of thc present century.[1]

Species *Castor Europæus,* Owen.—The existence of a species of beaver that cannot be differentiated with that now living in the Rhone and Danube, with the great extinct C. trogontherium, is proved by the occurrence of its remains in the same series of dcposits at Mundesley, Happisburgh, and Thorpe, on the Norfolk coast. A ramus from Grays Thurrock, preserved in the British Museum, and the entire lower jaw from Ilford, in the cabinet of Dr. Cotton, F.G.S., prove also that it was a contemporary of the leptorhine, megarhine, and tichorine rhinoceroses, of *Elephas primigenus, E. antiquus* and *E. priscus.* In size the remains coincide exactly both with the recent beaver, and with that that is found so abundantly in and under peat-bogs. It has not yet been found in any of the British Pleistocene caverns.

Genus *Arvicola.* Species *Arvicola amphibia,* Desm.—That the large water mole of our streams lived at the same time as the great extinct carnivora, and pachyderms in Britain is proved by the occurrence of their remains, both in caverns and river-deposits. In Banwell Cavern it was associated with the great cave-bear, the reindeer, and the panther; in Kent's Hole, with machairodus; in Kirkdale, with hyæna; and in the river-deposits at Ilford, Crayford, and Erith, with bison, lion, and the tichorhine, leptorhine, and megarhine rhinoceroses.

Snecies *Arvicola pratensis.* The Bank Vole has been found in Kent's Hole, in precisely the same condition as the other Pleistocene remains obtained from that famous cavern.

Species *Arvicola agrestis.*—The third species of *Arvicola,* the Field Vole, has also been obtained from Kent's Hole, by the late Mr. MacEnery, and from the Hyæna-den at Kirkdale, by Dr. Buckland.

Genus *Mus.* Species *Mus musculus,* Pall.—From Kirkdale Cavern has been obtained the only evidence for the existence of the common mouse in the Pleistocene period. The remains though, as Professor Owen remarks, slightly larger than the existing mouse, in no other respect differ from that species.

Genus *Lepus.* Species *Lepus timidus,* Erxl.—The remains of the common hare have been discovered in the Mendip bone-caves, by the late Rev. D. Williams; in Kent's Hole,

[1] ('Cuvier,' tom. cit., vol. v, pt. i, p. 59.) The large size of the anterior molar, as compared with the rest, and the absence of involutions of enamel on the outer side of the molars, with many other points, differentiate the teeth of this species from the living *Castor fiber* of Europe and North America. Its remains are confined to the localities mentioned above.

by the Mr. MacEnery; and in Kirkdale, by Dr. Buckland, in association with the extinct and living species of Pleistocene mammalia.

2. Species *Lepus cuniculus*, Pall.—The rabbit also has been found in Kent's Hole, Kirkdale, and the Mendip Caverns, and, on the authority of Professor Owen, also in the cave at Berry Head.

Genus *Lemmus*, Link. Species (?).—The remains of two or three individuals of the genus *Lemmus*, Lemming, obtained by Dr. Blackmore, from the low-level gravels of Fisherton, near Salisbury, in association with the remains of the reindeer, tichorhine rhinoceros, mammoth, and spermophilus, proves this northern genus to have been represented in Britain during the Pleistocene period. Whether or no it be identical in species with the Norwegian Lemming *Lemmus Norwegicus*, Desmarest, or that of Greenland, *Mus Greenlandicus*, Trail, *Arvicola Greenlandica*, Richardson, or that of Hudson's Bay, or any of those described by Richardson in his great work 'Fauna Boreali-Americana,' or of those described by Pallas, in Siberia and Lapland, is entirely an open question, requiring more time for its solution than this Introduction would allow. It will be fully discussed in the body of the work.

Genus *Lagomys*. Species *Lagomys spelæus*, Owen.—We owe to Professor Owen the determination and description of the tail-less hare, discovered by Mr. MacEnery, in Kent's Hole, and figured in the beautiful unpublished plates by Scharf, for a second volume of the 'Reliquiæ Diluvianæ,' of which the death of Buckland deprived the scientific world. Baron Cuvier had determined, with his usual sagacity, the occurrence of this northern genus of Rodent, in the ossiferous Breccia of Cette in Corsica and in Gibraltar; and he considered it to be closely allied to the *Lagomys Alpinus*, or larger species of tail-less hare described by Pallas. Professor Owen considers also that the Kent's Hole fossil is closely allied to the same species, but that it is slightly larger; and a comparison of pl. lxxxiv of the 'British Fossil Mammals,' with the figures of *Lagomys alpinus*, and *L. pusillus*, given in tab. iv, A, in the beautifully illustrated treatise on 'Novæ Species e Glirium ordine' of Dr. Pallas (4to, Erlangæ, 1778), proves the truth of his remarks. The genus at the present day is confined to the Himalayas, Siberia, and the high latitudes of North America. Richardson describes it as living in the Rocky Mountains. No species of it is found at the present day in Europe. A second instance of the occurrence of this species in Britain is afforded by Mr. Busk, F.R.S., who has identified among the remains from the Brixham Cave, those that can in no way be differentiated from the species found in Kent's Hole. Whether *Lagomys spelæus* be an extinct species or not is by no means satisfactorily determined; but in the absence of absolute evidence upon this point, we think it highly probable that it may turn out to belong to some one of the many species that live in the cold regions of the northern hemisphere.

Genus *Spermophilus*. Species *Spermophilus erythrogenoides*, Falc.—The identification of two lower jaws in the collection of mammalia from the Mendip Caverns, made by the late Rev. D. Williams, and now in the Taunton Museum, we owe to Dr. Falconer, who applied the specific name from their close resemblance to the *Spermophilus erythrogenys*, Brandt,[1] of Siberia.

Species *Spermophilus citillus*, Pall.—A third jaw in the same collection differing from the preceding in its greater stoutness, and in the greater outward extension of the process between the angle and condyle, is most closely allied to the pouched marmot, *Spermophilus citillus* found near the snow-line on the high mountains of central and northern Europe.

Remains of several individuals of this genus have been discovered by Dr. Blackmore also in the low-level gravels of Fisherton, near Salisbury. Unfortunately, from the very large number of the living species that must necessarily be examined before an accurate determination can be made, we have been unable to determine these in time for the Introduction, which we publish now in an imperfect state rather than keep back till the end of the work.

§ 10. If we now pass on to consider the relation which exists between the British Pleistocene mammalia and those now living on the earth, we shall find that the former fall into five distinct groups: the first comprehending all the extinct species; the second, those confined at the present day to northern climates; the third, those confined to southern; the fourth, those common to northern and tropical climates; and lastly, those still inhabiting the temperate zones of Europe.

§ 10, A. *Extinct species.*—Out of the fifty-three species, omitting *Bos longifrons*, which has not yet been proved to have inhabited Pleistocene Britain, but fourteen are no longer to be found on the face of the earth:

Machairodus latidens.	Elephas meridionalis.
Ursus spelæus.	Hippopotamus major.
Megaceros Hibernicus.	Rhinoceros tichorinus.
Cervus dicranios.	,, megarhinus.
Elephas antiquus.	,, leptorhinus.
,, primigenius.	,, Etruscus.
,, priscus,	Castor trogontherium.

And it is a fact well deserving of note that of these more than half had already begun to live in the preceding period. Thus, the Pliocenes of the Val d'Arno, near Florence, are characterised by the occurrence of *Machairodus*, *Elephas antiquus*, *E. meridionalis*, *E. priscus*, *Rhinoceros Etruscus*, *Hippopotamus major*, and *Cervus dicranios*, while the Pliocene strata of Montpellier have yielded the megarhine rhinoceros, which probably occurs also in the former locality. The *Castor trogontherium* may perhaps turn out also to have existed in Pliocene times; but at present we know nothing of the age of the sandy deposit

[1] 'Deux nouvelles especes de Sonsliks de Russie' (Spermophilus Eversmanni et Erythrogenys), Bull. Scient. Acad., St. Petersb., t. ix (1842), p. 43.

on the shores of the Sea of Aral, in which its remains were found. In Britain it is confined to the Preglacial formation of the east coast.

The only Pleistocene formations in Britain that have yielded the five Pliocene species, *Elephas priscus*, *E. meridionalis*, *R. Etruscus*, *R. megarhinus*, and *Cervus dicranios*, are the Preglacial deposits on the Norfolk and Suffolk coasts, and the river-gravels, and brick-earths of the lower part of the valley of the Thames. The precise geological age of the latter, as they are deposited along a line that roughly marks the southern limit of the Glacial Sea, the extension of which is marked by the Boulder-clay, is at present undetermined; but the Fauna they contain more closely resembles that of the Preglacial Forest Bed, and that of the Pliocenes of the south of France and of Italy than that contained in any Pleistocene deposit in Britain of Postglacial age.

Of all the Pliocene mammalia that lived on into Pleistocene time *Elephas antiquus* had the most extended range in Britain. To pass over the deposits in the valley of the Thames, and the Preglacial beds on the Norfolk and Suffolk coasts, where its remains are very abundant, it is found in Kirkdale Hyæna-den associated with *Hippopotamus major* and the leptorhine rhinoceros of Professor Owen; at Selsea with the mammoth and horse; in the Gower Caverns with reindeer and leptorhine rhinoceros; in Bleadon Cavern with wild boar, cave-lion, cave-hyæna, wolverine, bison, and roebuck. A very large number of other localities might be cited in proof of its having coexisted with most of the mammalia found either in Pleistocene caverns or river-deposits. For these we must refer to the table of the range and association of the British Pleistocene mammalia that we have now in hand.

The leptorhine rhinoceros (Owen), is associated with the tichorine in Wookey Hole Hyæna-den, with the megarhine in the Thames Valley. Its presence in these localities, as also in the caverns in Gower,[1] at Kirkdale and Durdham Down prove that it also coexisted with the great majority of the Pleistocene mammalia. The characteristic fossil mammals of the British Pleistocene, omitting *Castor trogontherium* are *Rhinoceros leptorhinus*, Owen, *R. tichorhinus*, *Elephas primigenius*, and *Ursus spelæus*. *Megaceros Hibernicus* lived on into the Prehistoric period.

§ 10, B. *Species confined to northern climates.*—The second group of Pleistocene mammals now confined to the colder regions of the north, or to high altitudes in the northern hemisphere, where a low temperature obtains, consists of eight.

Gulo luscus.	Spermophilus citillus.
Cervus tarandus.	„ erythogenoides (Falc.).
Alces malchis.	Lagomys spelæus.
Ovibos moschatus.	Lemmus ?

The *Cervus Bucklandi* of Professor Owen, and the *C. Guettardi* of Baron Cuvier

[1] See 'Quart. Journal of Geol. Soc.,' vol. xvi, p. 487. 1860. 'Dr. Falconer's account of Col. Wood's collection.'

appear to be only varieties of *C. tarandus*, analogous to those now found in the high latitudes of Europe, Asia, and America. Previously[1] to the year 1671 it had disappeared from the south side of the Baltic, and now is rapidly retreating northwards along with the Fins at the approach of civilised man. In Asia, in Pennant's time (1780), on the authority of Dr. Pallas, it extended along the Urals to the foot of the Caucasus. In America its southern limit is the parallel of Quebec.

The musk-sheep, *Ovibos moschatus*, De Blainv., associated with the mammoth, tichorhine rhinoceros, horse and deer, in the gravels of the Avon, is now confined to the high northern latitudes of the American continent, where it ranges over the treeless barren grounds from the River Mackenzie, through 105 degrees of longitude, along with Esquimaux, reindeer, wolverines, bears, and various species of lemming, and spermophilus, and hare. Sir John Richardson places the Mackenzie River as its probable western limit, but Captain Beechey[2] found that the Esquimaux near Eschscholtz Bay knew the animal, so that in all probability it ranges through the district to the west of this. Its southern limit extends from the edge of the woods up to the highest northern latitudes, yet reached by our explorers, "from the entrance of the Welcome into Hudson's Bay, about the 60th parallel of latitude, in a westward and northward direction to the 66th parallel, at the north-east corner of Great Bear Lake, and from thence nearly in the same direction to Cape Bathurst in the 71st parallel."[3] Within the last century it had a further range to the south to latitude 59, the enterprising traveller Hearne having seen its tracks in the neighbourhood of Fort Churchill in the year 1770. As an associate of the mammoth it ranged over the "tundras" or treeless "barren grounds" of Asia, on the borders of the great Polar Sea. In tracing its remains from the locality in which it still lives, southwards and westwards, we find them in the frozen gravels and brick-earths of Eschscholtz Bay, along with mammoth, elk, reindeer, horse, and bison.[4] On crossing Behring's Straits into Asiatic Russia they are described by Ozeretzkousky as occurring at the mouth of the river Jana, between the rivers Lena and Indigirka, in longitude 135°, and latitude 65°; and by Pallas, as occurring still further to the west, in the great "tundra" or moss steppe between the Obi and the Lena. The discovery of the skull of *Ovibos moschatus* at the mouth of the river Obi, in longitude 70°, and within the Polar circle, brings the animal almost to the borders of Europe.[5] Then passing over the vast areas of Russia in Europe, and Germany, where there are no authentic accounts of

[1] Zimmerman, 'Specimen Zoologiæ Geographiæ' (4to, Lugduni Batavorum, 1778, p. 285):— "Bartholino teste ('Acta Hasnens.,' 1671), Daniam *rangiferi* plene deseruerunt nec amplius ibidem ut olim proveniunt. Et Pontoppidanus ('Norweg.,' t. xi, p. 21), Reynardus que ('Œuvres de Reynard,' Paris, 1750, t. i), tentatas eorum educationes propagationesque secus ibi cecidisse omnesque periisse confirmant."

[2] 'Voyage to the Pacific' (4to, London, 1831), p. 324.

[3] 'Zool. of H.M.S. Herald,' 4to, 1854, p. 23.

[4] See 'Zool. H.M.S. Herald,' and Appendix, by Dr. Buckland, in 'Beechey's Voyage to the Pacific.'

[5] See Cuvier's 'Oss. Foss.,' vol. iv, p. 155, 1825.

its discovery, the next three localities in its southward and westward range, are Maidenhead, in Berkshire, whence Messrs. Lubbock and Kingsley obtained two heads, described by Professor Owen in 1856[1] under the name of *Bubalus moschatus*; the Avon, near Bath, whence Mr. Moore obtained also two skulls; and Green Street Green, in Kent. The discoveries of M. Lartet[2] extend its southward limit to the Department of Oise, the environs of Paris, and the banks of the Vezère. Thus, the range of the musk-sheep is as great, if not greater than that of the mammoth. The two running side by side throughout France, Germany, North Europe, and Asia, part company at Eschscholtz Bay; the former ranging eastward in a living state throughout the northern shores of the American continent; the latter being found in a fossil state through Oregon, as far south as the Zanesville, on the banks of the Ohio, and as far east as Rutland, in Vermont.[3]

The tail-less hare (*Lagomys spelæus*) of Kent's Hole and Brixham, found also by Baron Cuvier in a breccia at Gibraltar, is probably that described by Pallas as a living member of the Siberian Fauna, while the fossil lemming of Salisbury, and the elk or moose-deer of Llandebie are at present natives of the northern parts of Asia, America, and Europe, the province of the latter ending where that of the reindeer begins. The *Spermophilus*, or pouched marmot, of Salisbury and the Mendip Caves, is found throughout the high northern latitudes of Europe, Asia, and America; and it inhabits also the higher districts much to the south of these, where a low temperature prevails throughout the year, as the Alps, the Pyrennees, the Urals, and the Rocky Mountains. Pallas mentions[4] it also as inhabiting the water-shed of the Don and Volga, along with the *Sorex* (*Myogalea*) *moschatus*.

The glutton or wolverine (*Gulo luscus*), of Banwell, Bleadon, and Gower Caverns, ranges at the present day through the colder regions of North America, inhabiting alike the districts of the elk, the reindeer, and the musk-sheep, and extending as far north as Melville Island, in latitude 75°. According to Audubon[5] it occurs as far south as Jefferson County, in latitude 42°·46. It ranges also throughout the northern parts of Asia and Europe, living in the latter in northern Russia, Sweden, and Norway. Everywhere it is the great pest of the fur-hunters, destroying both their traps and their game, and tearing open their winter stores.

§ 10, c. *Species confined to southern climates.*—The third group of Pleistocene species now confined to hot climates, consists of two:

Felis spelæa, *var.* of F. leo.
Hyæna spelæa, *var.* of H. crocuta.

1 'Quart. Geol. Journ.,' 1856.

2 'Comptes Rendus,' lviii, 26.

3 Warren 'On the Mastodon,' p. 158, Boston, 1855.

4 Audubon, Richardson, Fischer, Brandt, Desmarest, Cuvier, and Pallas are the principal authorities upon which the geographical distribution of the northern group of mammalia is given.

5 'Quadrupeds of North America' (1847), 4to, p. 211.

The range of the first of these, *Felis leo*, has been considerably modified during the Historical Period. At the present day it is found, with but extremely slight variations, in the whole of Africa, with the exception of Egypt and the Cape Colony, from which areas it has probably been driven away by the hand of man. In Asia the maneless variety inhabits the valley of the Tigris and Euphrates, and the districts bordering on the Persian Gulph; and still lingers on in India, according to Mr. Blyth, in the Province of Kattywar, in Guzerat.[1] That, however, lions dwelt in Europe within the Historical times, is proved by the concurrent testimony of Herodotus,[2] Aristotle, Pausanias, and Ælian. The former mentions them as descending from the mountains in the night and attacking the baggage camels of Zerxes' army in their march through Pæonia; and he mentions that the mountainous district between the River Nessus, in Thrace, and the Achelöus, in Acarnania, was infested by a great number of lions. Aristotle confirms this statement of Herodotus, and adds that they were more numerous in Europe than in Asia or Africa, and also more powerful. In this latter respect the spelæan lion of Pleistocene Europe tallies exactly with his description of the lion of Thrace and Macedonia. Pausanias adds other details to the above account, and states that they were peculiarly abundant in the plains at the foot of Mount Olympus. There is, indeed, no geographical reason why, at a period still earlier than this, the species should not have inhabited Western Europe. On the whole, the sum of the evidence as to the relation between *F. spelæa* and the European lion of History, inclines us to believe that the latter was widely spread throughout France, Germany, and Britain in Pleistocene Europe, under the name of the former, and that probably it was gradually driven from Western into Southern Europe, and thence into Asia by the hand of man.[3] From the latter also it is gradually disappearing, having retreated from Asia Minor, Syria, and Palestine into Persia and India, which are the only countries in the Europæo-Asiatic continent where it is now found.

The remaining animal belonging to this section is the *Hyæna spelæa,* which a careful comparison leads us to consider as a variety of a living form—the spotted hyæna of South Africa. The present range of this animal presents a difficulty which is not felt in the case of the cave-lion, the latter being traceable in a living state into Europe, while the former is now confined to Southern Africa, and has never been found in the north of that vast continent. The *Hyæna spelæa,* on the other hand, of Pleistocene Europe, is very abundant in the caverns of France, Germany, and Britain. That, however, the spotted hyæna of the Cape is the living representative of the European Pleistocene species, which under

[1] 'Cat. Mam. Mus. Asiat. Soc., Beng.,' Calcutta, 1863.

[2] Herodotus 'Polymnia,' chap. cxxv, Ed. Wesseling; Aristotle 'Hist. Ann.,' chap. xxvii; Ælian 'Hist. Ann.,' lib. 17, chap. xxvi; Pausanias, on the authority of M. de Blainville.

[3] With reference to the lions of Greece, Zimmerman thinks this explanation improbable:—"Eos autem non auctis hominum catervis ad hanc discessionem perductos esse, ex eo patet, quod majori longe hominum multitudine Græcia Aristotelis ævo frequentata fuit quam quibus nunc temporibus ipsam sub Turcarum ditione immitique dominio cultam novimus."—'Specimen Zoologiæ Geographicæ,' 4to, p. 386.

conditions of existence, differing from those under which the former now lives, presents certain variations within the limits of the species, we hope satisfactorily to show in the Monograph upon Hyæna, to be published at a future day.

§ 10, D. *Species common to cold and tropical climates.*—One of the Pleistocene mammalia, the *Felis antiqua,* of Cuvier, or the fossil representative of the *F. pardus,* of Linnæus, has at the present day a most extended range throughout Africa, from Barbary to the Cape of Good Hope (Cuvier), and throughout Persia into Siberia. In this latter country M. Gotthelf Fischer[1] describes it as occurring in the Altai Mountains and in Soongoria, a tract of country also that is inhabited by tigers. The fox and the wolf are like instances of some of the living carnivora being able to endure almost every degree of temperature without being specifically modified by it.

§ 10, E. *Species still inhabiting the temperate zones of Europe.*—The fifth, and by far the largest, group of the Pleistocene mammalia embraces those still living in the temperate zones of Europe. It consists of twenty-eight species:

Homo.
Rhinolophus ferrum-equinum.
Vespertilio noctula.
Talpa vulgaris.
Felis catus ferus.
Canis lupus.
,, vulpes.
Mustela erminea.
,, putorius.
,, martes.
Lutra vulgaris.
Meles taxus.
Ursus Arctos.
Sorex vulgaris.
Sorex moschatus.
Bos primigenius (?).
Bison priscus.
Cervus elaphus.
,, capreolus.
Sus scrofa ferus.
Equus caballus.
Castor Europæus.
Arvicola amphibia.
,, agrestis.
,, pratensis.
Lepus timidus.
,, cuniculus.
Mus musculus.

The *Bison priscus,* or the aurochs of the Pleistocene, that spread over nearly the whole of the Pleistocene Europæo-Asiatic continent from the Pyrennees through France and Germany as far as Behrings Straits and Eschscholtz Bay on the American shore of the

[1] 'Zoognosia," iii, p. 221 (8vo, Mosquæ, 1814):—"Sic dictam unciam a Cl. Steven æstumatissimo nostri musei largitore accepi ex montibus Soongoricis et jugo Altaico, pantheram Africanam ex ditissima donatione Excell. Pauli de Demidoff obtinuimus. Hæc profundiore colore gaudebat, uncia vero albidiore, sed macularum nullam vidi differentiam. Individium vivum nunc apud Excell. Principem de Yussupoff conservatum ex Persia venit, etiam albidiore indutum est veste, et maculæ subannulares, in pedibus et cauda magis virgatæ sunt. Uncia itaque pelle albidiore, juniores pardos indicare videtur."—Cuvier (tom. cit., vol. iv, p. 428) endorses this determination.

Arctic Sea, now lingers in a Lithuanian Forest, protected by an imperial decree of the Czar of Russia. Its remains are found associated with those of the mammoth, in the frozen brick-earths and gravels of Eschscholtz Bay, throughout the Asiatic "tundras," the islands of New Siberia and the Lächow Group, and in the caverns and river-deposits of Northern and Western Europe. It is mentioned in a remarkable List of Graces[1] of the Abbey of St. Gall, written by Ekkehard the younger (who lived from A.D. 980 till 1036), as an article of food, together with the bear, the urus, the beaver (which they called a fish), the wild horse (*Equus feralis*), the marmot, and others. Mr. Wylie considers that the *Equus feralis* was the offspring of a domestic breed run wild like that of America; but when we consider the vast number of horses that have left their remains in association with those of bison in various Pleistocene deposits, and that at a far later date they formed the food of the tribes that lived in the pile-dwellings of the Swiss Lakes, and the hut-circles of Berkshire, the probability seems to us that reference is here made to a breed of horses as undoubtedly wild as the mouse-coloured wild horse of Central Asia.

The musk-shrew, *Sorex moschatus*,[2] of Pallas, described by Professor Owen from the Preglacial deposits of Bacton, under the name of *Palæospalax magnus*, is now found only in a

[1] The list of animals is so remarkable that we have subjoined the whole passage in which they are mentioned:

"Sit benedicta *fibri* caro *piscis* uoce salubri."—line 71

"Sub cruce diuina benedicta sit ista ferina.
Sub cruce diuina sapiat bene quæque ferina.
Et semel et rursus cruce sit medicabilis *ursus*.
Hunc medici sanum memorant nullique nocivum.
Dente timetur (petulcus) *aper*, cruce tactus sit minus asper.
Cerui (vel cerue) curracis caro sit benedictio pacis.
Hæc satan et Larvæ fugiant crustamina *cervæ*.
Signet *uesontem* benedictio *cornipotentem*.
Dextra dei ueri (uel benedicat) comes assit carnibus *uri*.
Sit *bos siluanus* sub trino nomine (crucis hoc signamine) sanus.
Sit *feralis equi* caro dulcis in (sub) hac cruce Christi.
Imbellem *dammam* faciat benedictio summam.
Capreus ad saltum benedictus sit celer altum.
Sit cibus illæsus *capreæ*. Sit amabilis esus.
Capreoli (us) uescam dent (det) se comedentibus escam.
Carnes *uerbicum* nihil attulerint inimicum.
Pernix *cambissa*[3] (fera alpina) bona sit elixa vel assa.
Sub cruce diuina caro dulcis sit *leporina*
Alpinum *cassum*[4] faciat benedictio crassum.
Sit caro syluana crucis omnis robore sana."—'Benedict. ad Mensas' Ekkehardi Monachi Sangallensis (lines 117—136), 'Archæological Journal,' vol. xxi, pp. 355 and 358.

[2] Pallas, 'Zoographia,' vol. i, p. 128; 'Second Travels,' trans., vol. i, p. 48, London, 1802. Fischer ('Synopsis Mammalium,' 8vo, Stut., 1829, p. 250-1) gives the literature of the species.

[3] Chamois. [4] Marmot?

living state in Southern Russia, in the area between the Don and the Volga. An animal of aquatic habits, it is especially abundant on the banks of the Soura River, in latitude 55° north, and longitude 47° east, under a temperate continental climate, cold in winter but hot in summer. Dr. Pallas, in his 'Second Travels,' describes the country which it inhabits, after an unusually severe winter, as covered with tulips, saffron, and the Star of Bethlehem, and although *Spermophilus citillus*, the Alpine marmot, was in the neighbourhood, there were vineyards close by. The water-shrew of the Pyrennees, *Myogale Pyrennaica*, Geoffr., is a closely allied species, differing from the *Sorex moschatus* (*Myogale moschata*, Fischer), in its smaller size, and long and rounded tail.

An analysis, therefore, of the fifty-three Pleistocene species, those about which there is any doubt being omitted, gives

14	as extinct.
8	as confined to northern climates.
2	„ southern climates.
1	as common to temperate and hot climates.
28	as still inhabiting the temperate zones of Europe.
53	

§ 11. *Inferences as to Pleistocene climate.*—The proportion of fourteen extinct to thirty-nine living species proves that, in the geological sense, the present order of things is separated by a small interval from the Pleistocene; while, from the fact that twenty-eight species, or half, are still living in the same European area, we may infer that the conditions of existence, the climate and food, and the like were then very similar to those now obtaining in the area in which they live. That, however, some great physical change has taken place in Europe since the Pleistocene times, is proved by the presence of other groups of mammalia—those confined now to cold and to hot countries. They afford evidence that at first sight appears conflicting, but which upon analysis we shall find to be very conclusive, that the climate in Britain, in those days, was very much more severe than at present. From the conditions under which the surviving Pleistocene herbivores now live, we can infer those under which they lived in Britain in that early period. The northern group of Pleistocene mammalia, living only now in a severe continental climate, consists of species that have very different powers of resisting cold and heat. Thus, the musk-sheep is found now only under the lowest temperatures in the vast treeless "Barren Grounds" of North America, while the reindeer lives also in the forests, along with the elk, of the Europæo-Asiatic and North American continents. The red deer and the bison range up to the edge of the province inhabited by the latter animals. The lemmings live under a very severe climate, while the marmots are found in the higher and colder districts in Southern Europe and Central Asia. Each of these northern species is dependent upon the oscillation of the climate for its particular habitat in a given year, retreating northwards or southwards, according to the temperature that regulates the supply of food necessary for its existence. Thus, in North America, Sir John Franklin writes that the migrations of the animals afford a means of foretelling the severity of the season. If the reindeer retreat far south then a severe winter is to be apprehended; if, on the contrary, they remain very nearly in their usual winter haunts, the season invariably is a mild one. The reindeer of Northern Russia are equally dependent upon the season for their locality; and if an unusual season occurs, to put the animals off their accustomed route, the inhabitants of the district at the mouth of the Kolyma, living upon the chase, endure the severity of famine. M. Von Matiuskin, the Lieutenant of Admiral Von Wrangel, had the good fortune to see one of these migratory bodies of reindeer crossing a river, consisting of many thousands, divided into herds of two or three hundred each. By some such oscillation of temperature, which regulates the supply of food for the herbivores, the remains of the animals of two contiguous zoological provinces may be found together in one spot, as in the case of the northward retreat of the musk-sheep which, living in Hearne's time (A.D. 1770—72) near Fort Churchill, has left that district to be occupied now by the elk and the waipiti. In this manner the admixture of the remains of animals living at the present day, respectively, in a severe, and in a temperate continental climate, may be accounted for in the Pleistocene caverns and brick-earths. Of the district in America, where the animals inhabiting the high northern latitudes meet with those that live under a comparative temperate climate, Sir John Richardson writes:—"The subsoil north of latitude 50° is perpetually frozen, the thaw on the coast not penetrating above three feet, and at Great Bear Lake, in latitude 64°, not more than twenty inches. The frozen substratum does not of itself destroy vegetation, for forests flourish on the surface at a distance from the coast, and the brief, though warm summer, gives birth to a handsome flora, matures several pleasant fruits, and produces many carices and grasses."[1]

But in the vast plains of Siberia, extending from the Altai Mountains to the Arctic Sea, we find probably a nearer approach to the Pleistocene climate of Western Europe. Covered by impenetrable forests, for the most part of birch, poplar, larch, and pines, and low creeping dwarf cedars, they present every gradation in climate from the temperate to that in which the cold is too severe to admit of the growth of trees, which decrease in size as the traveller advances northwards, and are replaced by the grey mosses and lichens that cover the low marshy "tundras." The maximum winter cold, registered by Admiral Von Wrangel,[2] at Nishne Kolymsk, on the banks of the Kolyma, is $-65°$ in January. "Then breathing becomes difficult; the wild reindeer, that citizen of the Polar region, withdraws to the deepest thicket of the forest, and stands there motionless as if deprived of life;" and trees burst asunder from the intensity of the cold. Throughout this area roam elks, black bears, foxes, sables, and wolves, that afford subsistance to the Jakutian

[1] Back's 'Journey to the Arctic Sea,' 4to, 1836, appendix, p. 479.

[2] Op. cit.

and Tungusian fur-hunters. In the northern part countless herds of reindeer, elks, foxes, and wolverines make up for the poverty of vegetation by the rich abundance of animal life. "Enormous flights of swans, geese, and ducks arrive in the spring, and seek deserts where they may moult and build their nests in safety. Ptarmigan run in troops amongst the bushes; little snipes are busy along the brooks, and in the morasses; the social crows seek the neighbourhood of new habitations; and when the sun shines in spring one may even sometimes hear the cheerful note of the finch, and in autumn that of the thrush." Throughout this region of woods a hardy, middle-sized breed of horses lives under the mastership and care of man, and is eminently adapted to bear the severity of the climate. Like the other northern quadrupeds they change their coats *in the midst of summer*. "They perform most laborious journeys, often of three months' duration, with no other food than the half-withered grass, which they get at by scraping away the snow with their hoofs, and yet they are always in good condition." The only limit to their northern range is the difficulty of obtaining food. The severity of the winter, through the southern portion of this vast wooded area is almost compensated for by the summer heat and its marvellous effect on vegetation.

The hypothesis of a series of conditions obtaining in Pleistocene Western Europe similar to those now found in this portion of Northern Asia, will alone satisfy the evidence afforded by the fauna, and the deposits in which they are found. The contortion of the gravels, and the angular state of the pebbles of which they are often composed, are, as Mr. Prestwich infers, explicable only on the theory of ice having been formed in our rivers in far larger quantities than at the present day; the one being the result of the grounding of miniature bergs, the other of their melting away and depositing their burden of pebbles. The large plateaux of brick-earths are probably the deposit of the floods caused by the sudden melting of the winter snow, similar to that which Admiral Von Wrangel describes in Northern Siberia, and Sir John Franklin in the area north of the Canadian Lakes. The winter cold would be sufficiently intense to allow of the northern group of mammalia living in the winter, and even the musk-sheep (of which the remains are rare) might have been obliged to leave the Pleistocene "tundras," and take shelter in the zone of the elk and even the bison, in an unusually severe season. On the other hand, in the summer, the animals that are now found in the temperate zones of Europe might advance even into the country of the elk and the reindeer; and even carnivora now confined to hot climates find their way into the temperate zone of the day. Thus, the *Hyæna vulgaris*, or common living hyæna, is found fossil in the South of France, without penetrating as far north as Britain, France, or Germany.

In fine, the evidence afforded both by the fauna and deposits of the Pleistocene seems to us to prove that the climate in Pleistocene Britain was more severe than it is now; that at a time when Britain formed a portion of the Europæo-Asiatic continent, it more closely resembled that now obtaining in the fur-countries of Northern Asia than elsewhere; and lastly, that it was subject to oscillations by which the migrations of the herbivores were directed northward or southward, as the case may have been.

The remarkable evidence afforded by the thick woolly covering on the carcases of the mammoth and tichorhine rhinoceros of Siberia, as to the temperature of the countries in which they lived, makes it very probable that the *Hippopotamus major* was in like manner defended from the cold; but at the same time we must bear in mind that the aquatic habits of the genus are incompatible with the severity of a climate suited to the reindeer; that it has not been found in Russia, nor in any of the vast deposits in the high northern latitudes; and that therefore it is rather to be put into the same category with the bison of North America, rather than the reindeer, as an occasional visitant rather than a dweller throughout the year in England, France, and Germany. Its remains are very rare, as compared with the other herbivores, the fossil elephants, rhinoceroses, Irish elks, bisons, reindeer, and the like. Its head-quarters probably were on the shores of the Mediterranean, and the north of Africa, from which latter locality M. Gervaise[1] cites it as occurring in a fossil state near Constantine, in Algeria. In the caverns on the European shores its remains are extremely abundant, as also in the Italian Pliocenes.[2]

There is another interesting point connected with climate. How it may be asked, can you reconcile the presence of the spelæan hyæna and the lion with the climate which the reindeer and the musk-sheep required for their existence? Is not the very fact of their coexistence with the reindeer a proof of their specific distinctness from the African or Asiatic lion, or the hyæna of the Cape? If they are identical in species must not the Pleistocene climate have been similar to that of the countries in which they now live? An appeal to the zoological distribution of the carnivora over wide areas, proves that it is not so. While the herbivora are dependant upon the temperature for the vegetation on which

[1] Tom. cit., p. 363.

[2] The occurrence of hippopotamus may be accounted for in a somewhat different manner. While we may be almost certain that the general climate of Britain, during the Postglacial epoch, has been more severe or, properly speaking, more extreme or continental than at present, a period or periods of some length may have intervened, while England and Ireland formed a portion of the European continent, when the climate may have been less severe, and the rivers free from ice throughout the year. This view of the case is strengthened by the fact that the fossil hippopotamus is frequently, if not generally, accompanied by forms of elephant and rhinoceros *i. e. Elephas antiquus* and *Rhinoceros leptorhinus*, which appear both in this hemisphere, and as far as *E. antiquus* is concerned, in America also, to have had a southern, and even a tropical, rather than a northern range. Among other facts which must be accounted for is the existence of a Lusitanian flora on the west coast of Ireland. This flora, or some member of it at least, with difficulty maintain their ground at the sea-level, and must have been exterminated by the severity of the glacial epoch; and we cannot suppose but that their migration from a southern land has occurred since, and that along a coast-line. It is true that Professor Forbes assigned the Miocene period as that of this migration, but he appears to have overlooked the great severity of the intervening glacial climate.

On these points compare, Forbes's "Flora and fauna of the British Isles," 'Mem. Geol. Survey,' vol. i, p. 336 et seq.; Trimmer, 'Quart. Journ. of Geol. Soc.,' vol ix, p. 13, 1853; Lyell, 'Ant. of Man,' ed. 1863, pp. 273 et 320; Croll, 'Nat. Hist. Review,' No. xx, p. 594; and authors quoted by them.—W. A. S.

they feed, and are restricted in range to those districts where the food most fitted for them is to be found; the only limit of the range of the carnivora is to be found in that of the animals upon which they prey.[1] Thus, the tiger preys upon buffaloes, deer, and the herbivores peculiar to each district, throughout the length and breadth of India. On the shores of the Sea of Aral it is the scourge of the horses of the nomad Tartars, and in the district of the Altai it preys upon the wild boars, and further north upon the reindeer; and yet specifically it is the same, the markings on the skin of that of the Aral being of the same character as that of India.[2] The fox is another example of the same kind, ranging throughout the old and new worlds, and yet not divisible into species. The wolf, also, and the panther, already quoted, are instances of the same kind. The fact, therefore, of the spelæan lion and hyæna having lived in a climate in the Pleistocene far differing from that in which they now live cannot be quoted in favour of the recent and the fossil belonging to distinct species. The remains of *Hyæna spelæa* are found in vast numbers in Britain, France, and Germany; those of *F. spelæa* being more sparingly found; and those of wolverine being abundant in the caverns of Liège and Gailenreuth, and absent from France, and met with but in three caves in Britain. Neither of the two former species have, as yet, been discovered in Russia or in the high northern latitudes of Europe and Asia, where there are such vast stores of fossil remains.

§ 12. *Relation of Pleistocene to Prehistoric mammals, and those now living in Britain.*—The following table of British genera and species of land mammalia, from the Pleistocene downwards to the present day, shows at a glance the close relation existing between them; and it shows, moreover, by the gradual elimination of the Arctic group of mammalia, that the increase in temperature from the Pleistocene to the present day has been gradual:

Genera.	Pleistocene species.	Prehistoric species.	Species now living in Britain.
Castor, *Lin.*	fiber, *Lin.*	fiber, *Lin.*	
	trogontherium, *Fisch.*		
Mus, *Lin.*	musculus, *Lin.*	musculus, *Lin.*	musculus, *Lin.*
			messorius, *Sh.*
			sylvaticus, *Lin.*
			rattus, *Lin.*
			decumanus, *Pall.*
Arvicola, *Lac.* = Hypudæus, *Ill.*	amphibia, *Desm.*	amphibia, *Desm.*	amphibia, *Desm.*
	agrestis, *Flem.*	agrestis, *Flem.*	agrestis, *Flem.*
	pratensis, *Bell.*	pratensis, *Bell.*	pratensis, *Bell.*
Spermophilus, *Fred. Cuv.*	citillus, *Pall.*		
	erythrogenoides, *Falc.*		
Sciurus, *Lin.*			vulgaris, *Lin.*
Myoxus, *Zimm.*			avellanarius, *Desm.*

[1] See M. de Serres, "Sur l'Origine des Animaux et des Végétaux," 'Revue du Midi,' tom. ix, v livraison.

[2] See preceding note on *Felis spelæa.*

Genera.	Pleistocene species.	Prehistoric species.	Species now living in Britain.
Lagomys, *Geoffr.*	spelæus, *Owen.*		
Lepus, *Lin.*	timidus, *Erxl.*	timidus, *Erxl.*	timidus, *Erxl.*
	cuniculus, *Pall.*	cuniculus, *Pall.*	cuniculus, *Pall.*
			variabilis, *Pall.*
Lemmus, *Link.*	lemmus, *Link.*		
Elephas, *Lin.*	primigenius, *Blum.*		
	antiquus, *Falc.*		
	priscus, *Gold.*		
	meridionalis, *Nesti.*		
Rhinoceros, *Lin.*	tichorhinus, *Cuv.*		
	leptorhinus, *Owen.*		
	megarhinus, *Chris.*		
	Etruscus, *Falc.*		
Equus, *Lin.*	fossilis, *Owen.*	caballus, *Lin.*	= caballus, *Lin.*
Sus, *Lin.*	scrofa, *Lin.*	scrofa, *Lin.*	scrofa, *Lin.*
Hippopotamus, *Lin.*	major, *Desm.*		
Bison, *Gesn.*	priscus, *Owen.*	?	
Bos, *Lin.*	primigenius, *Boj.*	= Urus, *Cæs.*	= ? taurus, *Lin.*
		longifrons, *Owen.*	= ? taurus, *Lin.*
Ovibos, *Blain.*	moschatus, *Desm.*		
Capra, *Lin.*		hircus, *Gm.*	hircus, *Gm.*
		ægagrus, *Gm.*	ægagrus, *Gm.*
Ovis, *Lin.*		aries, *Lin.*	aries, *Lin.*
Cervus, *Lin.*	elaphus, *Lin.*	elaphus, *Lin.*	elaphus, *Lin.*
	capreolus, *Lin.*	capreolus, *Lin.*	capreolus, *Lin.*
	tarandus, *Lin.*	tarandus, *Lin.*	
	dicranios, *Nesti.*		
			dama, *Lin.*
Alces, (*Cæs.*), *Lin.*	malchis, *Gray.*	malchis, *Gray.*	
Megaceros, *Hart.*	Hibernicus, *Owen.*	Hibernicus, *Owen.*	
Machairodus, *Kaup.*	latidens, *Owen.*		
Felis, *Lin.*	spelæa, *Gold.*		
	antiqua, *Cuv.*		
	catus, *Lin.*	catus, *Lin.*	catus, *Lin.*
Hyæna, *Briss.*	spelæa *Gold.*		
Canis, *Lin.*	lupus, *Lin.*	lupus, *Lin.*	
	vulpes, *Lin.*	vulpes, *Lin.*	vulpes, *Lin.*
		familiaris, *Lin.*	familiaris, *Lin.*
Lutra, *Erxl.*	vulgaris *Erxl.*	vulgaris, *Erxl.*	vulgaris, *Erxl.*
Mustela, *Lin.*	martes, *Lin.*	martes, *Lin.*	martes, *Lin.*
	putorius, *Lin.*	putorius, *Lin.*	putorius, *Lin.*
	erminea, *Lin.*	erminea, *Lin.*	erminea, *Lin.*
			vulgaris, *Lin.*
Meles, *Lin.*	taxus, *Lin.*	taxus, *Lin.*	taxus, *Lin.*
Gulo, *Storr.*	luscus, *Sabine.*		
Ursus, *Lin.*	spelæus, *Gold.*		
	Arctos, *Lin.*	Arctos, *Lin.*	
Talpa, *Lin.*	Europæa, *Lin.*	Europæa, *Lin.*	Europæa, *Lin.*
Sorex, *Lin.*	vulgaris, *Lin.*	vulgaris, *Lin.*	vulgaris, *Lin.*
	moschatus, *Pall.*		
	? ?		fodiens, *Pall.*
	? ?		remifer, *Geoff.*
Vespertilio, *Lin.*			mystacinus, *Leisl.*
			Daubentonii, *Leisl.*

MONOGRAPH

ON

THE BRITISH MAMMALIA

OF THE

PLEISTOCENE PERIOD.

Order—CARNIVORA.

FAMILY—FELIDÆ.

Genus—FELIS.

Species—*Felis spelæa,* Goldfuss.

CHAPTER I.

Felis spelæa—Lower jaw, Pl. I, figs. 1, 2, 3; Pl. VI,[1] 1, 2.

A COMPARISON of the jaws of large Feles from the caves and river-deposits, one with the other, and with those of the existing species nearest them in size, shows us most distinctly that, while there are some fossil jaws which, in form and size, are absolutely indistinguishable from those of the lion, others, which are generally considerably superior to them in some of their dimensions, offer characteristics which appear to prove that they are so closely allied to those of that animal that the differences between them probably do not amount to more than extreme variety, while they essentially depart by the same characters from those of the tiger.

If a large series of lower jaws of recent lions and tigers be compared together we find that, while the individual differences are great, resulting possibly from difference of sex, food, climate, and the like, there is one test of specific value by which the one can be distinguished from the other. In the lion the inferior border of the ramus bears a slight

[1] Unfortunately we have been unable, from want of time, to publish the Plates and descriptions of the bones of *Felis spelæa* in the order that they should naturally appear. We trust that this may be rectified in future monographs.

process immediately beneath the last molar, which is developed to a different degree in different individuals; in some it causes the outline of the inferior border of the lower jaw to present a regular rounded, convex outline, nearly straight from symphysis to angle, while in others it reaches a maximum of development, so that the jaw approaches the doubly arched appearance so manifest in the figures Pl. I, figs. 1, 2. In the tiger, on the other hand, the inferior border of the lower ramus is straight, or rather concave in outline, from the symphysis backwards, the only exception out of the large number of tigrine skulls in the museums of Oxford and London being that afforded by one in the Hunterian collection, killed in India, and presented by General Hardwicke, in which there is the faintest possible approximation to the leonine contour.

In this point the rami of *Felis spelæa* agree most remarkably with those of *Felis leo*, and, as far as the larger specimens are concerned, present us with the maximum development of this "*ramal*" process, as it may be called (A of figs. 1, 2, Pl. I). In these large specimens it is far more strongly marked than in any recent varieties of *Felis leo;* but, as the latter present great variations in this respect, we cannot consider the stout proportions which the former exhibit a proof of specific difference.

The smaller jaws above referred to (figs. 1, 2, Pl. VI) do not present a greater development of the "*ramal*" process than ordinary specimens of the lion; being in this respect, as in all others, indistinguishable from that animal. In the leopard, both of Africa and of India, the inferior outline of the lower jaws resembles that of the lion; but that of the jaguar (*Felis onca*) is straight or slightly concave, like the tiger.

In both the large and small varieties the height of the condyle above the angle coincides remarkably with that of the lion, but differs in the tiger; this dimension being in the latter greater, both proportionally and absolutely. The proportion of length to maximum depth of the condyle varies in different individuals; but in the few instances we have seen, both large and small varieties have this part proportionally somewhat stouter than in the recent species (Pl. I, figs. 1, 2, 3, B; Pl. VI, figs. 1, 2, B).

Baron Cuvier considers that the gradual ascent of the coronoid process from the alveolar border of *Felis spelæa* is one point of difference between that animal and the living lion. We cannot see that in this point any difference exists between the fossil and recent species. The coronoid process rises more gently from the alveolar border in the lions that we have examined than in the tigers, but the difference is very slight.

The apparently sharper angle at which this process rises from the alveolar border in the lion we find to be caused by the form of the anterior portion of the ramus in that animal, which tapers slightly forwards through the length of the molar series, while in *Felis spelæa* the alveolar and lower borders are nearly parallel (Pl. I, figs. 1, 2, C D, A E). The angle in both forms, *F. spelæa* and *F. leo,* is in reality as near as possible identical, when measured with the alveolar border C D produced backwards, *i. e.* about 30° in each case. But when the angle is measured from the lower border of the ramus A B, it is about 40° in the lion and 30° in *Felis spelæa.* This angle, however, is variable, and therefore not to be trusted to as a specific character. Another point appears to deserve more attention; it is that in *Felis spelæa* the coronoid process projects backwards far more beyond the neck of the condyle (Pl. I, fig. 1, F) than in the lion or tiger; in the former animal this excess of projection amounting to nearly an inch, while in the tiger it is barely perceptible; and, as far as we have measured, it does not exceed half an inch in the lion. The different appearance this gives to the bone is very remarkable. The superior border of the coronoid process is a strong, smooth, externally rounded ridge, somewhat stronger than that of the lion or tiger, but almost totally destitute of the strongly marked ridges which are on this part of the bone in those animals.

The angle in the larger jaw resembles that of the lion, except that in the lateral aspect it forms one end of an arch (Pl. I, figs. 1, 2, G), of which the *ramal* process (*a*) forms the other, whereas in the lion and in the small variety this aspect presents a slightly concave line (Pl. VI, figs. 1, 2, G, A). In the adult tiger the angle descends far lower, and the arch above mentioned extends without interruption to the symphysis.

The masseteroid ridge is perhaps proportionally somewhat thicker and stronger in the large jaws, and the upper external border of this portion is massive and rounded (Pl. I, fig. 1, H), instead of ending in a sharp and knotted ridge, as in the lion and tiger and smaller cave variety (Pl. VI, fig. 1, H). The contour of the lower border of the anterior half of the ramus is precisely the same in the smaller cave jaws and the lion, as well as in the large fossil jaws; but it is more concave in the tiger.

The contour at the symphysis differs in the large form of *Felis spelæa* from that of either of the others. The angle formed by the front edge of the symphysis and the produced plane of the lower border is much larger in *Felis spelæa* than in either *Felis leo* or the small cave specimens (Pl. I, figs. 1, 2, K, E, *a*). This angle amounts to 70° in *Felis spelæa*, while it is 45° in the smaller fossil forms, and 40° only in the lion; in the tiger it is 55°. This difference, though very striking to the eye, appears to be variable; it is probably of little, if any, specific value.

The alveolar border is straight in all the forms (Pls. I, VI, figs. 1, 2, C, D).

The mentary foramina are very variable in form and position (Pls. I, VI, fig. 1, I). In some of the fossil jaws they appear to be each divided so as to form four on each side; we have seen an approach to this variation in recent specimens of both lion and tiger.

We may observe here that the silky smooth surface, which is remarkable on the other more robust feline bones of the caves, is also observable on the larger jaws, while the smaller resemble in this respect those of the recent large Feles.

The jaws we have principally used in our descriptions are from Bleadon and Sandford Hill. Of these, nearly perfect specimens of both varieties exist in the Taunton Museum, being a portion of the collection of Mr. Beard. There are also in the same collection many large fragments which confirm the description taken from the more perfect specimens.

The fragments of lower jaw, showing the angle, condyle, and coronoid process (Pl. I, fig. 3), which enables us to complete the illustration of the part missing from the Bleadon jaw was obtained from the brick-earth of Crayford, in the Thames Valley, and is now in the possession of Dr. Spurrell, to whose kindness we are much indebted for the loan of the specimen. It was found in association with the tichorhine, leptorhine (Owen), and megarhine Rhinoceros, *Elephas antiquus* and *E. primigenius*, horse, red deer, bison, &c. It probably belongs to the smaller variety.

A reference to the table of dimensions will show that the measurement of this bone are not greater than those of the lion and tiger.

A second specimen from the same locality gives the extent of the alveolar border occupied by the teeth at 3·20 inches, while $\overline{PM3} = 0{\cdot}73 \times 0{\cdot}41 \times 0{\cdot}39$, $\overline{PM4} = 1{\cdot}12 \times 0{\cdot}56 \times 0{\cdot}66$, and $\overline{M1} = 1{\cdot}15 \times 0{\cdot}51$.

A third mutilated ramus from the brick-earth at Ilford, in the possession of Mr. Brady, has a circumference anterior to premolar three of 4·90 inches.

A jaw of the large form was found at Fisherton by Dr. Blackmore, and others exist in different parts of the country.

Messrs. Schmerling, Marcel de Serres, Dubrueil, and Jean-Jean describe under the name of *Felis leo*, and Messrs. Croizet and Jobert under the name of *F. antiqua*, various bones of large Feles found in the caves of Belgium and France, and in the Pleistocene deposits of the latter country, and consider them as distinct from *Felis spelæa*.

We have no doubt as to the correctness of the four first-named authors in their determination of these bones as those of *Felis leo*, confirmed as it is by the remains of that animal in the Taunton Museum, from Sandford Hill and Bleadon. We have endeavoured to show, by our analysis of the jaws of *Felis spelæa*, that, as far as indications afforded by this part of the animal are concerned, the latter is simply an extreme variation of the former, and that the differences between it and the lion are not specific, or, in other words, greater than those that occur in recent varieties of the existing lion.

Measurements of Lower Jaw. (In Inches.)	*Felis spelæa.* Taunton Museum. Figured specimen, Pl. I, figs. 1, 2., Bleadon Cavern. Bl. B. I.	The same, left ramus.	Figured specimen, Pl. VI, Sandford Hill. S. H. B. I.	The same, left ramus.	Sandford Hill Cave. S. H. B. 2.	Bleadon Cavern. B. L, B. 2.	Mendip. Williams' Collection. Wms.	Dr. Spurrell's Collection. Figured specimen. Pl. I, fig. 3. Crayford Brick-earth.	Crayford Brick-earth.	Ilford Brick-earth. Mr. Brady's Collection.	*Felis leo*, Gambia. Br. Mus.	*Felis leo*, Barbary. Br. Mus.	*Felis leo*, Coll. Surgeons, Asia, 4489.	*Felis leo*, W. A. S.	*Felis tigris*, Br. Mus.	*Felis tigris*, Br. Mus.	*Felis tigris*, Taunton. Captain Speke.	*Felis tigris*, W. A. S.
1. Symphysis to condyle	9·90	9·90	9·00	9·00	...	...	...	...	...	...	9·50	9·90	8·20	9·60	8·00	9·90	9·10	9·10
2. Circumference anterior to $\overline{PM3}$	5·40	5·21	4·08	4·05	...	...	...	...	...	4·09	4·36	4·70	3·50	4·30	3·50	4·30	4·10	4·10
3. Ditto posterior to $\overline{M1}$	5·50	5·29	4·70	4·71	...	...	...	...	...	...	4·90	5·00	4·30	5·00	4·00	4·60	4·40	4·60
4. Length of the inferior border from symphysis to angle	8·10	8·00	8·00	8·00	...	...	...	...	...	...	7·80	7·80	6·80	7·50	6·40	7·80	7·50	7·20
5. Length of exterior border of symphysis	3·60	3·60	3·00	3·00	...	...	...	...	...	...	3·20	3·30	2·50	3·60	2·70	2·80	3·10	3·50
6. Height of coronoid process from angle	5·00	...	...	...	...	...	...	4·80	...	...	4·80	4·50	3·60	4·50	4·00	5·10	5·30	4·90
7. Transverse measurement of condyle	...	...	...	...	...	...	...	2·17	...	...	2·60	2·60	1·95	2·30	1·80	...	2·50	2·60
8. Vertical ditto ditto	...	...	*0·80	*1·15	...	...	...	1·40	...	...	1·40	...	...	†0·80	0·70	1·10	†0·80	†0·65
9. Canine to $\overline{M1}$ inclusive	5·00	5·10	4·50	4·55	...	...	...	...	...	...	...	...	...	5·10	...	...	4·80	4·80
10. Canine to $\overline{PM3}$ exclusive	0·90	0·85	1·35	1·25	...	...	...	...	...	...	...	...	...	1 35	...	...	1·20	1·15
11. Molar series, length of	3·20	3·80	2·60	2·55	3·10	3·25	2·90	...	3·10	...	3·00	3·00	2·45	2·80	2·50	2·70	2·50	2·60
12. Depth of jaw anterior to $\overline{PM3}$	2·40	2·12	1·70	1·70	...	2·86	...	...	...	...	...	...	...	1·75	...	...	1·70	1·72
13. Ditto posterior to $\overline{M1}$	2·50	2·30	2·00	1·90	2·00	2·80	...	...	...	...	...	...	...	1·90	...	...	1·70	1·90
Extreme length from symphysis to end of coronoid process	10·10	...	...	...	...	...	...	...	...	...	...	...	...	9·20	...	...	9·20	9·10

* In columns 4 and 5, measurement 8 is the same in both specimens; that in column 4, is taken with calipers; that in column 5, is taken with the tape.

† In columns 15, 18, 19, the vertical measurements of the condyle (measure 8); *F. leo*, W. A. S.; *F. tigris*, Captain Speke; and *F. tigris*, W. A. S., are taken with callipers; taken with a tape they are respectively, 1·10″, 1·00″, and 0·97.″

CHAPTER II.

Felis spelæa—Fore-arm, Pl. II.

1. Ulna, figs. 5, 6, 7, 8, 9.

We have unfortunately been unable to procure the distal end of this bone.

The smaller specimens correspond so exactly with those of the lion that we are unable to perceive any difference, save a very slight diminution in size of the recent specimens, which, we believe, have been all, or nearly all prepared from animals which have lived most of their lives in cages.

The larger, however, present some differences, which, we think, necessary to describe.

The line drawn from the proximal end of the humeral articulation to the summit of the olecranon forms a more acute angle with the axis of the bone in *F. spelæa* than in *F. leo* (figs. 5, 6, 7, 8, 9, *a*, *b*).

The large humeral articulation (figs. 5, 6, 7, 8, 9, *a*, *a'*) is precisely alike in both.

The proximal radial articulation (*c*, *c'*, figs. 5, 6, 8, 9) is more nearly at a right angle with the axis of the bone in *F. spelæa* than in *F. leo,* though it still forms an angle of 60°, that in *F. leo* being 50°. In *F. spelæa* the articulation is shallowest posteriorly, in *F. leo* anteriorly.

The coronoid process *c* is strongly developed, but not more so proportionally than in the lion.

The shaft of the bone appears, from the largest fragments we have met with, to have been straighter and deeper, in proportion to the thickness in the larger, than the smaller form.

But the most marked difference to the eye is shown by the comparison of figs. 6 and 9, which show the extremes of the variation (fig. 8 being a somewhat intermediate form). It will be seen that in fig. 6 a strong ridge runs parallel to the back of the bone on the outer or radial surface (figs. 6, 8, 9, *d*, *d'*), forming a broad shallow groove which extends downwards as far as the specimens we have seen allow us to observe. It will be seen that this ridge terminates or dies away in fig. 9 a little below the radial articulation (fig. 9, *d*) ; in the recent specimens of the lion it is still less visible.

As, however, the length and prominence of the ridge appears to vary precisely as the size of the specimens, and we have examined above twenty, we cannot look upon it as a characteristic difference. Generally speaking, the surface of the bone in the larger specimens appear to present well-defined ridges with rounded contours, and smooth shallow grooves between; while the smaller and more strictly leonine forms present more angular and less defined ridges, and the grooves between appear to be more cut up by small irregular supplementary ridges.

Fragments of this bone are very numerous in collections of Somerset bones from the caves of Hutton, Bleadon, Sandford Hill, and Wookey Hyæna-den, specimens of both varieties having occurred in all. The largest number we know of together is in the Taunton Museum, from the collections of Messrs. Williams and Beard.

The only bone of the Pleistocene deposits that is likely to be mistaken for this is the same bone of the bear. The latter is, however, much straighter, and never has the broad external groove of the shaft described above. But the most marked distinction is in the proximal radial articulation, which in *F. spelæa,* as in all the Feles, invariably forms an acute angle with the axis of the bone, while in the bears it is at right angles. The form of the olecranon is also somewhat different, but its irregular form can be more easily recognised by a comparison of the plates of the bones than from the most elaborate description.

There is a figure of this bone belonging to the smaller variety in Schmerling's 'Oss. foss. de Liége,' vol. 2, pl. xix, fig. 1, and a very characteristic one figured by Marcel de Serres, &c. 'Oss. foss. de Lunel-Viel.,' pl. viii, fig. 3.

Measurements of Ulna. (In Inches.)	*Felis spelæa.*					*Felis leo.*		*Felis tigris.*
	Bleadon.			Sandford Hill.	Wookey Hyæna-den, Mr. Dawkins's figured specimen.	W. A. S.	Oxford Museum.*	Oxford Museum.*
	1. Figured specimen.	2. Apparently the pair of 1.	3.	1. Figured specimen.				
Length, extreme	...	...	...	...	...	14·75	12·62	14·0
Depth just below radial articulation, proximal	2·68	2·69	2·25	2·66	1·5	1·74	1·62	1·87
Thickness (transverse) at same point	1·05	1·00	1·17	...	1·1	0·86	0·87	0·75
Circumference at same point	6·00	6·00	5·12	6·10	6·5	4·39	3·24	4·0
Minimum circumference	...	...	...	...		2·40	2·0	2·25
Humeral articulation, vertical (linear)	...	3·00	3·40	...	2·0	2·80	1·37	1·75
Transverse humeral articulation	...	2·10	2·10	...	1·7	1·50	1·62	1·87
Radial articulation proximal, vertical — anterior	...	0·70	0·70	...	0·57	0·50	0·5	0·62
Radial articulation proximal, vertical — posterior	...	...	...	...	...	0·60		
Ditto ditto ditto, transverse	...	2·00	1·70	...	1·6	1·63	1·5	1·37
Ditto distal articulation, vertical	...	...	...	...	...	0·60	0·5	0·5
Ditto ditto ditto, transverse	...	...	...	...	...	0·60	0·6	0·62
Carpal articulation, vertical	...	...	...	...	...	0·75	0·62	1·0
Ditto ditto, transverse	...	...	...	...	...	0·48	0·37	0·5
From radial to carpal articulation, both inclusive	...	...	...	...	...	1·65	1·25	2·0

* For these measurements we are indebted to Mr. Charles Robertson, the able Demonstrator of Anatomy at Oxford.

2. Radius, Pl. II, figs. 1, 2, 3, 4.

The general form of this bone is like that of many other carnivora; the lower half is straight, while the upper is bent gently backwards in a slight curve; immediately below the proximal epiphysis it is bent sharply forwards, so that the humeral articulation which terminates the bone is set at an angle of about 70° to the axis of the bone (figs. 1, 2, 4, *a*).

The section of the bone at the distal epiphysis is nearly triangular, with the outer surface convex, while the inner is nearly flat or slightly concave, and the posterior deeply so. This section gradually passes into one which is a flat oval, rather wider on the after edge. The tuberosities (figs. 1, 4, *c*) give the bone, where they occur, a triangular section, the oval recurring just below the proximal epiphysis.

The humeral articulation is roughly oval (figs. 1, 2, 4, *a*), being produced into a blunt point on the anterior edge (figs. 1, 2, *e*). It is concave with the exception of the anterior edge, where it is vertically convex. There is a slight eminence on the external edge (figs. 1, 2, 4, *f*) which falls gradually away into the concavity of the articulation.

The proximal ulnar articulation commences just under this eminence (figs. 1, 2, 4, *f*), and is continued posteriorly round three fourths of the head of the bone to the anterior point (figs. 1, 2, 4, *e*), where it is deepest.

The distal ulnar articulation extends nearly the whole width of the bone, and forms a slightly concave oval, wider transversely than vertically, on the upper posterior edge of the distal epiphysis (fig. 3, *g*, where the edge alone is shown). This is set at an angle of 45° to the axis of the bone.

The carpal articulation (fig. 3) is roughly trapezoidal in form. The inner or ulnar edge of the articulation is bounded by a semicircular arc, and the surface is concave, the outer boundary is convex, and the inner is straight when viewed from below, while on the lateral aspect it is boldly curved vertically. The anterior edge of the styloid process is nearly semicircular; the surface of this part of the articulation is concave vertically, following the under surface of the styloid process, while it is convex transversely.

The styloid process (*i*, *i*, figs. 1, 3) is set slightly and obliquely inwards, while the process on the upper anterior edge of the epiphysis is set nearly in the plane of the greatest depth of the bone.

Some of these bones from the Somerset caves are, as far as considerable fragments allow us to judge, indistinguishable from those of the lion (fig. 4). Others, of which we figure one perfect specimen, are, as Cuvier remarks, generally far stouter in proportion to their length (figs. 1, 2, 3).

The only differences in form which we can discover in this or in numerous fragments that we have examined appear to be due to this excess in stoutness alone, and can hardly be regarded as of specific importance.

All the specimens that we have seen are from the caves of Bleadon, Sandford Hill, and Hutton, and are in the Taunton Museum.

This bone may be distinguished from that of the bear by the greater prominence of the eminence of the humeral articulation in the latter animal (figs. 1, 2, 4, *f*). This articulation is more circular in Felis than in Ursus. In the bear the ulnar proximal articulation is less pronounced and more rounded vertically; the tuberosities below this articulation are far smaller, and the bone is altogether more angular in section, more slender and flatter; the distal ulnar articulation is set nearly parallel to the axis of the bone on a small process. In the carpal articulation the strong upward curve on the internal edge altogether disappears, and the articulation is much less concave.

Schmerling, in his 'Oss. foss. de Liége,' gives good rough figures of this bone, both of the large variety (vol. ii, pl. xv, fig. 3) and of the smaller with the ulna (pl. xix, fig. 1).

Measurements of Radius. (In Inches.)	*Felis spelæa.*								*Felis leo.*		*Felis tigris.*
	Sandford Hill.		Bleadon.						W. A. S.	Oxford Museum.	Oxford Museum.
	Figured specimen.	Pair to ditto.	Large form.				Small form.				
			1.	4.	5.	6.	2.	3.			
Extreme length	12·75	...	...	...	...	...	...	...	12·40	10·37	11·0
Minimum circumference	3·50	3·50	3·85	3·60	...	...	3·10	3·10	2·66	2·5	2·75
Transverse proximal humeral articulation	1·42	1·45	1·50	1·30	...	...	1·00	...	1·09	1·12	1·12
Vertical proximal humeral articulation	2·05	2·00	...	1·95	...	...	1·50	...	1·42	1·5	1·62
Vertical proximal ulnar articulation	0·55	0·54	0·80	...	...	...	0·42	...	0·48	0·5	0·5
Transverse distal ulnar articulation	1·18	1·16	...	...	...	1·00	...	...	0·95	0·37	0·75
Vertical distal ulnar articulation	0·60	0·67	...	...	...	0·60		...	0·70	...	...
Transverse carpal articulation	1·40	1·36	...	...	...	1·40	...	...	1·05	1·0	1·12
Vertical carpal articulation	2·48	2·40	...	...	2·75	...	...	...	1·81	1·62	1·87
From proximal articulation to tuberosity, both inclusive	2·30	2·35	2·60	...	...	...	1·90	1·92	2·10	...	...

CHAPTER III.

Felis spelæa—Os innominatum, Pl. III, fig. 1.

We have met with but four specimens of this bone from the British Pleistocene deposits, all more or less imperfect. Of these, three were obtained by Messrs. Williams and Beard out of the bone-caverns of the Mendip Hills, and are preserved in the Taunton Museum, while the fourth and largest, which we figure, is derived from the brick-earth on the south side of the Thames Valley, at Slade Green, near Erith, in Kent, and is in the national collection. It consists of the ilium and ischium, tolerably perfect, and a portion of the os pubis of the left side.

The ilium may be described as resembling the blade of an oar in form, slightly concave on the external, and nearly flat on the internal or sacral surface; the parts answering to the crest (fig. 1, *a*, *a′*) and spinous processes (*b*, *b′*, *b″*) forming the strong rounded and raised border of the blade. The external surface is traversed by a longitudinal ridge (*c*, *c′*) that strengthens the attachments of the glutei muscles. This ridge is very slightly developed in the specimens from the Mendip caverns, while in that figured it reaches a maximum development. The symphysis of the sacrum extends slightly along the upper edge of the shaft or body, and takes the form of a small spine or process at *b*. This shaft or body (*c*, *d*) is massive, and of great strength, flattened internally and rounded externally, and ending inferiorily in a sharp free edge (*d*). The anterior inferior spinous process (*e*) varies in form and size in the different individuals, but bears a general resemblance to that of the lion.

The portion (*f*) of the os innominatum that composes the apex of the sacro-ischiatic arch immediately above the acetabulum is convex and rounded, and without any ridge. It forms the connection between the shafts of the ilium and ischium. That of the latter (*g*, *h*) is prismatic in form, tapering posteriorly and expanding downwards and transversely into a broad triangular blade, the anterior edge of which forms the posterior boundary (*i*) of the pubic arch. The ischial spine (*k*) is a small pyramidal process immediately above the posterior edge of the acetabulum.

The shaft of the pubis (*l*, *m*) is convex externally and flat internally, and in some of the fossil specimens is proportionally more massive than in those of the lion and tiger, with which they have been compared. The acetabulum is proportionally larger, and the cotyloid notch (*n*) shorter in the spelæan than in the recent lion.

With these two exceptions, a close comparison of the spelæan ossa innominata with those of the recent large carnivora proves that the only difference between the pelvis of *F. spelæa* and *F. leo* and *F. tigris* is one of merely size. We are unable to detect any specific differences between the pelves of the two latter animals.

We have given a figure (fig. 2) of the pelvis of *F. tigris* in the British Museum, three fourths of the natural size, to show the far greater size of that of the *Felis spelæa.*

Measurements of Os Innominatum. (In Inches.)	*Felis spelæa.* Thames Valley, Slade Green. Br. Mus.	*Felis spelæa.* Sandford Hill, Taunton Mus.	*Felis leo.* 112 L. Brit. Mus.	*Felis leo.* W. A. S.	*Felis tigris.* 114 L. Brit. Mus.	*Felis onca.* Brit. Mus.	*Felis leopardus.* Brit. Mus.	*Felis concolor.* Brit. Mus.
Total length	14·50	13·25	11·75	11·50	12·2	9·00	7·70	7·51
Vertical height of ilium	3·50 ?	3·25	2·48	2·92	3·80	2·00	1·64	1·45
Minimum height of ischium	2·00	1·75	1·40	1·45	1·60	1·40	1·03	0·75
Maximum thickness of ischium	0·95	0·98	0·47	0·77	0·80	0·55	0·50	0·36
Transverse diameter of acetabulum	2·25	2·25	1·54	1·75	1·75	1·23	1·15	0·97
Longitudinal diameter of acetabulum	2·20 } 7·30	2·25 } 6·75	1·52 } 5·66	1·75 } 5·50	1·60 } 5·95	1·25 } 4·30	1·15 } 3·90	0·99 } 3·89
Acetabulum to end of ischium	5·10	4·50	4·14	3·75	4·35	3·05	2·75	2·90
Acetabulum to end of ilium	7·42*	6·75*	5·90	6·00	6·00	4·75	4·02	3·70
Minimum circumference of ischium	5·40	4·72	3·35	3·60	4·05	2·77	2·44	2·35
Minimum circumference of ilium	7·10	5·90	4·10	4·92	5·25	3·60	3·25	2·95
Depth of ischium	...	...	2·0	3·40	2·40	1·50	1·05	0·95
Semidiameter of ischium	...	...	2·37	2·85	2·75	2·30	1·92	1·37
Pelvic height	...	...	2·70	3·90	2·90	2·25	1·90	1·75
Semipubic diameter	...	...	1·33	1·80	1·50	1·00	1·25	1·05
Semi-iliac diameter	...	...	2·30	3·00	3·00	1·38	2·05	1·55

* These ilia are both imperfect. This proportion would be generally the same as in the lion.

CHAPTER IV.

Felis spelæa—Tarsus, Pl. IV.

Astragalus, fig. 1.

The astragalus of *Felis spelæa* is precisely like that of the lion and tiger in form, but, with the exceptions of certain specimens which we shall notice, is much superior in size to those of either of the latter two animals we have met with.

The tibial or proximal articulation (fig. 1, *a*, *a′*) is of the usual pulley-like form; it is inclined to the antero-posterior diameter, at an angle of about 30°; at the back of this are set the two articulations for the calcaneum, the outer being concave and somewhat broader at the top than the bottom, and this matches the great sigmoid articulation; the other is subtriangular and matches the small lateral circular articulation (*e′* of fig. 2) of the calcaneum. These three articulations are the surfaces of the head or proximal portion of the bone.

This is connected with the navicular or distal articulation (fig. 1, *b*), by a short shaft or neck, as in all the other digitate carnivora.

This articulation is suboval in form, and bent vertically and diagonally, so that it is highly convex, and matches well the deep concave articulation of the navicular bone.

The only cave fossil that is likely to be taken for this bone is that of the bear. But the latter is easily distinguished by the extreme shortness of the neck or shaft joining the proximal and distal portions of the bone. The pulley-groove of the tibial articulation is also flatter in the bear, and on the inner posterior edge this articulation is terminated by a sort of spur rising at right angles to the surface, which does not exist in the Feles.

Among the many specimens of this bone that have occurred to us there are some in the Taunton collection which are much smaller than the rest, and very little exceed those of a large lion in size. They do not, however, offer any other difference.

MEASUREMENTS.[1]

No.	Felis spelæa.						Lion W. A. S.	Lion 112 L. Br. Mus.	Tiger 114 L. Br. Mus.
	Bleadon.					Sandford Hill.			
	L. 1.	1 R.	2 R.	1 L.	2 L.				
1	3·20	3·17	3·00	2·80	2·70	3·20	2·35	2·25	2·51
2	4·20	4·25	3·62	3·14	2·25	3·75	3·10	3·05	3·40
3	1·86	1·82	1·61	1·49	1·42	1·62	1·09	1·01	1·22
4	3·33	3·33	3·68	2·79	2·45	3·15	2·30	2·09	2·22
5	1·70	1·68	1·46	1·31	1·31	1·40	1·50	1·40	0·94
6	1·30	1·28	1·26	1·00	1·02	2·00	0·90	1·10	1·27

The 4th and 5th specimens in the above list are of the small variety above mentioned.

The specimen figured is the first in the above list of measurements. It is with many others in the Taunton collection, from Bleadon cavern. Others have occurred to us from Sandford Hill and Oreston.

Calcaneum, fig. 2.

The general form of the calcaneum of *Felis spelæa*, like that of all the Feles, and of most, if not all, the digitate carnivora, is nearly straight from the bulb which forms the attachment of the tendo Achillis (fig. 2, *a*) to the cuboidal articulation (fig. 2, *b*). From this bulb the bone slightly increases in size to the upper part of the outer astragaline articulation, at which point is the maximum vertical measurement (fig. 2 *c′*).

The posterior boundary is generally a gentle convex sweep through the whole length of the bone; in some specimens this becomes nearly straight or even very slightly concave as it approaches the bulb for the tendo Achillis. The outer astragaline articulation (fig. 2, *c*, *c′*) is a broad sigmoidal surface, bent backwards vertically on itself. Near the level of the middle of this surface a stout process rises laterally, at right angles to the body of the bone (fig. 2, *d*, *e*), and supports at an angle of about 30° to the axis, a nearly circular surface, which is the inner astragaline articulation (fig. 2, *e*). In the form of this articulation it resembles the lion, that of the tiger being transversely oval. The mass of bone which connects these with the cuboidal articulation is nearly cubical in form, and has on the external surface the prolongation of the cuboidal groove for the tendon of the *peroneus*

[1] In this, as in all cases throughout these monographs, when the numbers alone are given, the measurements are—1, extreme length; 2, minimum circumference; 3, virtual measurement at the proximal articulation; 4, transverse ditto ditto; 5, vertical measurement of distal articulation; 6, transverse ditto ditto.

longus (fig. 2, *f*). The cuboidal articulation (fig. 2, *b*) terminating the bone distally at right angles to the axis forms a nearly circular surface, a portion of the circle being cut off by a chord, which forms the inner posterior boundary of the articulation. If this cord were slightly bent, it then would approximate very closely to the recent leonine form, which is nearly an oval.

The attachment of the tendo Achillis is formed by the process rising on the inner edge of the bone at right angles to the rounded terminal surface (fig. 2, *g*). In this it appears to differ slightly from that of the lion, for in that animal the groove formed by the two surfaces is replaced by a nearly flat or slightly rounded surface at an angle of about 45° to the axis.

The only differences which we can observe between the corresponding bones of this animal and the tiger are that mentioned above, and the rounded or oval form of the cuboidal articulation in the former, while in the latter it forms a quarter circle.

Among the large number of calcanea we have examined, we find three or four which do not appear to differ in any respect from those of lion, with the exception of being very slightly larger, the difference of size in general being very great. That figured probably belonged to an aged animal, the outer portion of the bone being roughened by exostosis.

Measurements of Calcaneum. (In Inches.)	*Felis spelæa.*							Lion.		Tiger.
	Bleadon.				Sand-ford Hill.	Bleadon.		W.A.S.	Br. Mus. 112 L.	Br. Mus. 114 L.
	1*	2	9	11	19	12	13			
1. Total length	5·60	5·24	5·34	5·00	5·01	4·52	4·48	3·90	4·00	4·30
2. Minimum circumference	4·73	4·24	4·30	4·40	4·30	3·90	3·70	3·30	3·15	3·45
3. Maximum vertical measurement	2·36	2·10	2·08	2·27	1·82	1·87	1·80	1·59	1·60	1·77
4. Maximum transverse ditto	2·38	2·06	2·10	1·97	2·03	1·80	1·70	1·67	1·45	1·64
5. From inner articulation to the outer end of the bone, articulation included	3·95	3·70	3·90	3·68	3·77	3·36	3·45	3·13	2·90	2·74
6. Sigmoidal articulation, transverse measurement	0·92	0·82	0·82	0·85	0·75	0·74	0·72	0·60	0·55	0·64
7. Cuboidal articulation, transverse measurement	1·32	1·30	1·45	1·38	1·30	1·10	1·25	0·90	1·02	0·92
8. Ditto ditto, vertical	1·17	1·13	1·26	1·15	1·17	0·95	0·93	1·02	0·82	0·85
9. Inner astragaline articulation transverse	0·81	0·80	0·84	0·88	0·79	0·68	0·68	0·71	0·70	0·73
10. Inner astragaline articulation, vertical	0·74	0·70	0·72	0·74	0·55	0·70	0·57	0·67	0·69	0·55

The specimen figured is from Bleadon, and evidently belongs to the same individuals

* Specimen figured.

as the cuboid, astragalus, &c., which we have figured; it is at Taunton, with many others, from the collection of Mr. Beard. The adult bones are from Bleadon and Sandford Hill, and the same bone of young animals from Bleadon and Hutton.

Naviculare, fig. 3.

This bone, as its name denotes, is somewhat boat-shaped, the upper concave and nearly circular surface forming the articulation for the astragalus (fig. 3, *a*), and the two flat inferior surfaces, slightly inclined to each other (fig. 3, *b*, *c*), forming those for the ecto- and meso-cuneiforms (figs. 5, 6), while a slightly rounded surface on the inner side forms the proximal attachment for the endocuneiform (fig. 3, *d*).

The hinder portion of the astragaline articulation is curved sharply upwards, and this portion is supported by a process (forming, as far as this bone is concerned, the upper border of the great tarsal groove for the *peroneus longus*), which is generally much slighter in *Felis spelæa* than in lion or tiger, it being proportionately the largest in the latter of these three animals. This forms the only appreciable difference observable in this bone except size between them.

It is distinguished from the corresponding bone of the bear by the somewhat greater thickness and by the greater development of the upward prolongation of the astragaline articulation, and also by the more decidedly circular form, as contrasted with the oblong and somewhat angular plan of that of the latter animal.

Measurements.

	Felis spelæa. Bleadon.			Lion, W. A. S.	Lion, Br. Mus. 112 L.	Lioness, Col. Surg.	Tiger, Br. Mus. 114 L.	Tiger, Col. Surg.
1	0·75	0·66	0·66	0·65	0·63	0·59	0·55	0·56
2	5·45	5·00	4·77	4·03	4·20	3·98	4·90	4·35
3	1·24	1·20	1·15	0·98	0·91	0·90	0·91	0·97
4	1·79	1·54	1·50	1·38	1·17	1·10	1·25	1·20
5	1·33	1·27	1·26	1·02	1·02	1·00	1·06	1·00
6	1·94	1·66	1·51	1·00	1·10	0·91	1·00	0·83

The bone figured is from Bleadon, and is at Taunton; it probably belongs to the same animal as the astragalus, calcaneum, &c.; but it is from the right paw, and for the sake of uniformity is reversed in the plate. Schmerling gives two good figures of this bone, showing the proximal and internal surfaces ('Oss. foss. de Liége,' t. ii, pl. xvii, fig. 4).

Cuboid, figs. 4, 4′, 4″.

The general form of this bone is well expressed by the name, the bounding surfaces being roughly at right angles to each other; the distal surface, however, being larger than the proximal.

The outer and posterior or lower surfaces are traversed, diagonally and downwards, by a deep groove for the tendon of the *peroneus longus* (figs. 4, 4′, 4″, *b, b*); a continuation of the groove being formed on the outer and distal surface of the calcaneum in an upward direction, and by the hook of the ectocuneiform and the process on the hinder part of the naviculare in the opposite and transverse direction.

The proximal or calcaneal articulation (fig. 4, 4′, *c*) is nearly flat and subcircular. The distal or metatarsal articulation (fig. 4, 4″, *d*) is concave, and may be described as an oval, the outer side being bent inwards so as slightly to resemble a B in outline, while that of the ectocuneiform is trapezoidal and nearly flat (fig. 4, 4′, *a*).

The difference in size is the only difference we can remark between this bone and that of the recent lions and tigers. In some specimens of tigers we have observed a disposition in the tarsal articulations generally to separate up into small surfaces, whereas in the lion and *Felis spelæa* they appear to coalesce to a greater extent, and this is especially the case in the cuboid.

Measurements.

	Felis spelæa, Bleadon, Taunton.	Lion W. A. S.	Lion, Br. Museum, 112 L.	Lion, Col. Surg.	Tiger, Br. Mus., 114 L.
1	1·39	1·04	1·00	1·05	1·10
2	4·22	3·00	3·25	3·80	3·27
3	1·36	0·70	0·86	0·90	0·90
4	1·36	1·00	0·61	0·68	0·78
5	1·20	1·00	0·81	0·82	0·76
6	1·24	0·98	0·86	0·82	0·94

The only specimen we know of is from Bleadon. It evidently belongs to the same individual as the calcaneum and several other bones of the tarsus, which we have figured.

Schmerling gives rough figures of this bone, apparently taken from an imperfect specimen. They appear to be the external and posterior views, but one of them is reversed in position ('Oss. foss. de Liége,' t. ii, pl. xvii, fig. 5).

Ectocuneiform, figs. 5, 5′.

This bone has a wedge-shaped body, the superior surface (fig. 5) forming the head of the wedge, and the inferior or plantar the vertical edge. The flat navicular proximal (figs. 5, 5′, *a*) and slightly concave distal metatarsal (figs. 5, 5′, *b*) articulations are both nearly isosceles triangles. From the inferior surface of the bone a very stout hook-shaped process is developed (fig. 5′ *c*), that advances forwards to terminate in a rounded boss. This *hamular* process affords attachment to the plantar ligaments that extend to the cuboid and meso- and ectocuneiform, and to the *tibialis posticus* and *flexor pollicis* muscles. In all the British specimens of the bone that we have seen, the hamular process advances forward within a short distance, from 0·10 to 0·20 inch of the plane of the distal surface, and in no instance as far as the distal plane. This also is borne out by the examples from the cave of Gailenreuth, in the collection of the Earl of Enniskillen, F.R.S., to whose courtesy we are indebted for the examination of his museum.

A large series of ectocuneiforms belonging to lions and tigers, in the museums of London and Oxford, shows, as one might naturally expect, considerable variations in the development of the hamular process; and while we find many ectocuneiforms of lion that cannot, in this or any other respect, be differentiated from those of tiger, yet, on the whole, it has a smaller distal extension in the former than in the latter (fig. 5″, *c*). The maximum distal extension is seen in the specimen of tiger in the British Museum figured fig. 5‴, *c*, in which it extends as far down as the plane of the distal articulation. We must admit, therefore, that while the development of the hamular process in the ectocuneiform of *Felis spelæa* is no absolute test of leonine or tigrine affinities, yet that it points rather in the direction of the former than the latter.

Measurements.

	Felis spelæa.			Lion.			Tiger.	
	Bleadon.		Sandford Hill.	Col. Surg.	Br. Mus. 112 L.	W. A. S.	Br. Mus. 114 L.	Col. Surg.
1	0·83	0·81	0·96	0·64	0·70	0·70	0·80	0·74
2	3·95	3·52	4·00	2·77	2·90	3·10	3·25	3·05
3	1·05	0·87	1·00	0·82	0·62	0·90	0·70	0·80
4	1·05	1·02	1·04	0·98	0·95	0·93	0·94	1·12
5	1·08	0·98	1·04	0·85	0·80	0·93	0·90	0·80
6	1·36	1·19	1·45	1·00	1·03	1·11	1·15	1·14

The specimen figured is the first in the list of measurements, reversed in order to get the most perfect representation on the same side as the rest of the tarsus.

The three specimens measured formed part of the collection of Mr. Beard, and are now at Taunton. There is a good rough figure of the distal articulation of this bone in Schmerling ('Oss. foss. de Liége,' t. ii, pl. xvii, fig. 6).

Mesocuneiform, fig. 6.

This small bone has the proximal and distal articulations slightly inclined to each other, and wider apart internally than externally. The proximal or navicular articulation is roughly oval, but slightly pointed anteriorly, and is slightly concave transversely and convex vertically, while the metatarsal or distal is wider anteriorly than posteriorly, and is very slightly concave vertically.

The inclination of the articulations one to the other, and other minute points in the form of the bone, appear to differ in different individuals of lion and tiger; consequently the slight difference we observe between the only specimen we know of this bone in *Felis spelæa* and the above two animals is probably not of specific value. Generally speaking, however, it appears to be a shorter and thicker bone altogether in the fossil than in either of the recent large species.

It may be easily distinguished from the corresponding bone in the bear by the greater squareness and angularity of the anterior or upper face of the bone in that animal, as contrasted with the rounded and oval form in *Felis spelæa.*

Both distal and proximal articulations in the bear are also much more concave, and the articulation for the endocuneiform is well developed, whereas scarcely a trace of it exists in *Felis spelæa.*

Measurements.

	Felis spelæa, Bleadon, Taunton Col.	Lion.		Tiger.	
		Br. Mus. 112 L.	Col. Surg.	Br. Mus. 114 L.	Col. Surg.
1	0·55	0·39	0·35	0·61	0·51
2	2·90	2·10	1·89	2·00	2·40
3	0·54	0·40	0·35	0·43	0·42
4	0·91	0·66	0·70	0·68	0·68
5	0·50	0·46	0·42	0·54	0·52
6	1·02	0·72	0·65	0·69	0·79

The specimen figured is from Bleadon, and probably belonged to the same individual as the astragalus, calcaneum, naviculare, and cuboid, which we have figured. It is at Taunton. We know of no other figure of this bone.

Endocuneiform, fig. 7.

It is with considerable hesitation that we give a figure of this bone. The general form and surface resemble the same bone in the lion and tiger, but there are differences which make us doubtful whether we have assigned the bone its right place. It has lost the proximal epiphysis. If this is restored as a feline endocuneiform (fig. 7, *a*), it would then be very similar to the same bone in lion and tiger; but the anterior portion of the distal articulation points downwards in an acute angle, whereas in lion it points nearly directly forwards in a right angle.

The articulation also is slightly convex in our bone, whereas it is slightly concave in that of the lion. Unfortunately, the corresponding articulation of metatarsal 1 is broken in the only specimen we know of, so that we cannot say whether this bone showed a corresponding variation in form. We think, however, that attention should be drawn to the bone, in the hope that some one, more fortunate than ourselves, may discover a perfect specimen, and decide whether we are right or wrong in our determination.

The only specimen we have being imperfect, we give no measurements. It is from Bleadon, and is in the Taunton Museum.

We know of no other figure of this bone.

CHAPTER V.

Hind Paw, Pl. V.

The metatarsals of the carnivora are so well known, and so much resemble each other in the digitate forms, that comparative anatomists are generally content to refer to the figures of those bones rather than to attempt to discriminate them by descriptions, which must all very closely resemble each other. If we attempt the course which, in nearly all other portions of the skeleton, is held to be absolutely requisite, it is with the view of doing what we can to render the descriptive portion of our work as perfect as we can, rather than to trust to bare figures.

Metatarsal 1, fig. 1.

It is well known that the first metatarsal of the genus Felis is rudimentary. In fact, it would be difficult for one not acquainted with the bone in question to recognise it as a metatarsal at all.

In *Felis spelæa* it is a small wedge-shaped bone, the wedge thinning off anteriorly to an edge, and distally to a blunt point. The internal surface is slightly rounded; but the external is flat, and the posterior is irregular. The articulation for the endocuneiform is slightly concave transversely and convex vertically; and, as we suppose, from the corresponding bone in the lion, it would be furnished with a small hook-shaped process on the external[1] and posterior edge. This part is mutilated in our only specimen (fig. 1, *a*). In other respects it does not differ appreciably from that of the lion, except that in that animal the articulation is flatter.

The specimen figured is from Bleadon, and is in the Taunton collection, and is reversed from the left paw.

We have to repeat what we have written respecting other specimens of various

[1] Internal and external, in these descriptions, are invariably used in reference to the position of the whole limb in the skeleton, and not to the position of the bone as to the joint.

parts of large Feles from the Somerset caves, that there occur metatarsals which, both in size and form, so exactly resemble those of the recent lion, that they cannot be distinguished from them. (We have observed, however, a tendency in those of the tiger to a greater proportional development in the antero-posterior direction of the proximal articulation, which appears generally to distinguish the metatarsals of that animal from the other two large feline animals.) But in all the Pleistocene deposits there occur, but not numerously, except in the Somerset caves, bones of larger size. The set which we have figured evidently belonged to the same animal, though metatarsal 3 is reversed from the left paw. They were found by Mr. Beard, with many other parts of the same skeleton, in Sandford Hill Cave, in the Mendip, and are now in the Taunton collection. Some larger specimens from Crayford, in the valley of the Thames, are figured in Pl. VIII. They belong to Dr. Spurrel, and are nearly, if not quite, equal to the largest German specimens. They differ from those we have figured in Pl. V by having the distal articulations comparatively much smaller, as well as by their tapering more and being more bent. We have observed similar variations in some of the cave specimens, as well as in the metatarsals of recent lions and tigers.

Metatarsal 2, fig. 2.

The shaft of the second metatarsal is somewhat triangular in section, the sides being flatter towards the proximal and becoming more convex towards the distal articulation, so that the bone then becomes almost cylindrical. The shaft is slightly curved backwards, the outer boundary, or that facing metatarsal 3, being nearly straight, and the inner, or that facing metatarsal 1, being curved slightly inwards, so that the bone appears to bend slightly in that direction.

The proximal articulation for the mesocuneiform (fig. 2, *a*, *b*) is nearly at right angles to the axis of the bone. It forms a roughly triangular surface, of slightly double curvature from front to back, where it ends in a small spur, curving sharply upwards (*b*, fig. 2). The surface is concave, in a transverse direction.

The point of contact with metatarsal 1 can hardly be called an articulation; it is slightly smoothed, and is supported by a small process (*c*, fig. 2), a short distance below the proximal articulation, on the inner front edge of the bone.

The ectocuneiform articulations, together with those for the third metatarsal, form two very slightly concave oval surfaces at right angles to the proximal articulation, and continuous in direction with the outer surface of the bone. Each of these surfaces is divided by an horizontal ridge, very slightly marked; the upper part of each belongs to the ectocuneiform, the lower to the third metatarsal. The anterior edge of the anterior of these is bent outwards, so that the front of the bone presents the angular projection (fig. 2, *d*, *e*), and when the metatarsals are applied to each other the point *d* rests on the point *a* (fig. 3).

The distal or phalangeal articulation is, unfortunately, mutilated in all the specimens of this bone that we have seen; but it probably resembles that of the lion, excepting that the lateral development of the internal process (*g*, fig. 3) appears to be much less in the large cave form than in the recent. It probably, like that of the lion, had the outer surface of the bulb much flatter and more deeply indented than in the other metatarsals.

Metatarsal 3, fig. 3; and Pl. VIII.

The shaft of this bone is cylindrical, slightly flattened on the front surface; it is very slightly bent backwards, and expands slightly laterally at the distal epiphysis. The proximal or ectocuneiform articulation is very flat (fig. 8, *a*, *b*), and inclined at an angle of about 60° to the axis of the bone downwards and inwardly, being at right angles to the front surface. It is bounded anteriorly by the curved front edge of the bone, inwardly by a waved line, posteriorly by a very small spur, rising from the surface (fig. 8, *c*), and externally by a waved line like the internal boundary, but set at a right angle to the front, while the internal is at an acute angle with the same. The articulations for metatarsal 2 are the small polished heads of two small eminences, corresponding with the summit of the internal waves above mentioned; while those for metatarsal 4 are two larger oval surfaces, on the opposite side of the bone, the anterior lining the surface of a hollow facing diagonally backwards and downwards, the anterior edge of which forms the boundary of the front external expansion of the proximal extremity of the bone (fig. 3, *b*, *d*), while the posterior articulation is a flat surface, facing directly outwards and upwards. This, with the posterior articulation for metatarsal 2, and the posterior portion of the proximal articulation, are supported by a large process, the lower part of which gradually slopes into the body of the bone.

The bulb-shaped phalangeal or distal articulation is proportionally wider than that of the recent lion, but is in other respects precisely similar.

Metatarsal 4, fig. 4.

This bone is somewhat more bent than metatarsal 3, and the section is somewhat more angular, giving a square section just below the proximal epiphysis. It is rather more bent backwards than metatarsal 3, and in the slightest degree outwards. The proximal or cuboidal articulation (fig. 4, *a*) is rhomboidal and convex, both in transverse and vertical directions, and is bounded posteriorly by a shallow groove and small spur.

Of the internal articulations for metatarsal 3, the anterior (fig. 4, *b*) is a convex surface passing into a concave towards the ridge which separates it from the cuboidal articulation; it rests posteriorly on a slight process, and faces inwards, upwards, and towards the front. The posterior of these articulations (*c*) is slightly convex and oval in form, and faces backwards, inwards, and downwards, and is, like the corresponding articulation on metatarsal 3, supported on a massive posterior process.

The articulations for metatarsal 5 much resemble those corresponding with them on metatarsal 3, but they are more concave; and the posterior, instead of facing slightly upwards, faces directly outwards, or rather a little downwards. The distal articulation corresponds with that of the lion, except that it is slightly wider in proportion to the depth.

Metatarsal 5, fig. 5.

This bone is cylindrical, passing upwards into a triangular section, and downwards into an oval, wider transversely than in a vertical direction. The cuboidal or proximal articulation is a small oval surface, inclined to the axis of the bone (*a*, *b*, fig. 5), and slightly concave transversely, and convex in an antero-posterior direction. It is bounded, externally, by a high, strong ridge or crest, which passes from the front, round the outside to the back of the bone, where it terminates just above the posterior articulation for metatarsal 4 (*e*, *f*).

The anterior articulation for metatarsal 4 (fig. 5, *c*) much resembles the corresponding articulation already described in that bone; but the posterior (fig. 5, *d*) is a small, irregularly formed surface, the facing of which is generally backwards, inwards, and upwards. The form of the distal articulation corresponds exactly with that of the lion, being flattened internally, and extended laterally in an outward direction, but it shows the same slight difference in the greater transverse diameter.

This bone in the specimens we have examined is more bent outwards and backwards than in the recent lion and tiger.

In general, these bones may be easily distinguished, when perfect, from those of the bear, by the smaller proportional length, as well as by the far greater proportional size of the proximal end of the bone in *Ursus*. This gives these bones in the bear a taper shape, quite different to the solid, strong-looking bones of *Felis spelæa*. For the details of difference we refer to our descriptions, measurements, and figures—

Measurements.

Metatarsal 1 being mutilated, we cannot give measurements.

	Specimen figured. S. H. B. Taunton.	Bl. B. Taunton.		*Felis tigris*, Brit. Mus. 114 L.	*Felis tigris*, College of Surgeons.	*Felis leo*, College of Surgeons.	*Felis leo*, W. A. S.
Metatarsal 2.	Inch.	Inch.		Inch.	Inch.	Inch.	Inch.
1	4·92	...	...	4·04	4·25	4·08	4·66
2	2·18	2·36	...	1·75	1·60	1·45	1·72
3	0·91	0·70	...	0·60	0·59	0·56	0·63
4	1·30	1·50	...	1·15	0·98	0·78	1·00
5	...	...	...	0·84	0·71	0·65	0·85
6	1·80	...	...	1·60	1·45	1·37	1·60
Metatarsal 3.		4 Bl. B. Taunton.	5 Bl. B. Taunton.				
1	5·50	5·40	5·94[1]	4·97	4·88	4·53	5·20
2	2·40	2·20	2·55	1·98	1·78	1·60	1·83
3	1·10	1·05	1 27	0·98	0·98	0·83	0·94
4	1·50	1·37	...	1·32	1·32	1·17	1·24
5	1·00	0·90	0·86	0·84	0·78	0·70	0·80
6	2·20	1·80	1·80	1·60	1·15	1·40	1·70
Metatarsal 4.							
1	5·60	...	...	4·95	4·55	4·54	5·30
2	2·30	...	...	1·80	1 58	1·51	1·65
3	0·84	...	...	0·62	0·68	0·67	0·70
4	1·60	...	...	1·23	1·20	0·94	1·30
5	1·98	...	...	1·78	0·61	0·65	0·78
6	2·00	...	...	1·55	1·50	1·50	1·75
Metatarsal 5.		2 Bl. B. Taunton.					
1	5·20	...	...	4·33	4·05	4·20	4·60
2	1·87	1·26	...	1·37	1·53	1·40	1·37
3	1·00[2]	1·30	...	0·72	0·83	0·57	0.75
4	0·90[3]	1·10	...	0·74	0·90	0·83	0·82
5	0·80	...	...	0·64	0·72	0·63	0·63
6	1·80	...	...	1·38	1·53	1·26	1·50

Phalanges, Pl. V., figs. 6 to 14.

We have had in the Taunton Museum, and in other places, abundant means of examining the phalanges of *Felis spelæa*. The well-known difficulties of assigning to each

[1] The largest Somerset specimen.

[2] Both 4th metatarsal articulations inclusive.

[3] Across cuboidal and metatarsal articulations.

first phalange the correct digit have been felt by us; and, though we give figures of specimens in the order in which we believe them to occur, we are by no means confident that we are right in all, particularly as the great variation in size has added to our difficulty in that respect.

Generally speaking, the first phalanges of *Felis spelæa* present the usual characteristics of the genus. The deeply concave proximal articulation, the border of which is broken by a deep depression posteriorly (figs. 6, 7, 8, 9, *a*, *b*), the pulley-like distal articulation, and the strongly marked muscular attachment on the lower surface, are common alike to the Felidæ and to the other carnivora; whereas, the less taper form of the shaft, swelling out laterally and frontally on the anterior surface towards the distal epiphysis (figs. 6, 7, 8, 9, *c*, *d*), the deeper proximal articulation, and the less strongly marked muscular attachments below, distinguish the feline phalanges from those of the bear's, which are, as far as this species is concerned, the only phalanges that are likely to be confounded with them.

As we state above, the great variety in size added much to the difficulty of determining the proper place of each phalange, but we came to the determination to trust to form alone, and to figure the largest of each form which we found most to resemble the corresponding bone in the lion.

Most of the phalanges we have seen are from that great depository of feline remains, Bleadon Cavern, in the Mendip, though we have good specimens from Sandford Hill, Oreston, Caldy, and other places.

The phalanges of the hind paw may easily be distinguished from those of the front by the superior stoutness in proportion to their length; the flexure also is not so great. There is but little difference, except in size, between those of digits 3 and 4; but we have always found that of digit 2 curved at least slightly, but sometimes considerably, outwards towards the centre of the paw, and to have the distal articulation set at an inward angle of about 60° to the shaft of the bone (fig. 6, *e*). This angle is sometimes, but not always, followed in the corresponding phalange of digit 3 (fig. 7, *e*); that of digit 4 being always at right angles (fig. 8, *e*), and that of digit 5 being set inwardly also at an angle of about 60° (fig. 9, *e*). This last digit is always strongly curved inwards. The outer may be distinguished from the inner side, in all the digits, by comparing the form of the sides of the posterior depression in the border of the proximal articulation. The angle at the summit of the outer side is nearly a right angle (figs. 6, 7, 8, 9, *a*); the inner side is more or less sloped, so that this angle at the summit is obtuse (figs. 6, 7, 8, 9, *b*).

All those we figure are from Bleadon, and are nearly, if not quite, equal in size to the largest we have seen elsewhere, and are vastly superior in size to those of any living *Feles;* but there are many fossil specimens of phalanges which do not differ in size or proportion from those of the existing lion and tiger.

Second Phalanges, Pl. XI, figs. 10 to 13.

The second row of phalanges of *Felis* may, as is well-known, be easily distinguished from those of other carnivora, by the peculiar outward turn of the distal articulation, which is so formed that the last or ungual phalange may fall back on the outside of the second so as to allow the claw to point upwards and protect its point from injury when retracted.

We are unable to give any rule for placing the phalanges of each digit in order, except that the distal articulation of digit 2, and sometimes also that of digit 3, is not at right angles to the axis of the bone, but at an angle of from 15° to 30°, as represented in fig. 10 *a*. That of digit 5 is generally shorter and stouter, in proportion, than the others. We have figured the largest of each form that we have met with. They are all from Bleadon; they occur also from the Sandford Hill Cave, and from Oreston, Caldy, Ilford, and a great many other localities.

The bone may be represented as triangular in section, from the distal to the proximal epiphysis, gradually expanding from the former to the latter. The proximal articulation is triangular in form, the inner and outer sides being convex, and the posterior deeply concave, having a deep pit within the concavity. It is divided by a ridge into two lateral concave portions, corresponding with the convexities of the distal articulation of the first phalange, and ends anteriorly in a truncated spur, pointing forwards and upwards.

The distal articulation is, as is well known, a cylindrical roll, set transversely on the end of the bone, narrower in front than posteriorly, so that one end projects outwards considerably, and at a varying angle to the axis.

The same rule may be given for the determination of those of the hind paws, by their superior stoutness, in proportion to their length, as we have given for the first phalanges.

Third Phalanges, Pl. XI, fig. 14.

The third or terminal phalange is a bone of rare occurrence. Five examples have occurred to us from English deposits; they are all from Bleadon. But one of them is in a sufficiently perfect state to figure and describe. It is probably that of the smaller hind toe. The lateral aspect may be gathered from the fig. 14, *a* being the articulation, the point of attachment of the tendons of the flexor, and *c* that for those of the extensor or retractile muscles. The large triangular portion which extended beyond these points is a hollow sheath, which contains within it at *d* a strong core, upon which the claw is fixed, so that it is kept firm in its place by the sheath. The form of the whole of these phalanges is alike, and we can find no difference between those of either the fore or hind paw, except size, that of the thumb of the fore paw being enormous. One of these from Gailenreuth is in the possession of Sir P. De Grey Malpas Egerton, Bart., M.P., F.R.S., and measures 2·5 inches in antero-posterior length, and 0·8 inch in width.

Measurements.

1st Phalanges:

Digit 1.	Figured specimens. 44. Bl. B., Taunton.	Smallest Set. At Taunton. 51. Bl. B.	*Felis tigris*, Brit. Mus. 114 L.	*Felis leo*, W. A. S.
	Inch.	Inch.	Inch.	Inch.
1	1·86	1·70	1·80	1·70
2	2·20	1·80	1·60	1·71
3	0·97	0·80	0·80	0·80
4	0·67	0·48	0·54	0·52
5	0·73	0·67	0·63	0·58
6	1·25	0·70	0·84	0·80
Digit 2.	(1). Bl. B., Taunton.	23. Bl. B.		
1	2·36	1·90	2·15	1·90
2	2·36	1·80	1·70	1·74
3	1·10	0·82	0·86	0·80
4	1·65	0·50	0·59	0·50
5	0·90	0·67	0·67	0·65
6	1·45	0·72	0·52	0·61
Digit 3.	32. Bl. B., Taunton.	24. Bl. B.		
1	2·01	1·85	1·99	1·80
2	2·34	1·78	1·61	1·51
3	1·02	0·78	0·80	0·78
4	0·65	0·50	0·49	0·48
5	0·83	0·59	0·62	0·60
6	1·13	0·70	0·51	0·80
Digit 4.	48. Bl. B., Taunton.	26. Bl. B.		
1	1·51	1·40	1·64	1·60
2	1·97	1·83	1·42	1·46
3	0·83	0·74	0·68	0·72
4	0·62	0·55	0·52	0·48
5	0·68	0·60	0·51	0·60
6	1·10	0·94	0·49	0·75

THE

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THE

BRITISH

PLEISTOCENE MAMMALIA.

BY

W. BOYD DAWKINS, M.A., F.R.S., G.S.,

AND

W. AYSHFORD SANFORD, F.G.S.

PART II.

BRITISH PLEISTOCENE FELIDÆ.

FELIS SPELÆA, Goldfuss.

(Pages 29—124; Plates VI—XIX.)

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Measurements.

2nd Phalanges.

Digit 2.	14. Bl. B., Taunton.	*Felis tigris*, Brit. Mus. 114 L.	*Felis leo*, W. A. S.
	Inch.	Inch.	Inch.
1	1·76	1·26	1·38
2	2·00	1·45	1·42
3	0·78	0·68	0·60
4	0·60	0·43	0·50
5	0·78	0·64	0·60
6	0·91	0·50	0·54
Digit 3.	22. Bl. B.		
1	1·80	1·58	1·47
2	1·87	1·31	1·25
3	0·85	0·61	0·68
4	0·58	0·44	0·50
5	0·72	0·62	0·60
6	0·75	0·42	0·50
Digit 4.	15. Bl. B.		
1	1·65	1·50	1·28
2	1·75	1·36	1·31
3	0·83	0·56	0·66
4	0·56	0·43	0·51
5	0·75	0·60	0·54
6	0·69	0·48	0·58
Digit 5.	16. Bl. B.		
1	1·57	1·21	1·20
2	1·75	1·21	1·51
3	0·82	0·59	0·60
4	0·55	0·54	0·50
5	0·72	0·55	0·50
6	0·65	0·45	0·50

Sesamoids; Pl. V, figs. 15, 16.

The sesamoids figured are from Bleadon. They certainly belong to a large carnivore, and are precisely similar to those of a lion in form, though of course much larger in size; and as they are from the Bleadon Cave, where *Felis spelæa* abounds, and bear is extremely scarce, we do not doubt that we are right in ascribing them to the former animal.

CHAPTER VI.

Skull; Pls. VI, VII, VIII, IX, X, XI.

CONTENTS.

§ 1. *Introduction. Skulls of Felis spelæa discovered in Europe.*—Perfect skulls of *Felis spelæa* are so very rare that we have had the opportunity of studying no more than three which at all approach completeness—that from Sundwig, in Westphalia, now in the British Museum, of which Professor Owen has given excellent figures in his 'Memoir on Thylacoleo,'[1] and the two which we figure from the Mendip Caves, now in the Taunton Museum. The typical skull figured by Goldfuss, and copied by Cuvier,[2] has altogether eluded our search. It was from the cavern of Gailenreuth from which Lord Enniskillen and Sir Philip de Grey Malpas Egerton have obtained vertebræ and many other bones of Felis, as well as large quantities of the remains of bears.

There are, however, several figures of the skull. M. de Blainville[3] figures a fine and

[1] 'Philosophical Transactions,' 1859, pt. i, pls. xii, xv.

[2] 'Nov. Act. Nat. Cur.,' tom. ix, p. 476, pl. lxv; 'Oss. Foss.,' 1825, 4to, tom. iv, pl. xxxvi, fig. vi.

[3] 'Ostéographie, Felis,' pl. xv.

apparently perfect specimen, which M. Pictet reproduces in his 'Paléontologie.'[1] From the text of the former writer we gather that the figure was taken from a plaster cast in the possession of Count Münster, the original having been found in a cavern in Franconia. D'Alton[2] also figures a perfect or nearly perfect skull from Muggendorf. Other naturalists[3] who have turned their attention to the Pleistocene Fauna describe and figure fragments only of the spelæan skull; for the species, though widely spread through central and western Europe, is nowhere abundant, nor are the remains generally found in a perfect state. The largest English fragment hitherto figured is that found in Kent's Hole Cavern by Mr. McEnery, and drawn on a slightly reduced scale by Mr. Scharf, and published by Mr. Vivian. It is also figured in a woodcut in Professor Owen's 'British Fossil Mammalia.' It represents only a portion of the right maxillary and intermaxillary, with the dentition of an animal of the average size.

Of the two skulls from the caverns of Mendip which we figure, the more perfect and smaller lay for many years after its purchase from the Rev. D. Williams, broken and unseen in a box in the Taunton Museum. The fragments were put together by the present able curator, Mr. Bidgood, and the teeth were afterwards found among a quantity of those of hyæna; and thus a fair specimen of the skull of the British spelæan lion was obtained. Mr. Beard, the explorer of bone-caverns in Somersetshire, on his collection of bones being bought for the Somerset Archæological and Natural History Society, told us of the presence of a skull of a lion from Hutton Cavern, among the bones some time before purchased from his old rival the Rev. D. Williams. As the skull agrees in its condition and colour with the remains from that cave, we have no hesitation in affirming that the original of Pls. VI, VII, VIII, and IX, is the specimen alluded to. When Mr. Beard's collection was brought to Taunton, the small pair of nearly perfect lower jaws figured in Pl. VI was found to correspond exactly with the skull in respect to age, size, and colour. We know that it was the practice of Messrs. Williams and Beard to work at the same cave at the same time, and to share the contents. In this way very frequently a fine specimen was divided between them, even in the case of the long bones,—femora, humeri, and the like. These, now that both collections are in the hands of the Archæological and Natural History Society, are in many cases reunited, and form perfect bones. We have therefore every reason for believing that the lower jaws in Mr. Beard's collection belong

[1] 'Paléontologie,' 4to, 1853—7, pl. vi.

[2] 'Raubthiere,' pl. vii, fig. *a*, *b*, *c*, *d*.

[3] Leibnitz, 'Protogæa,' pl. xi; Buckland, 'Reliquiæ Diluvianæ,' pp. 17, 62, 261; Schmerling, 'Oss. foss. de Liége,' tom. ii, p. 14; Marcel de Serres, Dubreuil et Jean-Jean, 'Oss. foss. de Lunel-Viel,' pp. 101, 107, pl. vii, fig. 1; Rev. W. Vernon, 'Phil. Mag.,' 1829, p. 225; McEnery, 'Cavern Researches,' edit. G. E. Vivian, Esq., 1859; Owen, 'Brit. Foss. Mam.,' p. 161; 'Rep. Brit. Assoc.,' 1842; Falconer, 'Quart. Journ. Geol. Soc. Lond.,' vol. xvi, p. 490; Blackmore, 'Cat. of Fossils in Salisbury Museum,' p. 101; Boyd Dawkins, 'Quart. Journ. Geol. Soc.,' xviii, p. 115; Ed. Lartet, ibid., vol. xvi, p. 475; Falconer, ibid., pp. 99, 104; Baron Anca, ibid., p. 460. The last two notices may refer to a distinct species, as the animal is described merely as a large Felis.

to the same animal as the skull in that of the Rev. D. Williams. They were, however, among the bones from Sandford Hill, and were therefore described as from that cave in our first chapter. A closer examination has shown us that bones from different caverns in the Mendip can be recognised with much probability by their condition and the colour of the matrix. In both these respects the lower jaws strongly resemble the remains from Hutton. They exactly fit the spelæan skull from Hutton. We therefore suppose that they must have been accidentally misplaced either by Mr. Beard himself, or in the removal of his collection to Taunton, and that they really belong to the same animal that furnished the skull in the Hutton Cave to the Rev. D. Williams.

The skull in question is that of an adult rather past the prime of life. The teeth are decidedly worn, and the alveolus of the right upper tubercular molar is partially removed by absorption, which proves the loss of the tooth during the lifetime of the animal. Its state of preservation is shown by the following list of its component bones. A minute portion of the right nasal is present in the angle of the frontal suture, also small portions of the palatines adjoining the maxillary suture, and also that with the pre-sphenoid. The maxillaries with their dentition are nearly perfect, the palatine process being excepted. From the (otherwise perfect) inter-maxillaries the incisors have gone. The left third incisor was diseased, and probably lost during life. The right malar and squamosal are absolutely perfect, and the left nearly so. The posterior or cribriform plate of the ethmoid, and a part of its central plate, are present, so that the beautiful tracery with which it fills the anterior end of the cranial cavity may be seen by looking through the foramen magnum. The greater part, however, of the bone has disappeared. The vomer is entirely wanting. The pre-sphenoid and orbito-sphenoid are nearly perfect. The superior parts of both frontals are nearly perfect, but the orbital portions are much broken. The right tympanic bulla is perfect. The articular portion of the squamosal ("corsal" of Straus-Durkheim) is preserved on both sides, as also are the lower jaws, with the exception of the coronoid processes and a small portion of one of the condyles. The basi-sphenoids, ali-sphenoids, parietals, mastoids, basi-occipitals, exoccipitals, supra-occipitals, paro-occipitals, and Wormian, are nearly absolutely perfect. A small part of the lachrymals is attached to the frontals and maxillaries. The petrosals appear to be perfect, though of course they are but slightly visible.

The second skull (Pl. X) is from Mr. Beard's collection, and was found in Sandford Hill Cave. Along with it were found the lower jaws described in Chapter I and Pl. I of our work. They were accidentally labelled as coming from Bleadon, and the mistake transferred to our pages was not discovered until the chapter had gone to press. Both skull and lower jaws belong to a young adult. Several bones of an animal exactly corresponding in size and age were found along with them; and as those adjoining each other in the skeleton exactly fit, we have reason to believe that we have a considerable portion of the same individual. Unfortunately it was the practice of Mr. Beard "to restore," not very skilfully, the missing parts of crania and other fossils with hard plaster, and in this case the result has been very great difficulty and risk in taking his work to pieces and articulating the skull for scientific purposes. After such rough usage the exactness of fit of the component parts and the symmetry have been to some extent lost. We have figured the skull as it stands now free from plaster, without attempting a restoration which very possibly might have been erroneous, and which certainly could have served no scientific end. The specimen retains a small piece of each nasal *in sitú,* and a large part of the right palatine. The right maxillary is all but perfect, with a small portion of the left. The right intermaxillary also is in part present. The only teeth remaining are the large premolars (four), and a portion of the right canine. Both premolars are nearly perfect, together with the left squamosal and a large part of the right, so that we can form an adequate idea of the size and form of the zygoma ticarch. The frontal bones are present, but their supra-orbital processes are much abraded. The left tympanic bulla is much broken, and the right is almost entirely gone. The basi-sphenoid is all but gone, and only the lower and posterior portions of the ali-sphenoid are left attached to the lower part of the ali-sphenoids and the squamosals. Both mastoids are imperfect. The basi-occipital is present, but the exoccipitals are abraded, and the supra-occipital is gone; and of the par-occipitals, only the left fossa remains.

In addition, we figure in Pl. XI the maxillaries and intermaxillaries of another specimen from Sandford Hill Cave, which is also from Mr. Beard's collection. It is of very large size, and exhibits the perfect adult dentition, with the exception of the small tubercular upper true molars, the small premolars (two), and one first incisor. We also give a figure of the articular portion of the squamosal of a gigantic animal from Bleadon Cave (Pl. IX, figs. 2 and 3).

Besides the skulls we figure, we have examined a large number of fragments, which are for the most part in the Taunton Museum, as well as the nearly perfect specimen from the Sundwig Cave, in Westphalia, now in the British Museum; from it are absent the greater part of the zygomatic arches, a portion of the left palatine, the pterygoid processes, the upper part of the supra-occipital, and two thirds of the nasals, the left orbito-sphenoid, together with the adjoining part of the frontal, the ethmoid, and the vomer. We have also examined the specimen figured by Professor Owen and Mr. Scharf from Kent's Hole, and a similar fragment from Muggendorf, now in the British Museum, and another like it from Ravenscliff in Gower, in the possession of Colonel Wood. These constitute the materials which we have at hand for writing this chapter on the skull of *Felis spelæa.* We shall compare the spelæan skull bone by bone with that of the living species most closely allied to it, that is, lion and tiger, beginning with the basi-occipital.

§ 2. *Basi-occipital.* (Pls. VIII, IX. No. 1).—The basi-occipital forms the posterior portion of the base of the skull, and is regarded as the centrum of the occipital vertebra by all who hold the "vertebral theory." From the slight bulging of the sides it is somewhat hexagonal in form. It is rather longer than wide, and is slightly longer than the basi-sphenoid, to which it is firmly attached by a straight transverse suture. It forms a strong plate of bone of nearly uniform thickness, articulated behind to the exoccipitals in the whelp by a suture, of which the lateral portions are transverse. In the median line, however, it sends back a square process, the free end of which is the lower and anterior border of the foramen magnum. The lateral portions of this suture are interrupted by the "foramen condyloide," which passes from the posterior edge of the "foramen lacerum posterius" (*a*) to the interior of the cranium near the anterior border of the foramen magnum. This transmits the large motor hypoglossal nerve. The sides of the bone are in contact with rather than articulated to the tympanic, and above that to the petrosal, the junction between them being interrupted posteriorly by the large irregular "foramen lacerum posterius" (*a*) or "foramen jugulare" for the passage of the eighth pair of nerves and a large vein connected with the internal jugular. The medullary surface is somewhat concave, forming a lodgment for the "medulla oblongata." The flatness of the lower surface is broken by two large rough depressions on each side close to the tympanics for the insertion of the "recti antici majores" of the head, which take their rise in several roots on the pleurapophyses of the cervical vertebræ. Immediately behind them are the smoother but larger impressions of the "recti antici minores," which have their origin in the "atlas." These impressions are represented in Pl. VIII, in front of the "foramen lacerum posterius." In the median line we sometimes find in Lion the commencement of the tubercle for the attachment of the "constrictor pharyngis superior," which is, however, mainly attached to the basi-sphenoid. This does not occur, as far as we know, in *Felis spelæa*. With the exception, perhaps, of a slight tendency to greater width in the spelæan as compared with the leonine and tigrine basi-occipitals, there is no difference worthy of note.

§ 3. *Exoccipitals and Supra-occipitals*. (Pls. VI, VII, VIII, IX, X. Nos. 2, 3, 4).—It is more convenient for purposes of description to treat these as one bone rather than in accordance with their centres of ossification, because they are never found separate except in the very youngest individuals, and because, firmly anchylosed together, they form the main surface of connection between the head and the trunk. They compose a strong plate of bone, triangular in outline, firmly articulated to the basi-occipital (Pl. VIII, No. 1) at right angles, and with it circumscribing the foramen magnum (Pls. VIII, IX). On either side of the latter are two short thick pedicles of bone which point downwards and backwards, and support the condyles by which the head is articulated to the atlas. These point in their upper portion upwards, in the middle backwards, and in the lower downwards. Their edges project over the sides of the pedicle, forming a fossa, which is called the "condylian fossa" (*b*, Pls. VI and X). These are the portions termed by Professor Owen the exoccipitals (No. 2).

The two inferior angles of the bone are composed of the paroccipitals, or paramastoids, as they are sometimes called, which form on either side a wide and deep cavity on the outer surface, which may be called the paramastoid fossa (*c*, Pls. VIII and IX), receiving the projecting sides of the glenoid cavity of the atlas, and thus combining great firmness of articulation with freedom of lateral motion. It runs as far downwards as the origin of the massive bony pedicle which projects downwards, and ends in the paramastoid tubercle (Pls. VI, VIII, IX, *d*), which is homologous with the jugular tubercle in man. The par-occipital articulates with the mastoid in front, and inferiorly with the tympanic; if we hold to the "vertebral theory" of the skull, as propounded by Professor Owen, it is homologous with the parapophysis of the basi-occipital vertebra. The portion of the occipital which composes the apex of the triangle, and together with the exoccipitals complete the arch over the spinal cord, is the supra-occipital (Pls. VI, VII, VIII, IX, No. 3), which would be the neural spine of the vertebra. Its sides are decidedly convex, while the continuation on the paroccipitals is concave, so that the whole side of the triangle is distinctly sigmoid; the interior and inner surface forms the back wall of the cranial cavity, and is entirely in contact with the cerebellum, for the convolutions of which it is deeply grooved and waved. The upper edges of the superior and outer surface are covered with high radiating ridges, of great sharpness and strength circumscribing depressions of various depth, which may be called the splenial fossæ (Pl. IX, *E*), from their being the points of insertion for the tendon of the great splenius muscle. That descending from the apex, remarkable for its size, serves for the attachment of the cervical ligament (ligamentum nuchæ).

The articulation of the exoccipitals with the basi-occipital has already been described in our account of that bone. Each of the paroccipitals (paramastoids) covers by a broad overlap the posterior end of the tympanic bulla. Above this it is firmly articulated to the posterior border of the mastoid through the whole length of that bone. Above this, in some individuals among the larger Feles, the supra-occipital articulates with the parietal, but generally the descending process of the Wormian or interparietal passes downwards so as to join the upper part of the mastoid and prevent the connection of the parietal with both the ex- and the supra-occipital. The suture with the Wormian is of great depth in the aged animals of the larger Feles, owing to the great height of the lambdoid or occipital crest. In advanced age the whole of the lambdoid suture is obliterated, and its position is marked by a very sharp and massive crest, the lambdoid or supra-occipital.

Ligaments and Muscles of Occiput.—A very detailed account of the muscles and ligaments of Felis are given in Straus-Durckheim's great work,[1] to which we would refer those who wish to become acquainted with the details of this part of the subject. We shall content ourselves with giving a list of the principal ligaments and muscles, with their

[1] 'Anatomie, descriptive et comparative, du chat, par Hercule Straus-Durckheim,' 2 vols. 4to, plates folio, Paris, 1845. This work is perhaps the most perfect monograph on the comparative anatomy of a single animal that exists in any language.

points of origin and insertion, so far as they are connected with the part of the skull under consideration.

The ligaments which connect the head with the neck are the following:—The cervical ligament, or "ligamentum nuchæ," which is comparatively small in the genus Felis, springs from the neural spine of the first dorsal vertebra, and passes among the muscles of the neck to its insertion on the summit of the occipital crest. The "atlo-cephalic capsular," the representative of the capsular of the head in man, occupies the position expressed by its name. It connects the skull, not only with the atlas, but also with the odontoid process of the axis. The "anterior superficial atlo-cephalic" is the equivalent of the "anterior cervical" in man. It springs from the anterior and upper border of the hypapophasis of the atlas, and is inserted into the posterior border of the basi-occipital. The "median superficial posterior atlo-cephalic," the posterior superficial of the atlas in man, fills the space between the upper part of the foramen magnum and the corresponding part of the atlas. It also extends down the sides of the posterior portion of the paroccipital fossa, which it connects with the exterior of the glenoid cavity of the atlas. The "rectus posterior capitis" has its origin in this ligament. The "deeper" ligament of the same name as the last appears to be simply the fibrous envelope of the spinal cord. The "anterior lateral atlo-cephalic," or ligament of the first vertebra in human anatomy, springs from the border of the glenoid cavity of the atlas, and is inserted into the basi-occipital on the inner border of the condyles. The "lateral atlo-cephalic," a strong ligament not found in man, has its insertion on the internal border of the paroccipital fossa, whence it passes downwards and backwards, and is attached to the inferior border of the glenoid cavity of the atlas. It hinders the excessive rotation of the head on the atlas. Two other smaller ligaments, having the same function, are called the "superficial," and the "deep transverse posterior," "atlo-cephalic." They have the same insertion as the last, but pass upwards and backwards to their points of attachment on the upper border of the neurapophysis of the atlas. They are not found in man. The "lateral odonto-cephalic," having the same name in man, closes the list; it passes from the end of the odontoid process to the inferior angle of each occipital condyle.

In giving a list of the muscles attached to this part of the skull, we will begin with those that serve for the movement of the whole head.

The great "complexus"[1] of man is represented in Felis by two muscles, that called "biventer cervicis" by Eustachius and Albinus, the "intersectus" of Straus-Durkheim, and that to which the latter author confines the name of "complexus." The insertion of the "intersectus" is on the inner portion of the occipital arch, over the foramen magnum. Thence it passes backwards, dividing into four principal tendinous roots, which are attached to the transverse processes of the seventh cervical and first three dorsal vertebræ. It adheres to the cervical ligament through its whole length. Above this lies the "com-

[1] Op. cit., vol. ii, p. 241 et seq.

plexus" proper, which has the same insertion as the preceding, and passes backwards to the diapophyses of the cervical vertebræ, and thence to the three anterior dorsals. The great, lesser, and middle recti posteriores of the head underlie these two muscles; their insertions extending nearly to the upper edge of the foramen magnum, and their origins being in the atlas and axis. These five muscles serve to lift up, and to a certain extent to rotate, the head. Their points of insertion are therefore necessarily of great strength in the larger and more powerful Feles. In *Felis spelæa* they are not more massive proportionally to the size of the animal than in the living tigers and lions.

The great splenius muscle springs from the "cervical ligament," and an aponeurosis which connects it with the last cervical and first five dorsals, and ends in a short strong tendon which is inserted into the occipital bone immediately behind the lambdoid suture. Its enormous size and strength in *Felis spelæa* is seen by the large fossæ for its insertion in Pl. IX, fig. 1. It takes part in the same movement as the preceding five muscles. The "trachelo-mastoid" of Douglas rises from five tendinous roots attached severally to the last four cervicals and the first dorsal, and passes in the form of a long thin band along the side of the neck to its insertion on the paroccipital. Near it is inserted the "rectus lateralis," which has its origin on the ala of the atlas. The "superior obliquus" of the head has nearly the same direction as the last, but passes within it to be inserted on the surface of the paroccipitals in the upper part of the condyloid fossa, at the point where they join the exoccipitals.

These three muscles, together with the splenius, bend the head from side to side. The great size of the lateral alæ of the atlas stands in direct relation to the development of these muscles, in animals that shake and worry their prey, such as lion, tiger, and *Felis spelæa.*

M. de Blainville[1] states that the occipital crest is prolonged further backwards in the tiger than in the lion, a point which we have remarked to be by no means of characteristic value, and that the condyles are more detached in the former than in the latter animal. We have frequently found the converse of this latter statement to be true. He also writes that in these two points the plaster cast of Count Münster's specimen of *Felis spelæa*[2] agrees with tiger and differs from lion. We are unable to lay hold of any character in the occipital bone that would differentiate lion from tiger or from *Felis spelæa.*

§ 4. *Basisphenoid* (Pl. VIII, No. 5).—The basisphenoid is articulated to the presphenoid by a transverse suture, which is clearly visible even in animals of considerable age. It is much wider though about the same length as this latter bone. The form of the inferior or guttural surface exposed in the perfect skull is roughly triangular, the apex of the triangle being cut off by the presphenoidal suture, and the base being formed by

[1] 'Ost. Felis,' p. 28. [2] 'Ost. Felis,' p. 108.

that with the basioccipital, which in the old animal is obliterated as completely as the frontal suture of human anatomy. The sides are covered to a great extent by the overlap of the anterior portion of the tympanic bulla, and in front by the guttural process of the alisphenoid. The surface in the larger Feles is nearly flat or slightly concave. A small foramen on each side of the basisphenoid in the suture between it and the alisphenoid is the posterior opening of the canal which conducts the Vidian nerve and artery to the foramen sphenoidale: from this proceeds a well-marked groove backwards along the above-named suture, to the foramen lacerum medium; it then passes along the suture between the tympanic and alisphenoid just outside the foramen caroticum, to the small foramen by which the nerve makes its exit from the petrosal proper, within which bone it branches from the facial nerve.

When detached the bone in the lion is of the same truncated triangular shape, but it is somewhat wider than was before apparent in consequence of the overlap before described. Its vertical thickness is slightly greater anteriorly than posteriorly, owing to the commencement of the upward slope from the bottom of the "sella turcica" to the olivary process within the cranial cavity. The dorsum ephippii rises to a considerable height in all the larger Feles, and is turned much forwards, the inclination from the summit to the posterior edge of the bone being at an angle of 30° to 35° with the horizontal. The sides of the "dorsum" expand into lateral alæ, somewhat like the wings of a moth, and homologous with the "posterior clinoid processes" in man. The arch formed by them, and the anterior clinoid processes is sometimes completed in Felis. We have not, however, met with an instance of this in the spelæan skulls: on each side of the "dorsum" is a furrow for the "internal carotid artery." Sometimes there is a small median foramen on the guttural surface, and two minute foramina on the back of the "dorsum ephippii."

Muscles.—The peristaphyline (Straus-Durckheim) muscle, the representative of the internal muscle of the same name in man, has its origin close to the alisphenoidal suture, at a point where it crosses a line joining the "foramina ovalia." Its office is to lower the "velum palati." The superior constrictor of the pharynx is attached to the posterior portion of the bone close to the basi-occipital suture.

The only point worthy of note in comparing this bone in *Felis spelæa* with those of lion and tiger is that it has a tendency to be somewhat wider in the two former animals than in the latter. This width, however, is very variable, and cannot be considered characteristic.

§ 5. *Alisphenoid; Pterygoid* (Plate VIII, No. 6).—The alisphenoid, usually described as the ala of the sphenoid, and treated by Straus-Durckheim[1] as a mere process of that bone, lies immediately in front of the squamosal in the surface of the cranium. As,

[1] Op. cit., vol. i, p. 395.

however, it is easily separated from the basi- and pre-sphenoid, while the suture between it and the pterygoid is obliterated at a very early age, we treat the alisphenoid and the pterygoid as one bone for descriptive purposes.

Nearly the whole of the outer surface of the bone is visible in the perfect skull, as a vertical plate running upwards to form part of the walls of the cranium between the temporal and optic fossæ. It also extends horizontally as far back as the petrosal, passing under the anterior part of the tympanic. Inferiorly, the pterygoids extend downwards and backwards on either side of the great guttural groove, ending in the thin, strong, hamular processes in lion and tiger, which in our spelæan skulls are unfortunately broken away. For purposes of description this compound bone may be divided into the horizontal or guttural portion, the supero-vertical or temporo-optic, and the infero-vertical or pterygoid portions. The first of these is a narrow plate, transversely concave, covering the postero-lateral edges of the guttural surface of the presphenoid and the antero-lateral edges of the basisphenoid. In the basisphenoidal suture is the orifice of the Vidian canal, by which the nerve and artery of that name enter the alisphenoid, and pass forwards into the orbit at the external border of the "foramen sphenoidale." We have already described the groove connected with this canal on the surface of the basisphenoid in our account of that bone (§ 4). The infero-vertical or pterygoidal processes curve downwards from the horizontal portion, and articulate anteriorly with the palatine by a vertical suture. The hamular processes, in which they terminate, are the equivalents of the internal pterygoid plates of human anatomy, the externals being represented by a slight longitudinal ridge immediately in front of the foramen sphenoidale.

M. de Blainville[1] states that the hamular processes of the tiger are less delicate than those of the lion. The variations, however, in this respect, in both these species, do not enable us to confirm this observation. As might be expected, these parts have not occurred in a fossil state.

The horizontal plate expands posteriorly behind the Vidian canal, and articulates with the squamosal just within the boundary of "the glenoid cavity." At this point it joins the supero-vertical or temporo-orbital process, which is a long, thin, triangular plate, highly convex externally, articulating behind with, and passing under, the squamosal by a highly concave suture, above with the antero-inferior angle of the parietal, in front with the postero-inferior angle of the frontal, and the orbito-sphenoid. At the bottom of this suture is a notch, which, together with a corresponding surface of the latter bone forms the large "foramen sphenoidale,"[2] to a certain extent the representative of the sphenoidal fissure or "foramen lacerum anterius"[3] in man, and giving passage to the third and fourth nerves, to the first branch of the fifth pair, or the trigeminal, and to the sixth. Immediately behind this, and rather lower down, is the foramen rotundum, for the trans-

[1] 'Ost. Felis,' p. 28. [2] Straus-Durckheim, op. cit., vol. i, p. 395.

[3] Holden, 'Human Osteology,' 3rd edit., p. 78.

mission of the maxillary portion of the trigeminal, and more widely separated and exactly opposite the glenoid cavity is the foramen ovale (*g*), which transmits the infra-maxillary, or mandibular branch of the fifth pair.[1] The latter is called the carotid foramen by M. de Blainville[2] and some others, in the mistaken belief that it transmits the carotid artery.

The foramen caroticum is in all the Feles extremely small; and the external orifice being entirely covered by the Eustachian process of the bulla, and generally, but not always, surrounded by the substance of that portion of the tympanic, it may be said to be within the foramen lacerum medium, immediately on the inner edge of the groove for the Vidian nerve. The internal orifice which is immediately in front of the apex of the petrosal proper leads directly to the groove for the artery described above as on the cerebral surface of the basisphenoid. This is very distinct in the smaller cats, but is less so in the larger. The foramen itself is larger in the jaguar than in any other large Felis that we have examined, admitting a small wire. It is very small in the tiger, and still smaller in a panther, and even in very young lions; in some old animals of both these species it appears to be entirely closed. In *Felis spelæa* it closely resembles the lion.

The functions of the carotid artery, as it exists in most other mammalia, appear to be supplemented, or rather replaced, by those of the numerous vessels which accompany the nerves in their passage through the different foramina, and which in this part of the skull unite an external "rete mirabile" to an internal, for the supply of blood to the brain. We have observed in many skulls of Felis that the large foramina of the alisphenoid are accompanied by smaller, which appear to be appropriated to the transmission of vessels, though we have not ascertained this to be the case by the actual dissection of those specimens.

Muscles.—The hamular processes of the pterygoidal portion of the alisphenoid being broken away, we can say nothing of the origin of the constrictor superior pharyngis, or of Folian muscle, in *Felis spelæa.* The origin of the circumflexus[3] (Albinus) is under the foramen ovale (*g*), whence it passes round the hamular process to its insertion in the velum palati.

§ 6. *Presphenoid and Orbito-sphenoid* (Pl. VIII, fig. 9).—All that hold the "vertebral theory" of the skull agree in assuming the homologies of the centrum of a vertebra for some part of the presphenoid, though there are differences of opinion as to the morphological value of the different parts. The bone is firmly anchylosed to the orbito-sphenoid while still fœtal, and the sutures have all but disappeared at birth; for this reason we describe them as one bone.

[1] Straus-Durckheim, op. cit., vol. i, p. 295. Holden, 'Human Osteology,' p. 395.
[2] 'Osteol. Felis,' p. 14.
[3] Straus-Durckheim, op. cit., vol. ii, p. 229.

In the smaller Taunton skull this bone is nearly perfect, and as the palate is broken away the anterior portion is visible. We are consequently able to describe all the free surfaces of the bone.

The visible portion of the inferior surface is a narrow strip, widening slightly posteriorly and considerably anteriorly, which forms the central portion of the roof of the posterior nares. The posterior portion is covered by a deep overlap of the pterygoid, and the anterior by a similar overlap of the palatine. The posterior end is firmly anchylosed to the basisphenoid by a deep suture convex posteriorly. These sutures are indicated in Pl. VIII, No. 9, by faint lines, as they are nearly obliterated in the skull by age. This surface is nearly flat in *Felis spelæa;* this is also the case in the majority of the lions' skulls that we have met with; whereas in the majority, if not all of the tigers' skulls, as well as in most of the other Feles, there is a strong longitudinal central ridge, which receives on each side of it the prolonged posterior processes of the vomer. Anteriorly the bone is seen to consist of a thickened central mass, which rises into a thin vertical plate, separating the ethmoidal sinuses, and articulating firmly with the central plate of the ethmoid, a portion of this articulation is seen in the skull we are describing. The central mass expands laterally into two thin plates, covered by the overlap of the palatine before mentioned, which form the floor of the ethmoidal sinuses, for the reception of the infra-lateral processes of the ethmoid, sometimes called the "cornets de Bertin."

The outer walls of these sinuses are formed by thin plates rising from the outer edges of the floor, at first inclining somewhat inwards, and covered by the overlap of the vertical plates of the palatine, but posteriorly these are uncovered, and arch over outwardly and form the lower and posterior surface of the orbit. This free portion is pierced on each side near the centre by the large optic foramina, which pass backwards and downwards to the optic groove on the cerebral surface of the bone; the lower part of this surface is traversed by a strong ridge, below which the bone is roughened for the insertion of the powerful Fallopian muscle for raising the lower jaw.

The roof of the ethmoidal sinuses is formed by a thick plate, narrow horizontally and anteriorly, but widening much posteriorly, at the same time curving downwards, so that it unites with the much thickened posterior end of the central mass at its junction with the presphenoid, forming at this point the homologue of the olivary process in man. Above, in front of this is the very deep transverse optic groove, the ends of which lead outwards, as before stated, to the optic foramina. The anterior portion of this, the cerebral surface of the bone, is the floor of the rhinencephalic fossa, the walls and roof of which are formed by the frontals. Anteriorly this surface rises centrally into a strong vertical ethmoidal spine, to which is anchylosed the cribriform plate, for the lower foramina of which the anterior edge of the orbito-sphenoid is deeply furrowed. The anterior edge of the vertical walls of the ethmoidal sinuses is articulated to the vertical walls of the palatine by firm sutures inclining forwards, to the frontals by nearly horizontal sutures, which pass above the optic foramina, and to the alisphenoid by very firm sutures of considerable depth, which pass round the posterior portion of the bone, leaving on each side a considerable free space to form the inner surface of the foramen sphenoidale, the central and largest of the five foramina near each other in this part of the skull, which, as before stated, is homologous with the sphenoidal fissure, or foramen lacerum anterius in man.

The remaining muscles attached to this bone are the rectus externus of the eye; "grand abducteur" of Straus-Durckheim, and the "petit abducteur" of the same author, equivalent to a portion of the choanoid, which have their origin outside the optic foramen; and the rectus inferior, "grand abaisseur" of Straus-Durckheim, and the "petit abaisseur" of the same author, equivalent to another portion of the choanoid, have their origin immediately under the same foramen.

We have above indicated the only and very slight difference we have been able to distinguish on the guttural surface of the bone, between lion and *Felis spelæa* on the one hand, and most, if not all other Feles on the other.

§ 7. *Palatines* (Plates VI, VIII, X, XI, No. 20).—Of the palatines we have seen but a small portion in spelæan skulls from British localities but we are able to describe it fully from the skull, from the Sundwig cavern, preserved in the British Museum. It may be considered as composed of the horizontal naso-palatine portion, and the vertical plate that forms the lower surface of the optic fossa, its inner surface forming the floor and walls of the posterior nares. The naso-palatine portion presents a smooth horizontal surface joining its fellow by a thickened median symphysis, both forming a figure variably pentagonal in the bony roof of the mouth. Anteriorly it is firmly anchylosed to the maxillary by a serrated suture directed diagonally backward from the median line; posteriorly it presents a free edge that sends back a process to articulate with the pterygoid. The free edge forms the infero-posterior border of the posterior nares. Externally it joins at a right angle the vertical naso-optic process, along a line passing from the sectorial fossa (*h*) of the maxillary diagonally backwards to the pterygoid and the palato-maxillary suture; and nearly equidistant from the interpalatal suture and the sectorial fossa (*h*), is the small posterior palatal foramen (*i*) for the transmission of the palatal nerve. It is directed forwards, and opens upon a canal on the posterior surface of the maxillary. In some of the smaller Felidæ it is double, but in lion, tiger, panther, and all the larger species it is single, as in *Felis spelæa*. In all the leonine and tigrine skulls which we have examined, the position of this foramen is constant. It is much nearer to the postero-exterior border of the palate in lion than in tiger, when skulls of equal size are compared. The only apparent exception to this rule is presented by the skull of a small lioness in the British Museum, in which it is roofed in by an abnormal growth of bone from the maxillary, so that instead of opening as it usually does on, or rather in rear of, the suture, it is carried forward and opens far on the maxillary. We also find that in all the lions' skulls we have examined, a thin probe passed through this foramen passes directly into the orbit without showing itself on the nasal surface of the bone, while in all, except in one or two extremely small skulls of the tiger, it passes freely into the nasal cavity. In both these points *Felis spelæa* agrees with lion.

To these M. de Blainville would add a third point of difference between lion and tiger: that in the lion the posterior border of the horizontal plates terminates in sharp cusps, which form a somewhat deep notch at the interpalatal suture, while in the tiger it ends in a point without a notch (en pointe médiane sans échancrure).[1] We have carefully tested the value of this point of difference in a large series of recent skulls. In leonine skulls the notch is variable in size, and in some almost obsolete. In those of tiger on the other hand the median point often disappears, leaving the posterior border straight, and sometimes well defined cusps are present, and the notch more distinctly marked than in some leonine skulls. Although, therefore, M. de Blainville has rightly indicated the tendency of the two species in this respect, we cannot suppose that we have in this the means of absolute distinction. The only skull of *Felis spelæa* which gives us information on this point is that from Sundwig. It shows in its present state an affinity to the tiger. The bone, however, is abraded at the point where the cusp would be, had it ever existed, and on the other side the palatine is restored in plaster. We therefore do not consider the evidence afforded by it of any value as to the leonine or tigrine character of the animal.

From the postero-external surface of the horizontal plate rises the vertical or optico-nasal, articulated by a slightly convex vertical suture to the inner side of the base of the malar process of the maxillary, and to the lower and posterior edge of the lachrymal, to the frontal above by a long horizontal suture, and to the lower edge of the orbito-sphenoid, and the anterior of the alisphenoid by a descending suture *en échellon.* The upper surface is slightly concave vertically and horizontally; the lower is convex vertically. It is pierced by two foramina, the larger of which is the spheno-palatine for the maxillary branch of the fifth pair of nerves; the smaller, situated more in front and at lower level, conducts the palatal nerve to the small posterior palatal foramen in the palato-maxillary suture. These two foramina are erroneously called by Straus-Durckheim "trous gustatifs."[2] To the lower part of the orbital surface, and throughout the whole length of the horizontal process, is attached the Fallopian[3] muscle, or external pterygoid of human anatomy, which is among those which elevate the lower jaw, and is inserted at the infero-exterior border of the horizontal ramus below the coronoid process. In man this muscle is inserted into the neck of the condyle and the meniscoid fibro-cartilage, and is a pretractor or rotator, while in Felis, being inserted much lower down, it serves merely for an elevator.

[1] 'Ost. Felis,' p. 28. [2] Op. cit., vol. i, p. 426.
[3] 'Straus-Durckheim,' vol. ii, p. 217.

The only point of difference of specific value in this bone is in respect of the palatal foramen. In every case *Felis spelæa* agrees with lion in a most decided manner, the space between the foramen and the postero-exterior border of the palatine being even smaller in it than in the lion. In all the specimens of the panther and jaguar that we have examined, it is proportionally greater than in the tiger. *Felis spelæa*, then, is isolated from these two smaller species by this characteristic.

8. *Maxillaries* (Plates VI, VII, VIII, X, XI, No. 21).—The maxillaries of all the larger species of Felis resemble each other very closely, and yet it is in these very bones that we find minute differences which are specifically constant. Their surfaces may be described as the vertical or facial, the basal or palatine, the posterior or orbital, and the internal or ethmoidal. The first of these presents a roughly triangular outline, bounded behind by the malar, lachrymal, and frontal articulations; in front by those of the frontal, nasal, and intermaxillary, and below by the alveolar border. At its upper angle it is slightly concave; at the infero-anterior convex, for the reception of the fang of the canine, and at the infero-posterior flat. The concavity immediately behind the canine is the canine fossa, the muscle of that name passing along it from the malar to the upper lip. The upper angle forms the "frontal process," which is received into a deep notch in the frontal bone. It is truncated in the tiger, rounded in the jaguar, pointed or very rarely rounded in the lion and panther.[1] If a line be drawn joining the apices of the frontal processes, in the two former animals it falls below the extreme point of the frontal processes of the nasals, while in the two latter it falls above the nasals, and rests entirely on the frontals.[2] In two skulls of *Felis spelæa*, that figured in Pl. VII, and that from Sundwig, the frontal process is pointed, and the line rests on the frontals; in the third (Pl. X) the processes of the maxillaries are unfortunately abraded. If, however, the outline were restored, it would be impossible to make it otherwise than pointed; and if so, the line drawn from the frontal processses would also rest on the frontals without touching the nasal suture of these bones. Immediately opposite the superior portion of the malar suture is the great suborbital foramen, separated from the malar and the orbit by a stout bony arch, and giving passage to the suborbital nerve and artery. It is smaller, according to MM. Goldfuss, Cuvier, and de Blainville,[3] in tiger than in lion, and the arch is thicker; and those authors consider that in these respects *Felis spelæa* is tigrine in character. The specific value of these points is by no means confirmed by the study of a large series of skulls of lion and tiger, in which we find great variations in the

[1] We have seen some skulls which are said to be those of the panther or leopard from Eastern India and the peninsula of Malacca, in which the formation of the frontals and maxillaries resembled that of a tiger. The Western panthers, as far as our experience goes, all resemble the lion in this respect.

[2] This was first pointed out by Professor Owen, 'Proc. Zool. Soc.,' Jan. 1834, p. 1.

[3] Goldfuss., 'Nov. Act. Nat. Cur.,' vol. x; Cuvier, 'Oss. Foss.,' vol. iv, p. 453, ed. 1825; de Blainville, 'Ost. Felis,' p. 108.

proportions of their parts. We cannot, therefore, admit the tigrine affinity of *Felis spelæa* to be shown in the slightest degree either of the suborbital arch or foramen. From the postero-inferior angle of the facial surface springs the stout malar process, firmly articulated to the malar bone by an oblique suture. It is vertically convex on the outside; the inner side, vertically convex, horizontally concave, joins the posterior or orbital surface, which is inclined downwards from the suborbital foramen to the alveolar border behind the molar series, and articulates with the lachrymal and the vertical plate of the palatine. The orbital surface presents many small foramina for the nerves and arteries which supply the teeth, and affords attachment to the "inferior oblique muscle"[1] for the rotation of the eye, immediately below the lachrymal suture. The inferior or palatine surface is horizontal and very slightly concave in both directions. Posteriorly it is articulated to the horizontal plate of the palatine, on the inner side to its fellow, by a straight symphysis, which rises on the nasal surface into a sharp crest for the reception of the vomer. From the posterior palatine foramen (*i*),[2] which we have already described in the palato-maxillary suture, a broad shallow groove runs forwards the whole length of the bone, for the reception of the nerves and blood-vessels of the palate. In part it is joined to the premaxillary by a nearly straight suture, running obliquely forwards and outwards, passing into the alveolus of the canine, interrupted by a free oval space, which constitutes the posterior border of the naso-palatine canals. On its external edge is the alveolar border, for the reception of the canine and molar teeth, the alveoli of which will be described along with the dentition. At the postero-external angle is a round and deep cavity, which from its function of receiving the posterior blade of the lower sectorial molar may be called the sectorial fossa (*h*). The internal or nasal surface of the bone follows the contour of the palatine and facial surface. The large fangs, however, of the teeth necessitate large alveoli, which leave very little space for the antrum of human anatomy. To a ridge on the vertical portion of the surface the ethmoidal bone is attached.

Muscles.—To the facial surface of the bone the following muscles[3] are attached:—To the upper part of the frontal process the rhinæus, a double muscle for the elevation of the nostrils and upper lip; to the anterior edge of the orbit, close to the lachrymal suture, one of the roots of the palpebral, a muscle for the closing of the eyelids. Between these two points arises the elevator of the upper lip. The buccinator is not attached to the alveolar border, as in man, but is reduced in size, and confounded with the labial. The smaller branch of the lesser zygomatic springs from the alveolar border in front of the sectorial tooth, and its function is to aid in raising the lip. In no respect do the attachments of these muscles in *Felis spelæa* indicate any difference between that animal and the lion.

[1] Straus-Durckheim, op. cit., vol. ii, p. 207.

[2] These are erroneously termed "trous gustatifs" by Straus-Durckheim.

[3] Straus-Durckheim, op. cit., vol. ii, pp. 203, 207, 210, 211.

§ 9. *Intermaxillary* (Pls. VI, VII, VIII, X, XI, No. 22).—The inter- or pre-maxillaries form the anterior end of the face, and consist, like the maxillaries, of an ascending and an horizontal process. The first of these, which may be called the nasal process, is wedged in between the maxillary bone below and the nasal above, forming part of the lower portion of the alveolus of the canine, and is to a great extent overlapped by those two bones. The horizontal, incisive, or palatal process is articulated behind to the palatine process of the maxillary, and in the median line to its fellow by a straight symphysis, strengthened by a ridge on the superior or nasal surface, which with its fellow ridge forms a trough, which is articulated to and forms a continuation of the vomer. The palatine suture is interrupted by the two large oval naso-palatine foramina (*k*), which open into two grooves that pass forwards as far as the inner edge of the incisive border. The incisive border in front forms an arc of a large circle, and is separated from the alveolus of the canine by a shallow excavation for the reception of the canine of the lower jaw.

The intermaxillary bones form the lower and lateral boundaries of the nostrils, and present us with a character of specific value[1] by which we can separate lion from tiger. In viewing the lower half of the nasal aperture in front, its inner bounding line takes the form of an even curve, expanding regularly in the former animal, while in the latter it is distinctly a surface of double curvature. This character is more strongly impressed on the larger than the smaller skulls. In *Felis spelæa* it is strongly marked, and its evidence as to the leonine character of that animal is beyond doubt. The Sundwig skull, however, is somewhat exceptional, showing a tendency towards the double curvature of tiger, but the tendency is not greater than that presented by several small skulls of lion. The nasal, or ascending, is inclined backwards at an angle of from 50° to 60° with the horizontal process in Leo, Tigris, and *Felis spelæa*, the angle being greatest in the largest skulls.

Muscles.—The myrtiform[2] muscle for the dilation of the nostril, and the moustache muscle for the protrusion of the lip, take their origin from this bone; the one from the sides of the nasal aperture, and the other from the median suture.

§ 10. *Petrosal; Mastoid; Tympanic* (Pls. VI, VIII, IX, Nos. 16, 8, 28).—In the description of these bones we adopt Professor Owen's numbers and nomenclature, without committing ourselves to his views of their homologies, rather than enter into a discussion which has no immediate bearing on our present work. We shall therefore describe the petrous bone, together with the posterior descending process, as the petro-mastoid, and the remainder of the acoustic organ as the tympanic.

[1] This difference is pointed out by M. de Blainville, 'Ost. Felis,' p. 28.

[2] Straus-Durckheim, op. cit., vol. ii, pp. 208, 209.

The petrosal proper is so irregular in shape as almost to defy description. It may, however, be conceived as resembling a dried distorted pear, lying diagonally across the axis of the skull, so that the pointed end or stem points forwards, inwards, and somewhat downwards. It has three well-marked sides or divisions, the intero-posterior or cerebellar, the superior or tentorial, and the extero-anterior or tympanic. There is also a smooth, rounded, triangular surface between the posterior edges of the tympanic and cerebellar surfaces, which is partly in contact with the paroccipital (paramastoid), and partly forms the inner surface of the "foramen lacerum posterius." The names of these surfaces adequately show the position of the bone in the skull, for it is wedged in between the basi-occipital, the tentorium, and the tympanic, the inner surface alone being exposed on the side wall of the cerebellar cavity. The inferior edge between the cerebellar and tympanic surfaces is in contact with the exterior edge of the basi-occipital, the outer portion of the tentorial with the lower or inner edge of the squamosal, and the anterior apex of the stem reaches as far forwards as the extero-posterior angle of the basi-sphenoid. The cerebellar surface of the petrosal proper is roughly elliptical in form, having the anterior end pointed. A low ridge, running diagonally upwards and forwards, divides it into two long, shallow depressions. Near the middle of the lower depression is the "meatus auditorius internus," a foramen somewhat C-shaped externally, but divided internally into two canals, the one for carrying the facial-motor nerve, the other for the body of the acoustic nerve before its distribution in the cochlea and semi-circular canals. In the middle of the upper depression is the small foramen of the "aquæductus vestibuli," as in man. That of the aquæductus cochleæ is under the meatus auditorius, opening into the petrosal sinus, rather further back than in man. The antero-inferior edge of this surface is, as we have said, in contact with the basi-occipital. Between the two is the "infra-petrosal sinus," which ends posteriorly in the "foramen lacerum posterius" (*a*), a large opening left between the petrosal, the tympanic bulla, and the basi- and par-occipitals. This gives exit to the jugular vein and the eighth pair of nerves.

We are unwilling to pull to pieces the skulls of *Felis spelæa*, and therefore cannot describe the other three surfaces of the petrosal that are hidden in the perfect crania. A glance at the disarticulated skull of lion or tiger will convey a more adequate notion of it in *Felis spelæa* than we could convey by the most faithful word-painting.

Mastoid.—Firmly soldered to the posterior edge of the petrosal is a massive wedge-shaped-bone (No. 8), the thin end of the wedge passing upwards between the squamous bone and the paroccipitals, and the thick rounded head projecting freely downwards (*l*). Though cartilaginous in the young Feles, and incompletely ossified even at the age of five months after birth in the lion, it becomes very compact and hard in the adult animal, and perfectly coalesces with the squamosal and petrosal, the suture with the former being a continuation of the lambdoid suture, and rising into a sharp ridge continuous with the occipital crest. In the majority of leonine and tigrine skulls the narrow ascending process does not reach so high as the parietal. The lower internal surface of the thick rounded head of the wedge is concave and smooth, and is closely applied to the posterior surface of the tympanic bulla, with which it has no further connection. The free end bears the articular surface for the stylohyal. This point, therefore, represents the styloid process in man. We have ascertained that in this bone there are no mastoidal cells, similar to those in the mastoid of man, connected with the tympanic, their absence in the Felidæ being compensated for by the large tympanic bulla. In spite of this significant fact, bearing on the "vertebral theory" of the skull of Carnivora, we use Professor Owen's name of "mastoid" for the bone in question, without discussing the value of the many and conflicting theories of the homologies of the component parts of the cranium.

Tympanic.—The tympanic bone consists of two portions—the tympanic proper, and the bulla or supplementary portion. The tympanic proper forms a somewhat compressed oval chamber, the outer, upper, and posterior walls of which are in part firmly articulated to, and partly formed by, the inferior edge of the squamosal between the glenoid cavity and the mastoid, and which is directed from the latter downwards, inwards, and slightly forwards, parallel to the tympanic bulla. Externally it presents an oval opening under the supra-mastoid ridge of the squamosal—the "meatus auditorius externus" (*m*). This is the original portion of the bone which is in the young animal simply a thin plate, resembling a horseshoe in form, attached by the two ends to the squamosal, which thus completes the ring. Across it is stretched the membrana tympani, like the parchment over the head of a drum, the centre receiving the handle of the malleus. The outer surface of the chamber curves slightly forwards, downwards, and inwards (*n*), in front of the bulla, and it is much roughened for the attachment of the posterior branches of the stylo-maxillary ligament. In the anterior part of the articulation with the squamosal is the glenoid fissure. The anterior end of the bone turns downwards, and forms one or two small, thin, hooked processes (*n*), which are irregular in shape and number, and overhang the foramen lacerum medium, a large irregular cavity formed by the junction of the bulla, the posterior processes of the basi- and ali-sphenoids, and the petrosal. It transmits the canals for the Eustachian tube, the groove for the Vidian nerve and artery, and has within it the external orifice of the foramen caroticum. It is called, erroneously, in our opinion, "le trou déchiré antérieur" by Straus-Durckheim.

Inside the "meatus auditorius" a long septum or curtain partially divides the chamber, and forms a deep groove, open downwards, which passes under and in front of the "meatus." The inner wall of the chamber is formed by a thin plate of bone, that divides it from the bulla. It is said by Straus-Durckheim to be double in the cat. We have, however, examined it in the adult cat with a powerful microscope, and it appears to be homogeneous in structure throughout. The lower surface of the petrosal roofs in and thus completes the chamber, being soldered to the tympanic by exceedingly thin though firm connections at the posterior and upper borders of the cavity. The tympanic bulla, always present in the skulls of Carnivora, and very largely developed in the genus Felis, is a large chamber of oval shape, wedged in between the basi- and par-occipitals, the mastoids, and the petrosal. Its external walls are very compact and hard, though thin, and appear under the microscope to be somewhat fibrous in structure. It is closed on all sides, excepting at the top, where there is a long fissure, in which the promontorium of the petrosal lies in such a position that the "fenestra vestibularis" opens directly on the interior of the bullar cavity. The latter passes into the chamber of the tympanic proper. The bulla thus performs the same functions as the mastoid cells in man, and is consequently called the mastoid by Straus-Durckheim and some other anatomists. In front the bulla sends forward a long, solid, pointed process, that passes between, and articulates with the posterior processes of the basi- and the ali-sphenoid. On the inside it is in contact with the external and lower border of the basi-occipital, and with the whole length of the petrosal. Its relations to the mastoid and paroccipital, to the foramen lacerum medium, and the "stylo-mastoid" foramen, have been already described. In comparing these bones with those of the large Feles we labour under the disadvantage of being able to see but a small portion of them in the perfect skulls. So far, however, as we have been able to institute a comparison, the difference between the spelæan and leonine bones is so small that it is scarcely worthy of note. There is absolutely no difference between the cerebellar surfaces of the petrosal. As compared with those of tigers, the inter-tympanic width is greater in the Taunton skulls than in several skulls of tigers of similar size. The foramen lacerum posterius is shorter and rounder in lions and *Felis spelæa* than in the majority of tigers' skulls. These points, however, are of no great value, and are certainly not characteristic. They show merely the leonine character of these bones of *Felis spelæa*, which in the course of this Monograph we shall be able to trace throughout the rest of the skeleton.

Malleus (Pl. X, figs. 2, 3).—We found that in the tympanic of the larger skull at Taunton the malleus still existed in its original position, and nearly perfect. We extracted it, and are consequently able to give figures of it and describe it. The long process (the "manubrium mallei"), which in the living animal rested on the drum of the tympanic, sloped downwards and forwards, while the condyle-like head was articulated very slightly to the upper part of the tympanic cavity, formed by the external edge of the petrosal and the inferior and inner edge of the squamosal. The neck of the bone is bent inwards and upwards, and posteriorly there is a small facet for the incal articulation; on the opposite side of the neck from that to which the manubrium is attached a small sharp process rises, which affords insertion to the Eustachian muscle[1] ("internus mallei"). In the living lion a thin plate of bone fills up the acute angle formed by the neck; this is broken in the fossil. Two other small processes rise from the opposite side of the neck to the Eustachian process, which appear to be homologous with the processi longus

[1] Straus-Durckheim, op. cit., vol. i, p. 416.

or gracilis and brevis of human anatomy. A comparison of the bone with those of lion, tiger, panther, and jaguar showed no essential point of difference.

§ 11. *Squamosal* (Pls. VI, VII, VIII, IX, X, No. 27).—The squamosal consists of a slightly convex scale-like process applied to the exterior of the sides of the cranium, and a stout articular process, which rises at right angles, and forms the pedicle supporting the lower jaw. The former overlaps the ends of the following sutures, commencing anteriorly, and passing upwards round the edge:—the alisphenoid, parietal, mastoid, petrosal, and tympanic. It is so firmly soldered to the mastoid posteriorly that all trace of the suture is obliterated in the adult. In the young skull, however, of *Felis spelæa* (Pl. X, *o*) it is articulated so loosely that the mastoids have been broken away along the line of weakness thus presented. In the fully grown animal, however, the squamosal, mastoid, petrosal, and tympanic, form one bony mass, which is the exact homologue of the temporal bone of human anatomy. With the parietal it is articulated superiorly by a long horizontal, and with the alisphenoid by a vertical, suture, that ends in the glenoid fissure below. A small part only of the centre of the bone appears in the inner wall of the cranial cavity. From the lower and anterior angle of the squamous portion springs the strong pyramidal articular process, triangular in section, with its antero-inferior border deeply excavated, so as to form a transverse horizontal groove, which is the glenoid cavity (*p*) for the reception of the condyle of the lower jaw. On the postero-inferior surface it is slightly convex, on the superior somewhat concave. At from two to three inches from its origin it suddenly turns forwards at right angles to its long axis, becomes much compressed vertically, and is articulated by a long splice or diagonal suture to the malar, by which it is overlapped externally. A strong sigmoid ridge (*q*), equivalent to the "supra-mastoid ridge" in man, passes forwards from the lower edge of the squamous portion at its juncture with the mastoid, is carried round the upper and posterior edge of the articular process, and forms the upper edge of the zygomatic portion of the bone. Underlying this ridge, at the point where the squamous and articular portions meet, is the meatus auditorius externus (*m*), or external orifice of the ear, of which the upper edge is formed by the free surface of the bone. At the origin of the ridge, which from its position we may call the squamosal, and abutting against the inferior process of the mastoid, to which it is firmly soldered, is a strong process, in length equal to the latter, that supports the stylo-articular ligament. The depression at its end is marked *r* in Pl. VIII.

Muscles.—The whole space between the zygomatic arch and the cranium is filled by the masses of the great tearing and rending muscle which gives such enormous power to the jaws of the Felidæ and Hyænidæ—the "crotaphite," or temporal. Its first branch is in part attached to the inner side of the articular process above the malar articulation. The second springs from the squamous portion above the articular process, and the third is partially attached to the general surface of the squamous portion of the base. The second branch of the masseter also springs in part from the inferior edge of the zygomatic arch, and from the edge of the glenoid cavity.

MM. Goldfuss and Cuvier[1] agree in stating that the height of the zygomatic arch in *Felis spelæa* is greater than in either the lion or the tiger, while according to M. de Blainville[2] it is wider in *Felis spelæa* and tiger than in the lion. He adds also that the articular process rises from the temporal portion of the squamosal at more nearly a right angle in *Felis spelæa* than in lion. On testing the value of these points in a large series of leonine and tigrine skulls, we cannot admit them to be of specific value; and after comparing the two skulls of *Felis spelæa* in the Taunton Museum with those of both those species, we cannot lay hold of any character by which we can separate one from the other so far as this bone is concerned.

We figure in Pl. IX, fig. 2, a fragment of the articular portion of a squamosal from Bleadon Cavern, which is very much larger than any other we have met with, either recent or fossil.

§ 12. *Malar or Jugal* (Pls. VI, VII, VIII, X, No. 26).—The malar is a thin quadrangular bone which forms the anterior portion of the zygomatic arch, and stands out from the skull so as to form an angle of from 40° to 45° with the median plane, the angle being smaller in the younger than the older animals. This difference is very evident if we compare the young skull figured in Pl. X with the old one in Pl. VII. In front it is articulated to the maxillary, and a small process passes inwards, forming the inferior border of the orbit, and the upper half of the bridge over the infra-orbital foramen, to articulate with the lachrymal. Behind it joins the zygomatic portion of the squamosal by a very oblique suture, which passes diagonally upwards, inwards, and forwards, as far as the plane of the suborbital process (*s*). This latter is a strong, flattened, triangular mass of bone, produced into a sharp angle pointing upwards and backwards, connected in the living animal with the supra-orbital process of the frontal (*t*) by the fronto-malar ligament (gonio-malar[3] of Straus-Durckheim) which completes, with the frontal, malar, lachrymal, and maxillary, the orbit. From this ligament, as well as to the posterior part of the sub-orbital process, rises a portion of the large temporal or crotaphite muscle, which fills nearly the whole of the temporal fossa. Along the outer surface a ridge of considerable prominence runs parallel to the lower free concave edge of the bone, which affords an origin to the first portion of the masseter muscle, the second springing from the inner surface, without leaving any impression on the bone to mark its position. The infero-exterior surface also affords attachments in front to the "lesser zygomatic muscle"[4]

[1] 'Oss. Foss.,' vol. iv, p. 463, ed. 1825.

[2] 'Ost. Felis,' p. 108.

[3] Straus-Durckheim, op. cit., vol. ii, p. 14.

[4] Ibid., p. 210.

for the elevation of the lip; and within this to the wide thin "canine," which takes part in the same office.

The malar bone presents no point of specific difference in lion, tiger, and *Felis spelæa;* a comparison of upwards of one hundred skulls having convinced us that the character of greater depth in the latter than the two former animals, insisted upon by MM. Cuvier and Goldfuss, is not of specific value. The sub-orbital process, however, appears to be set rather further backwards in the majority of leonine skulls than in those of the tiger, so that the orbit is wider and rounder in the former than the latter animal. In this point *Felis spelæa* certainly agrees with the lion.

In the recent animal the whole orbit is surrounded by a strong deep ligament, resting on its edge, which renders it deeper and more complete.

§ 13. *Lachrymal* (Pls. VI, VII, X, No. 73).—The lachrymal bone occupies the anterior border of the orbit, and is articulated in front to the maxillary, behind to the frontal, below to the palatine, maxillary, and malar bones. It is a flat plate, of irregular form, varying from triangular to quadrilateral. Its greater part is within the orbit in the larger Feles, but the small portion adjoining the frontal process of the maxillary is continuous with the external surface of the skull. At its superior angle is the palpebral tuberosity (*u*) for the insertion of the palpebral muscle, and below it is the lachrymal foramen (*v*), sometimes excavated in the lachrymal, at others lying in the lachrymo-maxillary suture that runs downwards into the nasal cavity. The internal surface of the bone is ridged for articulation with a branch of the ethmoid. The sutures vary in direction according to the shape of the bone. In old animals they are almost entirely obliterated; a small flat bone, "os planum," is sometimes, though rarely, intercalated in Felis at the infero-internal angle. There is no appreciable difference in the shape of this bone in tiger, lion, and *Felis spelæa.*

§ 14. *Ethmoid.*—It cannot be expected that any large part of so fragile a bone as the ethmoid can be preserved in the fossil state; but as an important part occurs in one of our specimens, we describe the bone in the lion and tiger. In the genus Felis the ethmoid fills the great facial cavity, and may be considered as consisting of a central plate flanked on either side by a highly convoluted mass of bone, and a transverse vertical plate. The former is vertical, and firmly articulated to the ethmoidal spine of the presphenoid, as well as to the vertical plate which divides the ethmoidal sinuses; it rests on the vomer; it is also articulated to the median nasal crest of the symphysis of the frontal bones, and passes more than half way towards the anterior end of the nostrils. It is considered by Professor Huxley[1] as the continuation of the basis cranii

[1] 'Proc. Royal Society,' No. 33, "Croonian Lecture," 1858, p. 433.

formed by the basi-occipital and the basi- and pre-sphenoids, in opposition to the more strict vertebral theory of Professor Owen,[1] who considers the vomer as the centrum of the nasal vertebra. The posterior edge of the plate expands laterally into a transverse, nearly vertical plate, concave posteriorly, which closes the anterior end of the cranial cavity; from its being full of small foramina this is called the cribriform plate. From the lower and outer edges of these two plates spring others remarkable for their thinness and delicacy, which form a highly complicated tissue-like mass of bone, filling the greater part of the facial cavity, and sending prolongations upwards and backwards into the frontal sinuses, backwards and downwards into the anterior sinuses of the pre-sphenoid, and forwards into the nostrils. This mass is attached to the maxillaries, the frontals, vomer, and presphenoid, by delicate and thin articulations; and the whole is so arranged that the air breathed through the nostrils must pass over the greater part of its surface. Through the foramina in the cribriform plate pass the branches of the olfactory nerves, which are spread over the large surface afforded by the convolutions of the bone. The whole mass thus described is called a sense-capsule by Professor Owen.[2] This bone is naturally highly complicated in animals endowed with a fine sense of smell, such as the Felidæ. In the common cat it looks like a mass of lightly squeezed silver-paper. In the larger Feles it is of course somewhat thicker and coarser, and more slightly packed, but it is still of great delicacy and beauty. The pattern of the foramina in the cribriform plate may, perhaps, vary in the different species, but the position of the bone in the skull renders a comparison difficult and uncertain. In the smaller skull of *Felis spelæa* the plate appears like a beautiful plate of Saracenic tracery filling the end of the cranial cavity when viewed through the foramen magnum.

§ 15. *Wormian* (Pls. VI, VII, IX).—The Wormian or inter-parietal is a small triangular bone occupying the apex of the occipital crest, and firmly wedged in between the parietal and supra-occipital, the sutures being of considerable depth. The development of its downward processes is very variable, but sometimes they extend down to the squamosal, and even the mastoid, thus separating the supra-occipitals from the parietals. Its inferior surface forms the highest part of the cranial cavity.

Muscles.—The Wormian bone gives origin to several small muscles that regulate the movement of the ear; for their names we refer to the second volume of Straus-Durckheim's great work on the cat, which we have so often quoted.

§ 16. *Parietals* (Pls. VI, VII, IX, No. 7).—The parietals form the roof of the greater part of the cerebral cavity, and appear on the exterior of the skull as two nearly rectan-

[1] 'Homol. Vert. Skel.,' pls. 1 and 3.

[2] Ibid., pls. 2 and 3.

gular plates, convex vertically and horizontally, and thin except at the point of junction, where they form the strong sagittal crest for the attachment of the third branch of the temporal muscle. This crest increases in size and height, as in the recent Felidæ, in proportion to the age, being almost obsolete in the young animal that has not yet had time to use his jaws for tearing and rending, and gradually increasing in size in proportion to the age, and consequently the increased use of the temporal muscle, until it reaches its maximum in the old tiger. From the lower anterior angle of the bone a process is sent downwards and forwards to meet the alisphenoid, on which frequently in old lions, and in the smaller spelæan skull in Taunton, there is frequently a strong ridge defining the points of attachment of the second and third branches of the temporal muscle. The size and situation of this ridge recall the vast parietal processes in the genus Otaria, in which also the ramal process of the lower jaw, described by us as characteristic of lion and *Felis spelæa*, is enormously developed. Anteriorly they overlap the frontals by a straight suture; posteriorly they are overlapped by the Wormian; but in old age the latter suture is obliterated; it is very variable in position in the larger Feles, generally running clear of, and in front of, the occipital crest, but sometimes occurring in the crest itself. Inferiorly they are to a great extent covered by the squamosals, which almost entirely conceal their alisphenoidal processes, and entirely their long posterior processes, which may be called "petrosal," from their close contact with those bones.

Internal surface.—A plate, thin in the smaller but very thick and strong in the larger Feles, projects downwards from the cranial surface of the parietals, running diagonally forwards from the posterior angle of the symphysis to the petrosal process, where it is united to a small corresponding plate on the alisphenoid. This plate, with its fellow of the opposite side, forms the "tentorium" (Pl. X), or ossified[1] curtain of the "dura mater," that divides the cerebrum from the cerebellum. In the centre of the united processes is an arch rather more than half the height, and about one third of the width of the cranial cavity, which admits of the connection of the cerebrum and cerebellum. The symphysis between them projects forwards into a ridge, which is high and sharp in the larger Felidæ, and which sends down a sharp spine, which may be called the tentorial. This latter is present in tiger, but altogether wanting in lion and *Felis spelæa*. In the former, also, the arch appears to be narrower than in the two latter.

The whole of the cranial surface of the parietal and tentorium is ridged and furrowed for the convolutions of the brain.

Nearly the whole of the temporal surface of the bone is occupied by the great third branch of the temporal muscle, which has its principal attachments along the posterior part of the sagittal crest. The other muscles associated with the sagittal crest are small, and spring rather from the Wormian, and the front of the occipital crest rather than from the parietal. They are all connected with the movement of the ear, and are termed by

[1] Pl. X, "tentorium."

Straus-Durckheim "sagitto-pavillien," "occipito-pavillien," and occipito-scutien.[1] The first appears to have a retrorsal and the others a rotary action on that organ. There are also many other small muscles connected with the movement of the ear, for which we would refer to the pages of the author we have so often quoted on the myology of the cat.

The proportions of the Wormian and parietals are not constant in the skulls of the larger species of Felidæ. There is, however, a tendency in those of the adult tiger to a greater development of the whole of the posterior and upper solid mass at the juncture of the sagittal and occipital crests than in those of the oldest lion. It also has a greater upward projection, which gives to the tigrine skull the "serpentine" outline, which Cuvier considers characteristic.[2] The examination, however, of a very large number of skulls shows their variability in this respect, and compels us to look upon it as a tendency only. In the straightness, and even in one case the downward curvature, of this portion of the sagittal crest, *Felis spelæa* agrees with *Felis leo.*

§ 17. *Frontals* (Pls. VI, VII, VIII, IX, X, No. 11).—The frontals in many, if not most, mammalia, present characteristics of more or less specific value, and especially in the leonine and tigrine skulls. They roof in the highest and most central region of the carnivorous skull, whether taken longitudinally or transversely. Each presents the following surfaces :—The superior or coronal, the antero-lateral or orbital, the postero-lateral or temporal, the postero-internal or cerebral, and the antero-internal, nasal, or ethmoidal. There are also two other surfaces, the median or symphysial, by which each is united to its fellow, and the parietal, a deep triangular suture, inclined diagonally backwards and downwards. Of this latter the great depth and deeply serrated structure is well seen in the spelæan skull, Pl. X, the parietals having been broken away. The superior or coronal surface of each half is somewhat triangular in form, the interfrontal portion of the sagittal suture being straight, up to the point of junction with the nasals, where the edge curves outwards and passes under the latter bones. This edge, about one inch and a half more or less in length, ends in a sharp point, where it meets the maxillary. It then sweeps backwards, parallel to the median line, forming a deep notch for the reception of the frontal process (*i*) of the maxillary, by which it is overlapped. The process of the frontal thus lying between the nasal and the maxillary may be called the naso-maxillary process (*w*). It is proved, by an examination of a large series of skulls, to be wider in lion and *Felis spelæa* than in the tiger. From the top of the frontal process the fronto-maxillary suture passes forwards and downwards to meet the lachrymals. The edge of the bone, then passing backwards into the orbit, is articulated to the latter bone by a suture directed diagonally downwards and backwards, from the latter of which it is connected with the palatine and orbito-sphenoid by a long horizontal suture. It then on the

[1] Op. cit., vol. ii, pp. 195 et seq.

[2] 'Oss. Foss.,' vol. iv, p. 453.

temporal surface is united to the temporal process of the alisphenoid by a small process passing into the anterior and upper angle of that bone. Thence it passes obliquely backwards to join the straight, transverse, parieto-frontal suture, that has already been described.

The boundary between the frontal and orbital surfaces is the "superciliary" ridge, that between the frontal and temporal the "temporal;" and these two unite in the massive supra-orbital process (*t*). The frontal surface is generally wider and flatter in the fully adult lion than in the tiger; and in the latter animal it rises on either side of the inter-frontal suture into a well-defined rounded elevation, so that the entire mass of the supra-orbital process is directed more decidedly downwards than in the former animal. In lion the surface is more or less widely concave, and the mass of the supra-orbital process is nearly horizontal, the point only being directed downwards. Some aged skulls of lion, however, and particularly in the smaller varieties, approach those of the tiger in this respect; and the young of each species are, as one might expect, to be determined only with great difficulty as far as this character is concerned. But as we can discriminate adult leonine skulls from those of tiger in every case that has come before us by this character alone, we believe that it is tolerably constant. The smaller spelæan skull (Pl. IX) agrees with the average and therefore typical lion in the possession of this characteristic, as also does the larger specimen (Pl. X), so far as its abraded condition allows us to judge. The small skull in the British Museum, from Sundwig, on the other hand, is somewhat tigrine in this respect, but not more so than small skulls of *Felis leo* in the same collection. Across the inter-frontal suture, at a small distance from the nasal notch, a semilunar depression[1] exists in many skulls of tiger, that is only slightly indicated in those of lion. We do not, however, find this constant. In all the three spelæan skulls this depression is absent.

The temporal ridges bounding the posterior part of the frontal surface pass diagonally backwards from the supra-orbital process on either side to unite in the sagittal crest. In the young of the larger and in the adult of the smaller *Feles*, they pass far over the parietal before they join, so that the sagittal crest does not reach as far forwards as the frontal bone. In the adult tiger it passes over the parieto-frontal suture, sometimes to the extent of an inch and a half before its point of junction with the ridges, while in the adult lion its extent on the frontal bone is very small, and in many cases the temporal ridges extend as far back as the parieto-frontal suture. In this respect the smaller skull of *Felis spelæa* (Pl. IX), which is that of an old animal, is typically leonine, and the larger, though younger, figured in (Pl. X), shows the same tendency, as does also, though in a somewhat less degree, that from Sundwig. Also, if a line be drawn across the frontal surface joining the posterior edges of the supra-orbital processes, and from the point where it cuts the inter-frontal suture a measurement be taken to the fronto-parietal

[1] See Owen, 'Proceed. Zool. Soc.,' Jan., 1834, p. 1.

suture, we get the temporal length of the frontal bone. If this be taken proportionally to the basal length of the skull, it is, so far as our experience goes, invariably greater in tiger than in lion; the nearest approach to an equality being afforded by a very small tigrine skull in the Oxford Museum, from the Himalayah, and a large Gambian lion (112 *d*) in the British Museum.

The orbital surface may be considered as a section of the interior of a hollow cone, of which the apex is directed obliquely backwards and downwards. The greater projection of the supra-orbital process causes the concavity to be deeper in lion and *Felis spelæa* than in tiger. It is pierced near the palatine suture by the small "internal posterior orbital foramen," homologous with that in the human fronto-palatine suture. It serves for the passage of the ethmoidal nerve and artery from the orbit into the anterior end of the cranial cavity, close to the cribriform plate. The postero-external or temporal surface is highly convex vertically, and extends to the temporal ridges and the sagittal crest where the latter reaches the frontals. It roofs in the anterior portion of the cerebral cavity. In old animals of lion and tiger strong ridges are sometimes present in the lower part, directed obliquely upwards and forwards. The mass of solid bone immediately over the anterior lobes of the cerebrum is of great thickness for the size of the animal, being 1·55 inches in the larger spelæan skull (Pl. X), and 1·54 in a lion in our own possession. The cerebral surface is deeply concave, and excavated for the convolutions of the brain, and for the arteries. A slight groove marks the inter-frontal suture. The vault formed by the cerebral surfaces of the frontals is interrupted anteriorly by an oval arch of about half its height. It leads anteriorly into a chamber, the rhinencephalic fossa, the end of which is closed by the beautiful tracery of the cribriform plate. The abutments of the arch are of great strength. The latter is the equivalent of the "ethmoidal notch" in man. It appears to be generally wider in lion and *Felis spelæa* than in tiger. Its width in the skull figured in Pl. X is 0·55, in a lion's skull of our own 0·54 inch.

The ethmoidal surface follows for the most part the form of the thin optic plate. The great thickness, however, of the coronal plate makes the roof of the cavity underneath convex longitudinally. The inter-frontal suture is strengthened below by a long spine projecting far into the nasal cavity, and attached to the vertical plate of the ethmoid. It is called the "nasal spine of the frontal," and divides the posterior part of the cavity into two large hollows, which receive the upper and posterior masses of the ethmoidal convolutions. The walls also of the optic plates are ridged longitudinally (see Pl. VIII). These cavities for the reception of the ethmoid are called the "ethmoidal sinuses of the frontal." The arrangement of the frontal, cranial, and optic, plates is such as to form opposite the supra-orbital process two large pear-shaped chambers, connected by small orifices with the ethmoidal cavities described above. These chambers are the frontal sinuses, separated from each other by the nasal spine.

This massive bone affords points of insertion to many important muscles, the largest of which is the great temporal or crotaphite, the antero-external branch of which rises from the temporal ridge and posterior border of the supra-orbital process. The anterior part of the third and internal branch springs from the lower portion of the temporal fossa, while the posterior takes its origin from the parietal. Several muscles of the eye, namely, those for the rotation and general movement of the eyeball and the eyelids, also have their point d'appui in this part of the skull. The rectus internus or "grand adducteur" and "petit adducteur" of Straus-Durckheim, equivalent to a portion of the choanoid, rise near the orbito-sphenoidal suture. Above them are the roots of the rectus superior or "grand élévateur" and the "petit élévateur" of the same author, equivalent to another portion of the choanoid; and above these is that of the elevator of the upper eyelid. The palpebral, in addition to its other attachments to the maxillary, the lachrymal, and the fronto-malar ligament, springs also from the extremity of the supra-orbital process. Of the muscles of the ear, the "sourcilio-scutien" of Straus-Durckheim does not appear to be represented in man. It rises within the orbit, and performs the function of bringing forward the ear. Another muscle taking part in the same office, the fronto-auricularis, springs from the superciliary ridge. The scutiform cartilage is attached by means of the temporal aponeurosis to the anterior part of the temporal fossa. To it are attached muscles which control the motions of the ear. In the temporal aponeurosis a considerable portion of the great temporal muscles takes its origin, besides other muscles of no particular importance.

§ 18. *Nasals* (Pls. VII, X, No. 15).—The nasals in Felis are two thin plates of bone forming the anterior part of the roof of the skull. They are scalene-triangular in form, deeply curved transversely, nearly straight longitudinally, and united somewhat loosely by a long, straight, deep suture. They form the upper covering of the nostrils, being articulated behind to the frontals by a deep overlap, as we have described in our description of that bone, laterally to the maxillaries by a suture, the inner edge of which projects into the nasal cavity, forming a sharp ridge for the attachment of the anterior branch of the ethmoid. They are also articulated for a short distance to the inner and upper edges of the nasal processes of the inter-maxillaries. In the living animal the anterior edges of the bones afford attachment to the epirhine cartilage anteriorly, and to the pararhine externally, which form the outer portions of the nostrils.

The nasals appear generally to be stouter and more decidedly triangular and flatter posteriorly in the lion than the tiger, being depressed so as to form a median groove at the symphysis in the latter animal.[1] M. de Blainville[2] also notes as differences in the latter animal as compared with the lion—"La déclivité des os du nez, qui sont aussi plus étroits, plus allongés, plus parallelogramiques, le lobe inférieur de leur bord libre étant plus prolongé et plus detaché:" we have found, however, that the variations are so great in these

[1] Owen, 'Proceed. Zool. Soc.,' 1834.
[2] 'Ost. Felis,' p. 28.

points in a large series of leonine and tigrine skulls that we cannot consider them of specific value.

The frontal[1] muscle is inserted into the lower extremity of these bones: it passes upwards to join the fronto-auricular muscle, another branch forming a part of the elevator of the nose and upper lip.

These bones are not perfect in any skull of *Felis spelæa* which we have seen, being almost entirely absent from the British specimens, and in that from Sundwig presenting only sufficient to show the flatness of the posterior portion which is characteristic of lion.

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[1] Straus-Durckheim, op. cit., vol. ii, p. 187.

§19. Measurements of Skull of Felis spelæa, Lion, and Tiger.	*Felis spelæa.*				*Lion.*				*Tiger.*				
	Sandford Hill Cave.	Hutton Cave.	Sundwig, British Museum.	Sandford Hill Cave, No. 2.	Oxford, 692 *a*, (large).	Oxford, Cape, (small).	British Museum, Gambia, 112*d*.	W. A. S. (rather large).	Oxford Museum, Capt. Thornhill, (large).	Oxford Museum, Himalayah, (small).	British Museum, Nepaul, 114 *c*.	W. A. S. (large).	Taunton Museum, Capt. Speke, Oude, (large).
1. Basal length (median)	13·00[1]	11·55	10·45	...	11·78	9·37	11·95	12·00	10·75	9·40	10·75	11·50	11·00
2. Zygomatic width	9·10[2]	9·20	...	...	10·14	7·38	9·05	10·08	8·90	7·15	9·20	9·42	9·38
3. Height from palate to supra-orbital	4·85	4·24	4·80	...	4·12	3·49	4·05	4·79	4·20	3·70	4·10	4·65	4·39
4. Extreme length	...	13·22	11·95[6]	...	13·62	10·65	13·81	13·60	13·17	10·60	13·65	14·22	13·49
5. Sagittal length of parietal	...	4·00	3·42	...	3·80	2·51[7]	3·63	4·60	3 00[7]	3·00[7]	4·20	4·50	5·13
6. Median frontal length	4·60	4·53	4·12	...	3·95	3·31	4·20	4·00	3·95	3·76	4·23	4·25	3·76
7. Median nasal length	...	...	...	...	3·15	2·38	3·35	2·70	3·62	3·16	4·05	3·62	3·65
8. Maximum parietal width	3·63	3·45	3·30	...	3·40	3·07	3·63	3·10	3·22	3·05	3·43	3·80	3·05
9. Maximum frontal width	...	4·47	3·75	...	4·53	3·40	4·50	4·87	3·70	3·25	3·37	3·86	3·50
10. Width at parieto-frontal suture	2·70	2·98	2·48	...	2·50	2·36	2·45	2·60	3·32	2·75	2·85	2·75	2·90
11. Minimum width at orbits	3·20	2·66	2·50	...	2·93	2·15	2·75	2·87	2·27	2·16	2·27	2·68	2·80
12. Maximum width of nasals	...	2 54[4]	2·25[4]	2·90[4]	2·45	2·02	2·48	2·45	2·17	1·77	2·16	2·13	2·25
13. Malar width at maxillary suture	6·36	6·00	5·87	7·00	6·70	5·46	6·24	6·75	5·64	4·81	6·14	6·44	6·13
14. Infra-orbital width of maxillaries	3·98	3·86	3·57	4·12	3·51	3·05	3·95	3·90	3·40	2·50	3·28	3·50	3·40
15. Width of maxillaries above PM2	...	3·85	3·88	4·75	4·26	3·39	3·92	3·76	3·60	2·88	3·50	3·64	3·75
16. Maximum width of premaxillaries	...	2·80	2·75	3·67	3·20	2·38	2·88	3·00	2·85	2·12	2·51	2·70	2·65
17. Incisal width	...	1·80	1·79	2·15	1·78	1·55	1·90	2·10	1·63	1·60	1·88	1·75	1·64
18. Paroccipital width	...	4·27	...	...	4·28	3·68	4·47	4·25	3·90	3·37	4·00	4·10	4·34
19. Occipital height	...	3·85	...	...	4·00	3·08	3·81	4·00	4·00	3·08	4·29	4·55	4·50
20. Mastoidal width	5·50[3]	5·29	4·88	...	5·14	4·03	5·38	5·33	4·82	4·25	4·50	5·16	5·10
21. Maximum tympanic width	3·72	3·66	3·62	...	4·25	3·45	4·13	3·75	3·61	3·15	3·57	3·72	3 75
22. Minimum between tympanics	1·30	1·29	1·50	...	0·95	1·11	1·20	1·25	1·12	1·06	1·10	1·20	1·18
23. From paroccipital to anterior border of articular	...	3·20	...	...	2·87	2·40	3·00	2·85	3·08	2·30	2·88	3·05	2·95
24. Glenoid cavity to alveolar border	3·90	3·54	3·35	...	3·65	2·62	3·80	3·50	2·75	2·75	3·78	3·48	3·40
25. Maximum internal width of zygoma	2·90[8]	3·10	...	...	3·50	1·10	3·26	3·60	3·35	2·50	3·75	3·40	3·62
26. Minimum width of posterior nares	...	...	1·32	...	1·70	1·77	1·60	1·45	1·32	1·06	1·40	1·35	1·40
27. Minimum palatal width	...	...	1·78	...	1·87	2·30	2·15	2·20	1·95	1·62	1·78	1·85	1·75

28. Maximum width, palatal bones	...	3·50	2·25	...	4·30	4·20	3·85	3·90	3·23	2·50	2·36	3·60	3·23
29. Width of maxillaries at PM4 (internal)	5·12	5·00	4·25	6·00	5·20	5·13	4·50	5·08	4·42	3·50	4·25	4·40	4·54
30. Width at premaxillary suture	...	2·30	2·00	2·75	2·40	1·78	2·15	2·45	2·04	1·68	1·95	2·10	1·94
31. Median length of entire palate	...	...	5·75	...	6·18	5·13	6·63	6·20	5·88	5·10	5·63	6·00	6·13
32. From alveolar border of MI to external edge of premaxillary	...	5·29	5·00	6·88	6·00	5·08	5·72	5·70	5·00	4·50	5·34	5·28	5·28
33. Lacrymal to infra-orbital process	2·24	2·02	...	...	1·98	1·74	2·00	2·10	1·85	1·58	1·87	1·90	1·90
34. Maximum from malar to supra-orbital process	2·90	2·64	2·50	...	2·72	2·11	2·50	2·64	2·80	2·27	2·87	2·65	2·70
35. Thickness of arch of infra-orbital foramen	0·63	0·60	0·55	0·85	0·45	0·28	0·58	0·52	0·64	0·50	0·58	0·57	0·50
36. Maximum width of anterior nares	...	2·20	1·75	2·70	2·05	1·50	2·10	2·25	1·75	1·46	1·75	1·85	1·90
37. From posterior palatal foramen to posterior edge of palate	0·60	0·55	0·56	0·66	0·77	0·48	0·75	0·65	1·23	0·75	0·92	1·12	0·90
38. Temporal length of frontals[9]	2·24	2·20	2·15	...	2·00	1·50	2·25	1·85	3·00	2·00	3·12	2·92	2·52

[1] The length of the whole skull is estimated by placing it on the jaws that belong to it; thirteen inches is probably somewhat below the true length.

[2] 9·10 inches is probably somewhat below the truth, as the bones have been slightly displaced in setting up the skull.

[3] Approximate, for the same reason as the last.

[4] Estimated from the intermaxillaries.

[6] The summit of the supra-occipital is slightly broken.

[7] Exclusive of the Wormian.

[8] 2·90 is probably somewhat below the truth, owing to the reason stated in the second note.

[9] We give measurement "38" in Lions and Tigers of different sizes from specimens in the British Museum: thus—

Lions.		*Tigers.*	
Very large	2·25	Small	2·78
Large	2·18	,,	2·65
Small	1·90	,,	2·62
Very small	1·50	,,	2·62
Small	1·78	Large	3·12
Small and young	1·75	,,	3·00
Large old animal	1·84	,,	3·15
		Small	2·15

The last Tiger is a very small animal, which has many points of approximation to the Lion, but is Tigrine on the whole. The above were selected from a large number as fairly representative of the different varieties of form and size of the two animals.

§ 20. *Summary.*—We have compared each bone of the head in detail, in order that the resemblances and the differences between Lion, Tiger, and *Felis spelæa,* should be thoroughly, as far as lay in our power, examined and exhausted. We subjoin a summary of our observations of the characters, dividing them into those we consider constant, and those that we have found to be mere tendencies.

Professor Owen, in the 'Proceedings of the Zoological Society,' January, 1834, enumerates the first of the three following points:—1. The prolongation backwards of the frontal (nasal) processes of the maxillary bones in the lion, at least as far back as the transverse line passing through the fronto-nasal articulation; whereas, in the tiger, the former always falls short of the latter by at least one-third of an inch. In the tiger, also, the frontal processes of the maxillary are truncated, in the lion pointed. 2. The form of the nasal aperture, which we describe somewhat differently from the mode of expression adopted by Professor Owen; this difference is also noted by M. de Blainville. 3. The greater flatness of the frontal ends of the nasal bones in lion, which in the tiger are bent downwards, so as to form a median depression at the symphysis. 4. Baron Cuvier points out the greater flatness, and generally speaking the greater width of the inter-orbital space of the frontal bones in the lion, an observation which is confirmed by Professor Owen; the latter, however, does not consider this character as constant. We consider that, with the qualifications expressed in our description of the frontals, the skulls of the two species may be distinguished by this character alone. An examination of a very large series of feline skulls has convinced us, that these four points are strictly typical, and we have always been able to distinguish the skulls of lion or tiger by any one of them taken by itself. We have also remarked the following points: 5. The smaller temporal length of the frontals, and consequent forward position of the parietal suture, and backward position of the post-orbital process in the lion as compared with the tiger. This arrangement causes the leonine skull, when looked at from above, to assume what may be readily understood as a short-waisted aspect in contradistinction to the long waisted aspect of the tigrine. It also causes the great extension of the sagittal crest on the frontals in the adult tiger compared with its shortness in the lion. Baron Cuvier appears to have recognised this difference, though he expresses it very differently. 6. The comparatively shorter space between the posterior palatal foramen and the orbital edge of the palate in lion. This measurement must always be compared with the basal length of the skull to arrive at a true conclusion. 7. The presence of the ramal process pointed out in Chapter I is an essential character of the lion. 8. To these perhaps may be added the presence of the tentorial spine in the tiger and its absence in the lion.

We have also observed that the following tendencies are evinced by the two animals, which are not sufficiently constant to be regarded in the light of absolute specific characters. 1. Baron Cuvier mentions the "serpentine form of the profile" as peculiar to the tiger, the more rectilinear profile to the lion, and the gentle curve to *Felis spelæa.* We cannot admit that any of these characters are of specific value. 2. M. de Blainville's distinction between the two animals already described in our section on the palatals we are also unable to admit. 3. The occipital portion of the skull is often narrower and more sigmoid in the tiger than in the lion. 4. The posterior nares are also generally narrower. 5. This observation may also be made concerning the basi-occipital and basi-sphenoid. 6. The size of the sub-orbital foramen and thickness of the arch dividing it from the orbit, which is greater in tiger and *Felis spelæa* than in lion, are not characters of great importance, for both are very variable in the latter animal: in the Asiatic lion the foramen is sometimes double. 7. The depth of the zygomatic arch insisted on by several anatomists we find so variable, that we cannot regard it as any guide whatever in the determination of feline skulls.

We can now proceed to the application of these characters to the settlement of the question of the leonine or the tigrine affinities of *Felis spelæa*. The smaller Taunton skull which we figure, and which probably from the size of the canines was that of a female, so closely resembles that of a lion of average size, that we cannot detect any difference whatever. It differs from every tiger's skull which has passed through our hands, not only in the characters, but also in the tendencies, with the exception only of the size of the sub-orbital foramen and the thickness of the arch separating it from the orbit. The smaller skull also from Sundwig, though it shows an approach to the tiger in some of its tendencies, in all the characters is decidedly leonine. Besides these spelæan skulls, there are the larger and less perfect ones. We have shown that these differ in no respect except size, from the average leonine skull; while, whenever those parts remain in which constant differences may be looked for, they differ invariably from tiger and agree with lion. With regard to differences which have been cited by other naturalists, we have not been able to detect the "museau renflé" of the French anatomists in either the English or German specimens. In comparing animals of the same size, the muzzle in no respect differs from that of the lion; but we have observed, that the shortness and width of the muzzle varies directly in proportion to the size of the animal. We have had no means of examining the pterygoid processes or the anterior ends of the nasals in *Felis spelæa*, and we cannot consequently apply M. de Blainville's distinctions founded on these parts to that animal.

With regard to size, the measurements given by Cuvier of the largest skull of lion passed through his hands closely agree with those of the most perfect of the large Taunton specimens. The maxillaries figured in Pl. XI are somewhat larger, but they differ in no other respects from those belonging to the more perfect skulls. Aristotle, in his 'Natural History,' gives the large size of the Thessalian lion as a characteristic. In Pleistocene times, before man had increased and multiplied on the earth, the abundance of food and the great range were more favorable to the more powerful and larger breeds of animals, while now the necessity for agility and concealment, caused by man's disturbing influence in the animal world, would favour the smaller. We cannot therefore expect the largest of the living lions to equal in size the largest of the cave lions, because the conditions of their existence are different.

The difference in size between the largest cave lion on the one hand, and the average living lion on the other, is not so great as between the largest Barbary lion and the smallest Asiatic. We therefore consider that there is no ground for regarding the largest and smallest individuals of *Felis spelæa* as distinct species; and we find every reason to consider them both as undistinguishable from the lion, and as distinguishable in all respects from the tiger, so far as relates to crania.

The numbers used in the Pls. VI to XI, to denote the separate bones, are those given by Professor Owen in his 'Homology of the Vertebrate Skeleton.' The letters are as follows:—

a. Foramen lacerum posterius.
b. Condylian fossa.
c. Para-mastoid fossa.
d. Para-mastoid tubercle.
e. Splenial fossa.
f. Vidian foramen.
g. Foramen ovale.
h. Sectorial fossa.
i. Frontal process.
j. Posterior palatine foramen.
k. Naso-palatine, or anterior palatine foramen.
l. Mastoidal process.
m. Meatus auditorius externus.
n. Outer surface of tympanic chamber.
o. Line of articulation of squamosal with mastoid.
p. Glenoid cavity.
q. Squamosal ridge.
r. Squamosal pit (see squamosal, § 11, p. 3).
s. Sub-orbital process.
t. Supra-orbital process.
u. Palpebral tubercle.
v. Lachrymal foramen.
w. Naso-maxillary process.

CHAPTER VII.

Pls. I, VI, VIII, XI, XII, XIII.

CONTENTS.

§ 1. *Introduction.—The Elements of the Teeth.*—The large numbers of the teeth from the caves and river-deposits of Great Britain afford ample materials for working out the whole of the dentition of *Felis spelæa*, with the exception of some of the milk incisors. All the specimens we figure are from the bone-caves of Somerset, with the exception of a large upper canine and two small incisors, from a cave in Gower.

The teeth of *Felis spelæa* consist of the same elements variously modified according to the functions each tooth has to perform. The primary element is a cone for piercing flesh, the form of the whole tooth being modified, as the case may require, by the addition of one or more parts. The permanent canines are examples of the first form (Pl. XI, figs. 1, 5, 6, 7; Pl. XII, figs. 4, 5, 6), in which the "primary" cone (*a*) represents the whole of the crown, the secondary cusps being reduced to all but obsolete tubercles; while in the milk canine of the lower jaw (Pl. XIII, fig. 7), it is modified by the addition of a "secondary" internal or *anterior* cusp (*b*). In the lower incisors (Pl. XII, figs. 1, 2, 3), it is modified by an outer or *posterior* cusp (*c*). In premolar 3 (Pl. XI, figs. 9, 10, 11) of the upper jaw, we find the primary cone (*a*) with large anterior and posterior "secondary" cusps (*b* and *c*), and a small posterior "accessory" (*e*). On premolar 4 (Pl. XI, figs. 1, 12, 13) of the same jaw, (*a*, *b*, and *c*) are modified for a sectorial purpose, and a minute anterior accessory (*d*) is added, which, in the milk molar 3 of the same jaw (Pl. XIII, figs. 2, 6), becomes an important portion of the tooth. In both these teeth there is in addition an internal projecting "tubercular" cusp (*f*), the base of which is connected with the summit of (*a*) by a well marked buttress or rounded ridge, and with the summit of (*b*) by a similar buttress with a sharper edge. This "tubercle" (*f*) is represented in the upper incisors by small posterior or *internal* cusps. We find that in all cases the anterior fang of the tooth, which we will call (a), is concerned in the support of (*a*) as well as (*b*) and (*d*); whereas the second outer fang, reckoning backwards, supports the remainder of (*a*), together with (*c*) and (*e*), when they exist; while the remainder, whether one or more, &c., support (*f*), and the cusps serially connected with it. In one-fanged teeth, the relative size of (*a*) appears to absorb the whole fang (a), the cusps being of perfectly subordinate importance. It may be further remarked, that *a* has invariably a double cutting edge anterior and posterior to the more or less pointed summit, that the edge of (*b*) and (*c*) extend only in the cases where (*d*) and (*e*) exist into the clefts which separate these cusps from (*b*) and (*c*), but that when either of them terminate the tooth, the edge merges into the more or less rounded anterior or posterior surface. If we apply these rules to the true molar of the lower jaw (Pl. XII, figs. 13, 14, 15), we shall see that the posterior blade is *a* slightly inclined backwards, and that the anterior is (*b*), being precisely similar in form, though much enlarged, to the same cusp in $\overline{\text{PM 4}}$.

The only remaining tooth, which offers any modification different to those noticed above, is the small true molar of the upper jaw. The extremely slight definition of the cusps of this tooth, in the genus *Felis*, would render the determination of them a matter of some difficulty, were it not for the light thrown on their arrangement by other genera. It will be seen, that in the unworn tooth in this genus, there are three minute elevations on the posterior border of the tooth separated from each other by slight depressions; slight ridges from the posterior bases of the two inner cusps, pass round the back of the tooth towards the outer, while a similar ridge is seen to pass round the fore part of the tooth from the summit of the middle to the summit of the outer cusp, on comparing this with that of the corresponding tooth of *Canis*, say the jackal, we immediately see that these minute elevations represent three well defined and separated cusps in the latter tooth; the outer cusp is immediately seen to represent (*a*), the middle one (*f*), and the inner, a cusp with which we have hitherto not met, which assumes a very considerable development in other genera, and which we call (*g*.)

This system of assigning names and letters, and of analysing each tooth, may, perhaps, seem the offspring of fancy; but we find it to be of great value, both in the accurate determination of the tooth of the Carnivora, and especially in affording a means of exact correlation of the dentition of the recent with the extinct forms, or in other words, of testing, by means of the analysis of the supposed serial development of the teeth, the doctrine of "ordinary succession with modification."

The dental formula of *Felis spelæa* is that of the restricted family *Felidæ ;*

$$\frac{\text{DI. 1, 2, 3. DC. DM. 2, 3, 4. I. 1, 2, 3. C. PM. 2, 3, 4. MI.}}{\text{DI. 1, 2, 3, DC. DM. 3, 4. I. 1, 2, 3. C. PM. 3, 4. MI.}} \quad \text{D. 26. P. 28.}$$

$\underline{\text{PM 2}}$ is often wanting. $\overline{\text{PM 2}}$, though often found in other species, has not occurred in *Felis spelæa.*

§ 2 *a. Upper Permanent Dentition.* Pls. VI, VIII, XI.—The upper permanent teeth of *Felis spelæa* present no important differences as compared with those of lion and tiger.

Incisors. Pl. XI, figs. 1, 2, 3, 4.—The small incisors 1 and 2 are so closely alike, that the inner (Pl. XI, figs. 1, 2) is only to be known from the outer (figs. 1, 3) by the possession of a shorter crown, and by its smaller size. Each has a simple fang compressed parallel to the median line, and nearly straight: the crown of each is somewhat strongly recurved and traversed by a transverse ridge, so that it presents a cutting edge. On the posterior or *internal* base rise two small lobes (*f*), which are usually more evident on $\underline{\text{I 2}}$ than on $\underline{\text{I 1}}$. The third (figs. 4, 4′, 4″), as in all the Carnivora, is larger, and more caniniform than the other two, and is implanted by a stout subcylindrical fang. In the unworn state, it presents a recurved cone, springing from a base oval in outline, but flatter internally than externally, and transversed posteriorly by a broad and, in part, deep groove, passing obliquely from the base downwards and inwards, the tooth being held in the natural position, which is representative of that on $\underline{\text{I 1}}$ and $\underline{2}$, and marks off a corresponding small tubercle or cusp (*f*) on the inner posterior or *internal* side. The cingulum is slightly or moderately developed. We are able to figure a perfectly unworn tooth from Bleadon Cave, which had belonged to so young an animal that the fang has never been ossified. This tooth is easily differentiated from the corresponding tooth of the hyæna, by the more slender and slightly more curved form, by the smaller breadth and greater depth of the posterior groove, by the consequently greater size of the cusp (*f*), as also in young specimens, by the perfect smoothness of the enamel. The canines of the glutton with which this tooth is sometimes compared, are essentially different in form, and are also far more slender, and their enamel surface is much rougher than even in the teeth of hyæna.

Canines (Pl. XI, figs. 1, 5, 6, 7).—The canines of the larger specimens of *Felis spelæa* were truly formidable weapons, and exceeded in size those of any adult lion or tiger we know of. The largest we have seen is from Crayford, in the Thames Valley. It measures 6·80 inches in length, the point being somewhat abraded. This somewhat exceeds the large specimen figured by De Blainville.[1] It unfortunately did not come into our hands until our plate of the dentition was finished, in which we had figured as the largest British specimen one about the size of the French tooth, from Wookey

[1] 'Ost. Felis,' pl. xv.

Hyæna-den. This has the point and the inner side a little abraded by the wear of the lower canine. We figure a second specimen (Pl. XI, fig. 5) found in Ravenscliff Cave, Gower, by Colonel Wood, to whose courtesy we are much indebted for the loan of this specimen, as well as of the incisors $\underline{1}$ and $\underline{2}$, for the purposes of this work. This specimen is smaller than the last, and may be considered as a good example of the average size from the large form of the animal. Those figured in the under view of the maxillaries (fig. 1) are about the same size. They are slightly restored at the apices, which are a little splintered, but as sufficient of the points of the teeth remained to show that they were unworn, and the restoration was most carefully copied from exactly similar teeth, it is probable that it is perfectly exact. We have also figured specimens of the smaller form, which occurs in all the deposits which produce the larger, and were probably the canines of females (Pl. VI, VIII, and XI, fig. 7). At the time the plate was lithographed the last specimen was the smallest we had met with. We have, however, lately seen the teeth which were referred to, at p. xxi of the "Introduction," as probably those of *Felis antiqua,* on the authority of drawings shown us by Colonel Wood. The examination, however, of the teeth themselves, proves that they differ from those of that animal, and of its existing representative *Felis pardus,* in precisely the same respects, except size, as do ordinary canines of *Felis spelæa,* although they are very slightly larger than those of the former animal. We must therefore consider them as abnormally small specimens of teeth of *F. spelæa,* unless they afford the only known traces of another species. The great variations in size are given in the Table of Measurements of the Teeth.

The long recurved conical crown of the tooth (*a*) is supported by a strong subcylindrical fang, truncated at the base, that extends in old animals further into the maxillary than the suborbital foramen. The inner surface of the crown is somewhat flattened, and bounded intero-anteriorly and posteriorly by two sharp ridges passing from the apex to the base. In the unworn tooth the anterior of these is very slightly, and the posterior strongly serrated. This is also the case in other larger Feles, and corresponds with the similar character which is more highly developed in *Machairodus.* The intero-anterior ridge ends in a small basal tubercle (*b*): each of the external and internal triangular areas defined by their ridges and the base of the crown are traversed by two longitudinal furrows (*sillons*), of which the anterior is the deeper. The external surface of the crown is highly convex. The fang is considerably thickened in old age by a deposit of cement (fig. 6). The external contour of the whole tooth is a simple convex curve; that of the internal, in the old animal (fig. 6), presents a double curvature, whereas in the young (fig. 5) it forms a very obtuse angle with a slight bulge at the base of the crown. The anterior aspect is slightly sigmoid, the fang bending slightly outwards, and the conical point inwards.

The canines are separated from the incisive border by the canine fossa, and by a small diastema of very variable extent from the first of the premolar series.

Premolar 2. (Pls. VI, VIII, XI, fig. 8).—We have seen one specimen of the larger, and two of the smaller variety of Premolar 2 of *Felis spelæa.* The two former are in the smaller skull of which we have given a figure, and the latter is in a fragment of a jaw from Bleadon, which also retains a part of PM 3. The partially divided alveolus in the upper jaw, which we figure in Pl. XI, fig. 1, shows that the tooth had a tendency to become fanged, as generally in the panther. But the examination of other specimens of *Felis spelæa,* and of a large series of skulls of lion and tiger, shows that this tendency was not constant in either of these animals. The tooth is frequently entirely wanting, particularly in small specimens, in all three species. The crown consists of an obtuse central cone (*a*), traversed by a median ridge, the posterior portion of which becomes worn in old age (Pl. VIII). The contour is from nearly circular to oval, the two-fanged specimens being more oval than the monofanged. The fang in the smaller form is nearly straight, cylindrical, and tapering. It is separated by a small diastema from the next tooth.

Premolar 3. (Pls. VI, VIII, XI, figs. 1, 9, 10, 11).—The crown of this tooth consists of a stout primary cone inclined slightly backwards and inwards (*a*), with a secondary cusp (*b*) on the antero-internal aspect, and the secondary and accessory cusps behind (*c*), (*e*); each of these is divided from its fellow by a cleft, and is traversed by a sharp ridge that passes over the principal cone and gives the whole tooth a trenchant character. This ridge turns inwards as it passes from the apex of the tooth to the anterior cusp (*b*), by which character the upper tooth is distinguished from premolar 4 in the lower jaw. Occasionally, a minute tubercle (*d*) appears on the anterior surface of (*b*). The inner surface supported by the posterior fang is slightly flattened. The fangs are two, divaricate and subcylindrical; the cingulum is very stout. The tooth varies much in size in different individuals, and sometimes, as in fig. 11, the secondary cusp (*b*) all but disappears. A strong bulge of the cingulum on the internal base of (*a*) occurs in many teeth of *F. spelæa* (fig. 1), from which ascends a strong buttress to the summit (*a*). This appears to be an indication of the tubercle (*f*) which assumes much larger proportions in PM 4. The extreme variations of size are shown in our plate; the smallest belongs to the same jaw as the smallest canine which we have figured. The only tooth that by any chance could be confounded with this is that of *Hyæna spelæa.* In the latter, however, the principal cone is higher, more decidely conical, and stouter; the posterior cusp is wanting; the cingulum is far more developed, and the sectorial character is exchanged for a bluntly pointed form, adapted for crushing rather than for cutting and tearing.

Premolar 4. (Pls. VI, VIII, XI, figs. 1, 12, 13).—This tooth may be described generally as consisting of two portions, the first, the tubercular set internally at right angles to the second, the two blades which compose the sectorial or trenchant portion of the tooth. The tubercular consists of a stout conical "secondary" cusp (*b*), occupying the antero-external angle of the tooth, and separated by a cleft from the anterior blade, and the tubercle (*f*) supported by the small inner subcylindrical fang, and which, though always present, is sometimes reduced to a minimum. This small and uncertain development contrasts strongly with the large size of the corresponding tubercle of *Hyæna spelæa.* The anterior blade which forms the primary cone of the tooth (*a*) is the higher. A small rounded ridge passes from its summit to the tubercle (*f*). Posteriorly, its trenchant edge declines in height to the point where it is divided by a cleft from the posterior blade (*c*). The latter forms a trenchant waved horizontal edge, situated at an angle to the blade (*a*) which is very obtuse externally; below the cleft, the external side is hollowed out, so that the surface of the crown at this point is horizontal. The internal surface of the tooth is flattened from the tubercle (*f*) backwards, and is at a moderately early age worn away by the friction of $\overline{\text{M 1}}$. A tooth in this condition is represented in fig. 13. The cingulum is well developed, forming anteriorly, in most of the larger specimens, a well-developed cusp on the outer edge of the cusp (*b*); this may be taken as the rudiment of an "accessory" cusp (*d*), which assumes much larger proportions in $\underline{\text{DM 3}}$ of *Felis.* Half the cone (*a*) and the whole of (*c*) are supported by a fang of flattened oval section, and triangular or trapezoidal in outline, and the other half of (*a*), and (*b*), and (*d*), by a smaller one, subcylindrical, and nearly straight, diverging at a considerable angle from the first, and, as before stated, the tubercle (*f*) by a still smaller fang, similar, and of equal length, and generally connate with the second, and sometimes united to it through its whole length. The extreme variations in size that we have met with are shown in our plates of the smaller skull (Pls. VI and VIII, and in Pl. XI, figs. 1, 12, 13).

Molar 1. (Fig. 14).—We have seenbut one specimen of the true molar of *Felis spelæa.* It is from Bleadon. It is elliptical in outline, the long axis of the ellipse being transverse; it is supported by two connate and confluent fangs; but we have met with alveoli which indicate that they are sometimes connate only. This specimen is much worn, as is generally the case with the corresponding recent teeth. We do not, therefore, give a more particular account of the tooth than that given in our Introduction to the Dentition (p. 66); but refer to our figures, which give the general appearance. The alveoli are represented in Pl. XI, fig. 1, and in Pl. VIII, at the postero-internal angle of $\underline{\text{PM 4}}$.

A comparison of the upper permanent dentition of *F. spelæa* with that of lion and tiger, has compelled us to infer that there are no points of difference of specific value between them; the largest teeth of *F. spelæa* are larger than those of the largest living lions and tigers; but they form a regularly graduated series from the smallest to the largest form. The smallest teeth of *F. spelæa,* indeed, are far smaller than the average of the living animals. Those already alluded to from the Gower cavern are only to be matched by the very smallest leonine and tigrine teeth. Dr. Schmerling long since determined that the character of the absence of $\underline{\text{PM 2}}$, depended on by MM. Goldfuss and Cuvier as characteristic of *Felis spelæa,* was a simple variation, which is also, as we have before stated, common to lion, tiger, and other *Feles.*

§ 2 β. *Permanent Dentition of Lower Jaw* (Pls. I, VI, and XII).—The dentition of the lower jaw in *Felis spelæa* precisely resembles that of the lion, except in the size of the larger specimens. There appears to be a very slight difference in the form of $\overline{\text{PM 3}}$ in most specimens of tiger.

Incisors. (Pl. XII, fig. 1, 2).—$\overline{\text{I 1}}$ and $\bar{2}$ agree in all respects save that of size, the latter being the larger in every dimension, though not to the extent indicated in our plate; $\overline{\text{I 1}}$, being the tooth of a much smaller animal than that to which $\overline{\text{I 2}}$ and $\bar{3}$ belonged. The crown (*a*) is conical in the unworn tooth, and slightly recurved; it is hollowed behind, and the base of the hollow is filled by a small lobe to which a slight ridge descends from the apex; and, on the outer (*posterior*) side is a small cleft which marks off a cusp (*c*) from the trenchant edge of the tooth. The fang is long and slightly recurved, subcylindrical, but compressed. $\overline{\text{I 3}}$ (fig. 3) is characterised by the larger size, the higher crown the greater distinctness of the lateral cusp, and the greater curvature of the fang. The incisors both of the upper and lower jaw can be distinguished from those of the hyæna, by the shorter crown, the smoothness of the enamel, and by the greater length of the fang. The incisors of the wolf have still longer crowns, and shorter and more slender fangs. The incisors of the bear are less curved, and more conical in the crown; and both fang and crown are stouter. We know of no other fossil teeth that can be confounded with the incisors of *Felis spelæa.*

Canines. (Pl. I, VI, XII, figs. 4, 5, 6).—The lower canines are differentiated from the upper by the more decidedly sigmoid curvature of their anterior aspect, their somewhat smaller size, and the presence of but one groove or "sillon" on the exterior of the crown. The crown is shorter, stouter, and more curved, and the internal triangular area marked off by the sectorial ridges is more distinctly marked, and smaller, owing to the more backward position of the anterior ridge, which ends near the cingulum in a small but well-marked tubercle. Both ridges in the unworn tooth are strongly serrated. The cingulum is but feebly developed. The fang is hardly so massive as that in the upper jaw; it is somewhat compressed, and truncated at the base. The anterior outline of the whole tooth is a gentle convex curve, the posterior or internal is more or less slightly sigmoid. The postero-external face and point are often worn by the upper canine, sometimes to such an extent as almost to obliterate the external sillon. Similar remarks apply to the size of these canines (including those with regard to the small specimens from Ravens Cliff), as we made with reference to those of the upper jaw.

Premolars.—$\overline{\text{PM 3}}$ (Pls. I, VI, XII, figs. 7, 8, 9) of the lower jaw consists of a primary trenchant cone (*a*), accompanied by the anterior and posterior cusps (*b*) and (*c*). The cingulum is strongly developed posteriorly, forming a sharp edge interiorly. The crown is somewhat oval in section, and is supported by two fangs, connate, and nearly parallel in the larger, and highly divaricate in the smaller specimens, the posterior being the larger of the two. The anterior cusp (*b*) is obsolete in some specimens of both larger and smaller teeth. The anterior portion of the crown is always much smaller in transverse measurement than the posterior. In this last respect it resembles the lion; in the tiger, both anterior and posterior transverse measurements of the crown are nearly equal. The highly divaricate character of the fangs of the smaller teeth appears to be more characteristic of the recent lion than the more parallel arrangement of the larger, which we have found more prevalent in the jaguar. PM 2 of the hyæna somewhat resembles this tooth. It is, however, much shorter and broader, the cone (*a*) is lower, the cusp (*b*) is generally obsolete, the cusp (*c*) is much larger, and the cingulum more developed.

Premolar 4. (Pls. I, VI, XII, figs. 10, 11, 12).—This tooth is built precisely on the same plan as PM 3 with the exception that the cingulum is developed into a generally well-marked, posterior cusp (*e*), which, however, is occasionally obsolete, as in fig. 12. The primary cone (*a*) is also much higher and more trenchant, and (*b*) and (*c*) are much larger and more distinct. The cingulum is strongly marked, and developed, as in PM 3, into a cutting edge posteriorly and internally. The section of the crown is oval; the posterior and anterior transverse measurements being nearly equal. The fangs are stout and long, cylindrical, slightly divaricate, and narrowed at the tips.

True molar 1. Pls. I, VI, XII, figs. 13, 14, 15.—The lower true molar consists of two trenchant blades; the cutting edges are inclined to each other at an angle, slightly obtuse on the lateral, and very open internally on the vertical aspect; externally the surface is convex, fitting the sectorial portion of the upper premolar 4. Internally the surface is excavated in such a fashion that the trenchant edges are always preserved as the tooth is worn by PM 4 as in fig. 13. The width of the excavation at the base of the cleft is one of the distinctions between this tooth and that of the hyæna. The posterior blade (*a*) is somewhat higher than the anterior (*b*); the former is traversed throughout by a trenchant edge, which leads posteriorly to the almost obsolete cusp (*c*), and anteriorly it is divided from the cusp (*b*) by a deep cleft. The trenchant edge of (*b*) is continued only on its posterior upper border, the cusp being rounded anteriorly. The cingulum is well developed, and on the inner surface there are three well-marked central tubercles, besides others which are variable in number and size. The cusp (*b*), and half the cone (*a*), are supported by a large anterior fang, a compressed oval in section, slightly recurved and trapezoidal in outline; the remainder of (*a*), with the little cusp (*c*), are supported by a posterior fang), small, short, straight, cylindrical, and slightly tapering.

We have already indicated the only difference we can perceive between lion and tiger in the dentition of the lower jaw, in our description of PM 3. The variations, however, in this respect, in the corresponding teeth of the recent *Felidæ,* prove that it is a mere tendency and not a specific character.

The only fossil teeth of *Felis* we know of that can be compared with those of *Felis spelæa* are those of *Felis aphanista* of Dr. Kaup, from the Miocene of Darmstadt, and the *Felis arvernensis* of MM. Croizet and Jobert. The teeth of the former animal, among which may be reckoned the upper premolar 4, ascribed by Dr. Kaup to

F. prisca,[1] are not sufficiently well preserved to warrant an accurate comparison. $\overline{\text{PM } 4}$, however, appears comparatively smaller, and the cusps (*b*) and (*c*) are more nearly of the same size and shape than in *Felis spelæa*, and $\overline{\text{PM } 3}$ is proportionately much larger. It also closely resembles $\overline{\text{PM } 4}$ in shape, which is not the case in the more recent large *Feles*. Although in *Felis arvernensis*[2] $\overline{\text{M } 1}$ is nearly of the same size as in the smaller *Felis spelæa*, the summits of the blades are closer together, so that the tooth assumes a more pyramidal aspect, and the remainder of the dentition is proportionately of much smaller size. The species is considered doubtful by M. Gervais,[3] but he does not indicate its probable affinity. The distinctions between the teeth of *Felis* and *Machairodus* will be noticed in our description of the latter genus.

§ 3. *Milk dentition* (Pl. XIII).—The materials we have for describing the milk dentition of *Felis spelæa*, all obtained from the bone caves of Somerset, enable us to give the characters of all the teeth, except the upper incisors and the two inner incisors of the lower jaw.

The specimens we have examined are the following:

A left upper maxillary (Pl. XIII, fig. 1) that belonged to an animal of rather more than three months old, as far as we can estimate the age by a comparison with the skull of a lion's whelp in our own collection, which was about four months old when it died. It retains $\underline{\text{DM } 3 \text{ and } 4}$, with the alveolus of $\underline{\text{DM } 2}$, while germs of $\underline{\text{premolars } 3 \text{ and } 4}$ are imbedded in their alveoli in the substance of the bone. It was found in Hutton cave, in the Mendip. We also figure the anterior portion of a maxillary from Bleadon (fig. 2), which retains $\underline{\text{DC}}$ and $\underline{\text{DM } 2}$. The vertical aspect of the latter tooth is given in fig. 1″, in order to save space, and give, as far as possible, the natural arrangement of the milk molar dentition. We have a pair of maxillaries of a very young animal from Sandford Hill, one with $\underline{\text{DC}}$ and $\underline{\text{DM } 3}$, and the other with $\underline{\text{DM } 3}$; of this latter tooth we give a separate figure (fig. 6). We have also from Bleadon cave a crushed maxillary with $\underline{\text{DM } 3}$, and two other detached upper deciduous molars, 3. We are uncertain as to the exact locality whence came four upper canines, one of which we figure (fig. 5).

Of the lower jaw we have two nearly complete rami from Hutton, apparently belonging to the same animal as did the maxillary which we have figured. One of these, represented in fig. 3, possesses the deciduous molars 3 and 4, the fang of the deciduous canine, the alveoli of the deciduous incisors, and shows the germ of the true molar; the other has the fangs of the milk dentition and the germ of the molar. From the cave in Sandford Hill we have a pair of very young rami, which apparently belonged to the

[1] Kaup, 'Oss. Foss. de Darmstadt, Carnivora,' pl. ii, fig. 1, 16, 2.

[2] MM. Croizet et Jobert, 'Oss. Foss. du Puy de Dome,' pl. v, fig. 3.

[3] 'Zool. et Palæont. Françaises,' ed. 1859, p. 228.

same animal as the maxillaries above mentioned. The most perfect of these rami we figure with $\overline{\text{DC. DM 3 and 4}}$, (fig. 4); the other retains $\overline{\text{DC}}$ only. There is also a half ramus of a still younger animal, with $\overline{\text{DC}}$; and a $\overline{\text{DM 3}}$ of large size with very long fangs, of which we give a separate figure (fig. 8).

From Bleadon we have four more or less crushed rami of large size; one of which has $\overline{\text{DI. 3, DC. DM. 3 and 4}}$, the fangs of $\overline{\text{DI. 1 and 2}}$, and the germs of $\overline{\text{I 1. C. and M 1}}$ visible. The third milk incisor of this jaw is that represented in the figure of the large ramus (fig. 3), for the sake of economising space. A second ramus has $\overline{\text{DC. DM 3 and 4}}$; two others fangs only, and germs of permanent dentition; a fifth has $\overline{\text{DM 3 and 4}}$, and germ of C; a sixth, $\overline{\text{DM 3}}$; a seventh $\overline{\text{DM 4}}$. We are uncertain as to the locality whence were derived another ramus, with $\overline{\text{DM 3 and 4}}$; and three canines, the crown of one of which is represented in fig. 3, and the whole tooth in fig. 7. We know, however, that these teeth, as well as the upper canines, were from one or other of the Mendip caves. The whole of these specimens are in the Museum at Taunton.

We have met with notices of the occurrence of the fossil milk dentition of *Felis spelæa* in France and Germany.[1] MM. Marcel de Serres, Dubreuil, et Jeanjean have figured and described $\overline{\text{DM 3, DM 4, and DC}}$ of the lower jaw, and $\underline{\text{DM 3}}$ of the upper; the lower $\overline{\text{DM 3}}$ being wrongly described as "premiere fausse molaire." In Germany,[2] Professors Giebel and Heintz figure and describe a lower jaw, containing $\overline{\text{DC, DM3, and 4}}$. The whole of these teeth agree in every respect with those figured in our Pl. XIII.

§ 3 *a*. *Milk dentition of the upper jaw.*—Unfortunately we have met with no examples of the milk incisors of the upper jaw of *Felis spelæa;* but they probably differ in no respect, save size, from those of the lion. The milk upper canine $\overline{\text{DC}}$, (figs. 1, 1′, 8), somewhat resembles the lower permanent $\overline{\text{C}}$ in general form, but is more compressed on the intero-posterior side. The crown is traversed by two trenchant edges, the anterior of which is placed further forward than in $\overline{\text{C}}$; these circumscribe a nearly flat triangular area, and end basally in two small tubercles. This area presents, near the apex, two grooves or sillons, similar to those which are characteristic of the adult upper canines of *Felis;* but of which, on the external aspect, there is no trace in the deciduous tooth. The internal base of the fang is excavated, to afford room for the growth of the permanent canine.

Milk molar, 2. (Figs. 1″, 2, 2″.)—The small milk molar 2 is separated both from the canine and milk molar 3, by diastemata. It has a small cylindrical crown, consisting of a small central cusp, traversed by a low trenchant edge. It will be remembered that the above figures are all taken from the same tooth, in order to complete,

[1] 'Oss. Foss. de Luml. Viel.,' pl. vii, fig. 8, 9, 10, p. 111.

[2] 'Zeitschrift. für die Gesaminten Naturwissen schaften.,' vol. iv, 1854, p. 295, tab. vi.

as far as possible, in fig. 2, the appearance of the milk molar dentition in one maxillary. The tooth is supported by one small cylindrical and slightly tapering fang.

Milk molar, 3. (Figs. 1, 1′, 1″, 2, 2′, 6.)—This tooth, which is sectorial, is by far the largest of the series. The cone (*a*) of this tooth is central, compressed, rounded externally, and flattened internally; but a distinct buttress can be traced from the summit to the internal base, where a few minute prominences represent the tubercular cusp (*f*). It is furnished with sharp-cutting edges, anteriorly and posteriorly, the latter being nearly perpendicular, and separated from the long, horizontal, blade-like cusp (*c*), by a deep cleft; the latter, in the unworn tooth, has the appearance of being double, the trenchant edge being deeply waved, but the cleft, if any, is very slight; the tooth ends posteriorly in a much compressed but rounded lobe, formed by the cingulum; anteriorly the knife-like edge of (*a*) is inclined at an angle of about 45° to the horizontal line, and is divided from the cusp (*b*) by a cleft. The cusp (*b*) is of blade-like form, but short, and with a central point, from which descends obliquely in a backward direction a sharp-edged buttress to the tubercular (*f*), anteriorly this is again separated by another cleft from the "accessory" cusp (*d*), which is again of a short blade-like form, but rounded anteriorly. The summits of (*b*, *c*, *d*) are nearly in the same horizontal line, from which the cone (*a*) rises to a considerable height. They are so disposed that the trenchant edge they form is concave externally. The cingulum is strongly developed, and has two rows of minute raised dots on it externally, and one similar row internally. It is supported by two similar highly compressed trapezoidal divaricate fangs of flat oval section, the anterior supporting half (*a*), (*b*), and (*d*), and the posterior the rest of (*a*) and the whole of (*c*); a normal cylindrical internal fang supports the very minute representation of (*f*).

Milk molar, 4. (Figs. 1, 1′, 1″.)—The minute cusps and ridges which point out the true homologies of this tooth in *Felis* being easily worn, their determination is very difficult, except in the very young specimens. The crown is somewhat triangular in form, the longest side of the triangle forming the anterior border. The posterior angle forms a rounded lobe, on the summit of which is a minute cone, traversed by a sharp cutting ridge; this descends posteriorly to a minute cusp at the extremity of the angle, and anteriorly it turns outward, and terminates in the very young lion at a minute cleft, which separates it from a ridge forming the summit of another cusp, of the same shape as (*b*) in $\underline{\text{PM 4}}$ on the external angle of the tooth. The minute cone is the homologue of (*a*), and the small posterior cusp of (*c*). From the summit of (*a*) descends inwardly a broad rounded buttress, from the base of which arises, in very young lions, a small conical cusp, with distinct furrows passing from the summit to the base. This is the homologue of the tubercle (*f*). This portion is broken in our specimen of *Felis spelæa*, and the crest connecting (*a*) and (*b*) is continuous, instead of being interrupted by a cleft. This appears to be the result of wear. In other respects the teeth of the two animals resemble each other. The body of the tooth is supported by a broad flat fang, passing backwards into a shallow alveolus. This fang appears from its formation to be essentially double, and to represent the fangs of Premolar 4. The tubercular portion is supported by a normal cylindrical fang in its proper position. It is thus seen that in this tooth all the essential parts of the permanent upper carnassial are represented, but they are so modified in form as to cause the tooth to fulfil the functions of a tubercular molar.

§ 3 β. *Milk dentition of the lower jaw.* (Pl. XIII, figs. 3, 4, 7.)—The third milk incisor, which we have represented in fig. 3, is the only one which has come before our notice; it is from Bleadon cave, and is introduced in this figure for the reason assigned above, in our account of the milk molar 2 of the upper jaw. The tooth differs from the permanent incisor, by possessing not only the posterior cusp (*c*), but also the anterior (*b*), on each side of the low, blunt, slightly recurved cone (*a*). The three cusps are traversed by a slight blunt edge, and the crown is larger than the fang, which is, as far as can be seen, subcylindrical, slightly compressed, and recurved. Of the remaining milk incisors, we know nothing but the fangs; they appear to be more equal in size to incisor 3 than in the adult animal.

The deciduous canine $\overline{\text{DC}}$ of the spelæan lower jaw (figs. 3, 4, and 7), is of so remarkable a form, that it can hardly be confounded with that of any other animal. The crown (*a*) is compressed parallel to the median line, short and recurved, without grooves on the external aspect; the flattened internal area is well defined posteriorly by the trenchant edge, anteriorly it is separated from the external surface by another ridge, passing from the tip of the crown downwards to the point where a small buttress or cusp of enamel (*b*) occupies the inner base, and gives the crown almost the appearance of a flattened upper permanent incisor three. The fang is very broad antero-posteriorly, and deeply indented on the inner surface to make way for the germ of the permanent canine. $\overline{\text{DM 3}}$ (figs. 3, 4) is separated from the canine by a diastema, increasing with age. It consists of a stout, primary cone (*a*) inclined slightly backwards, with the secondary subequal cusps (*b*) and (*c*). The cingulum is well developed, and forms a well-marked but blunt cusp on the intero-anterior border of (*b*), and a very distinct and sharp-edged accessory cusp (*e*) posterior to (*c*). The whole tooth is traversed from the summit of (*b*) to (*e*) by a sharp trenchant ridge, the cusps being divided from each other by clefts. The cone (*a*) is smaller than its homologue in *Hyæna spelæa.* There is occasionally a supplementary, minute cusp on the internal side of (*c*). The tooth is supported by two strong, cylindrical, divaricate fangs.

The sectorial $\overline{\text{DM 4}}$ consists of two blades, the posterior (*a*) and the anterior (*b*), and a small secondary (*c*), posterior to which the cingulum folds into the posterior accessory (*e*), which, however, is frequently obsolete. The cone (*a*) is higher than (*b*), and is inclined backwards, but less so than in $\overline{\text{M 1}}$, which in other respects the tooth very closely resembles, both in form and in the scissor-like function that it performs with $\underline{\text{DM 3}}$, by which it is overlapped. A trenchant edge passes from the summit of (*b*) backwards to the posterior base of the tooth, the divisions of all the cusps being strongly marked by clefts, except between (*c*) and (*e*). The tooth is supported by two fangs, which in form and function resemble those of $\overline{\text{M 1}}$.

§ 4. *Measurements.*—The following tables of measurement in inches show the amount of variation in size of the teeth of *Felis spelæa*. Some are very much larger than any of those of the lion of modern times, while others are as small as those of the smallest recent lioness. Leonine, spelæan, and tigrine teeth form a graduated series, in which there are no valid points of specific difference.

TABLES OF MEASUREMENT.

Adult Dentition. Upper.	*Felis spelæa.*				*Felis leo.*		*Felis tigris.*	
	Bleadon. Taunton Museum.	Kent's Hole. British Museum.	Col. Wood. Ravenscliff. Figured Specimen.	Sundwig Skull. British Museum.	Large. Oxford Museum. 1.	Small. Cape. Oxford Museum.	Small. Himalayah. Oxford Museum.	Nepaul. British Museum, 114 C.
Incisor 1.								
1. Length	...	...	1·29	...	...	...	...	...
2. Height of crown	...	...	0·40	0·30	0·40	0·35	0·30	0·29
3. Width of ditto	...	...	0·23	0·24	0·22	0·22	0·23	0·23
4. Circumference	...	...	...	...	...	...	...	...
Incisor 2.			Ravenscliff. Figured Specimen.	Sundwig Skull.				
1. Length	...	...	1·32	...	...	...	...	...
2. Height of crown	...	...	0·43	0·45	0·43	0·36	0·39	0·31
3. Width of ditto	...	...	0·29	0·25	0·24	0·30	0·25	0·25
4. Circumference	...	...	...	...	...	...	...	...
Incisor 3.			Figured Specimen. Sandford Hill Cave. Taunton.	Sundwig Skull.				
1. Length	1·59	...	...	...	...	...	...	...
2. Height of crown	0·59	...	0·64	0·70	0·70	0·67	0·65	0·68
3. Width of ditto	0·51	...	0·52	0·45	0·40	0·43	0·48	0·54
4. Circumference	1·43	1·55	1·40	1·45	1·50	1·30	0·90	1·51

Adult Dentiton. Upper.	*Felis spelæa.*								*Felis leo.*			*Felis tigris.*		
	Colonel Wood. Ravenscliff, Gower.	Wookey Hyæna-den. Dr. Boyd. Taunton.	Williams. Bleadon. Taunton 8.	Beard. Sandford Hill. Taunton 1.	Small figured Skull.	Colonel Wood. Gower.	Sundwig Skull. British Museum.	Crayford. Prof. Morris.	W. A. S.	Large. Oxford Museum, No. 1.	Small. Cape. Oxford Museum.	Oude. Captain Speke.	W. A. S.	Large. Nepaul. British Museum, 114 C.
Canine.														
1. Length (extreme)............	5·50	5·25	4·80	4·25	...	3·35	...	6·0	...	...	...	4·80	...	...
2. Length along the outer curve	5·75	6·00	5·52	5·00	...	3·80	...	6·8	...	...	...	5·60	...	...
3. Length of the crown	2·29	2·42	2·10	1·80	1·35	1·30	1·60	2·9	1·80	2·10	1·90	2·35	2·15	2·10
4. Circumference	...	3·76	2·77	2·70	2·30	2·20	2·50	4·1	2·15	3·10	2·60	3·00	2·90	3·00

	Felis spelæa.			*Felis leo.*			*Felis tigris.*			
	Bleadon.	In Skull figured Pl. VI and VIII.		Large. Oxford Museum.	Cape. Small. Oxford.	W. A. S.	Oude. Captain Speke.	W. A. S.	India. Capt. Thornhill. Oxford Museum.	Nepaul. British Museum, 114 C.
Premolar 2.										
1. Length	0·36	0·31	0·31	0·37	0·35	0·37	0·31	0·32	0·46[1]	0·38
2. Breadth......................	0·28	0·27	0·27	0·31	0·26	0·29	0·23	0·25	0·25	0·25
3. Circumference	1·04	0·92	0·92	1·05	0·90	0·95	0·85	0·96	1·10	1·00

[1] This specimen of tiger's $\underline{\text{PM2}}$ is two-fanged, like that of *Felis spelæa* figured Pl. XI.

	Felis spelæa.										*Felis leo.*			*Felis tigris.*		
	Beard Collection, Taunton Museum.							Skull. Hutton. Williams' Collection, Taunton.		Kent's Hole. British Museum.	Large. Oxford Museum, 602 A.	Small. Cape. Oxford.	W. A. S.	Large. Oxford. Captain Thornhill.	Small. Himalayah. Oxford.	Large. Oude. Captain Speke.
	Bleadon Cave.					Sandford Hill.										
	8	4	3	5	7	1	2	1	2							
Premolar 3.																
1. Antero-posterior measurement ...	1·27	1·25	1·21	1·03	1·02	1·13	1·15	0·89	0·95	1·08	1·05	0·90	0·90	0·93	0·90	0·95
2. Postero-transverse measurement ...	0·58	...	0·62	0·50	0·51	0·58	0·57	0·44	0·45	0·54	0·50	0·45	0·45	0·48	0·40	0·45
3. Antero-transverse measurement ...	0·40	0·51	0·51	0·40	0·41	0·41	0·50	0·39	0·39	0·48	0·40	0·45	0·38	0·39	0·30	0·40
4. Height	0·70	0·65	0·80	0·55	0·62	0·65	0·64	0·55	0·60	...	...	...	0·50	...	...	0·47
5. Circumference ...	2·99	...	3·00	2·60	2·48	2·82	2·88	2·46	2·50	2·65	2·70	2·25	2·38	2·28	2·20	2·40

Adult Dentition. Upper.	*Felis spelæa.*											*Felis leo.*			*Felis tigris.*		
	Bleadon. Williams' Collection, Taunton.		Beard Collection, Taunton Museum.							Sundwig. British Museum.	Kent's Hole. British Museum.	Large. Oxford Museum, 602 A.	Small. Cape. Oxford.	W. A. S.	Large. Nepaul. British Museum.	Small. Himalayah. Oxford.	Oude. Captain Speke.
			Sandford Hill.				Blea-don.	Hutton.									
			1	2	3	4		1	2								
Premolar 4.																	
1. Antero - posterior measurement ...	1·75	1·70	1·65	1·62	1·60	1·60	1·50	1·35	1·34	1·50	1·54	1·50	1·31	1·35	1 45	1·40	1·35
2. Postero-transverse measurement ...	0·50	0·50	0·53	0·54	0·50	0·54	0·48	0·36	0·40	0·40	0·53	0·55	0·40	0·45	0·50	0·45	0·45
3. Antero-transverse measurement ...	0·86	0·82	0·84	0·83	0·90	0·90	0·68	0·70	0·70	0·60	0·70	0·85	0·60	0·71	0·75	0·65	0·72
4. Height of crown posterior to principal lobe, in cleft	0·40	0·40	0·50	0·40	0·41	0·40	0·36	0·31	0·30	...	...	...	...	0·29	...	...	0·30
5. Circumference ...	4·20	4·00	3·80	3·80	4·04	4·00	3·78	3·39	3·31	3·50	3·60	3·60	3·20	3·14	3·85	3·10	3·60

	Felis spelæa.	*Felis leo.*			*Felis tigris.*	
	Sandford Hill. Beard. Taunton.	Large. Oxford Museum.	Small. Cape. Oxford.	W. A. S.	Large. Nepaul. British Museum.	Oude. Capt. Speke.
Molar 1.						
1. Length	52	0·40	0·36	0·50	0·48	0·45

Adult Dentition. Upper.	*Felis spelæa.*				*Felis leo.*			*Felis tigris.*		
	Large figured Maxillaries.	Small figured Skull.	Sundwig Skull. British Museum.	Col. Wood's Fragment, Ravenscliff.	Large. Oxford Museum, 602 A.	Small. Cape. Oxford.	W. A. S.	Large. Nepaul. British Museum, 114 C.	Large. Oxford Museum.	Small. Himalayah. Oxford. Without PM2.
Molar series.										
Length of	3·40	2·74	2·70	3·10	3·00	2·80	2·80	2·75	2·50	2·20

Adult Dentition. Lower.	*Felis spelæa.*			*Felis leo.*			*Felis tigris.*		
	Figured Specimen. Mendip.	Bleadon. Taunton Museum.	Sandford Hill. Taunton.	W. A. S.	Large. Oxford Museum.	Cape. Small. Oxford Museum.	W. A. S.	Oude. Capt. Speke.	Small. Himalayah. Oxford Museum.
Incisor 1.									
1. Length	1·04	Crown worn.	...	...	...	...	...	...	...
2. Height of crown	0·29		...	...	0·26	0·25	0·26	0·28	0·28
3. Width of ditto	0·20	0·20	...	...	0·15	0·17	0·15	0·20	0·28
4. Circumference	0·60	0·60	...	...	...	...	0·45	0·50	...
Incisor 2.	Sandford Hill. Figured Specimen.								
1. Length	1·35	1·38	1·25	0·93	...	...	1·0	...	...
2. Height of crown	0·35	0·38	0·32	0·25	0·32	0·30	0·30	0·34	0·34
3. Width of ditto	0·26	0·29	0·22	0·18	0·22	0·20	0·24	0·20	0·24
4. Circumference	0·80	0·85	0·75	0·65	...	...	0·70	0·75	...
Incisor 3.									
1. Length	1·65	1·51	...	1·20	...	...	1·30	...	...
2. Height of crown	0·45	0·47	...	0·40	0·68	0·40	0·40	0·40	0·44
3. Width of ditto	0·42	0·33	...	0·29	0·28	0·27	0·30	0·30	0·35
4. Circumference	1·05	1·00	...	0·98	...	...	0·87	0·90	...

	Felis spelæa.								*Felis leo.*			*Felis tigris.*		
	Williams' Collection at Taunton, from Bleadon.					Beard Col., from Sandford Hill.	Col. Wood. Ravenscliff, Gower.	Oreston. Jermyn Street.	W. A. S.	Large. Oxford Museum.	Cape. Small. Oxford Museum.	Oude. Capt. Speke.	W. A. S.	Small. Oxford. Himalayah.
	1	11	12	9	5									
Canines.														
1. Length of outer curve	5·40	5·00	5·50	5·50	4·20	4·78	...	3·9	...	...	...	...	...	...
2. Length of crown	2·10	1·60	1·70	2·10	1·50	1·90	1·30	1·5	1·50	1·60	1·58	1·95	1·70	1·65
3. Antero-posterior diameter	1·10	1·20	1·20	1·10	0·98	1·10	0·90	0·85	0·90	1·15	0·87	1·07	1·00	0·82
4. Circumference	3·25	3·20	3·20	3·10	2·60	2·80	2·10	...	2·10	2·90	2·50	2·75	2·45	2·10

Adult Dentition. Lower.	*Felis spelæa.* Williams' Collection at Taunton, from Bleadon. 1	2	Beard Collection. Figured Specimen in Pl. I.	14, Bleadon.	Figured specimen in Pl. IV.	W. B. Dawkins. Wookey Hyæna-den. 1	2	*Felis leo.* W. A. S.	Large. Oxford Museum.	Cape. Small. Oxford Museum.	*Felis tigris.* W. A. S.	Oude. Capt. Speke.	Small. Oxford. Himalayah.
Premolar 3.													
1. Antero-posterior measurement	0·80	0·80	0·78	0·84	0·62	0·66	0·60	0 57	0·80	0·70	0·58	0·58	0·78
2. Maximum transverse ditto	0·50	0·45	0·42	0·47	0·34	0·35	0·34	0·29	0·40	0·40	0·34	0·34	0·32
3. Height of crown	0·54	0·53	0·46	0·47	0·39	0·38	...	0·30	...	...	0·34	0·34	...
4. Circumference	2·10	2·10	2·10	2·20	1·60	1·72	1·62	1·52	2·10	1·80	1·52	1·70	1·72
5. Transverse measurement, anterior lobe	0·36	0·34	...	0·37	...	...	...	...	0·30	0·28	...	...	0·28

	Felis spelæa. Williams' Collection, from Bleadon Cave. 1	2	3	5	*a*	*b*	Beard Collection. Figure of Jaw, Pl. I. 1	2	Figure of Jaw, Pl. VI.	*Felis leo.* W. A. S.	Large. Oxford Museum.	Cape. Small. Oxford Museum.	*Felis tigris.* W. A. S.	Oude. Capt. Speke.	Small. Oxford. Himalayah.
Premolar 4.															
1. Antero-posterior measurement............	1·25	1·16	1·10	1·20	1·30	1·29	1·22	1·25	0·90	0·95	1·20	1·00	0·90	1·00	0·90
2. Width of crown, maximum	0·64	0·52	0·50	0·55	0·60	0·54	0·54	0·57	0·41	0·50	0·60	0·50	0·46	0·49	0·48
3. Height of crown	0·88	0·75	0·60	0·80	0·80	0·84	0·78	0·80	0·58	0·60	...	...	0·53	0·60	...
4. Circumference	3·10	2·90	2·70	3·00	3·19	3·10	3·08	3·03	2·28	2·35	2·85	2·35	2·20	2·60	2·30
5. Transverse measurement of anterior lobe..................	0·50	0·49	0·43	0·49	...	...	...	...	...	0·38	0·45	0·40	0·30	0·40	0·40

	Felis spelæa. Wookey Hyæna-den. Sanford.	Williams' Collection, from Bleadon. 1	3	4	5	Beard Coll., Bleadon. 4	5	*Felis leo.* W. A. S.	Large. Oxford Museum.	Cape. Small. Oxford Museum.	*Felis tigris.* W. A. S.	Oude. Captain Speke.	Small. Oxford. Himalayah.
Molar 1.													
1. Antero-posterior measurement	1·03	1·30	1·10	1·30	1·15	1·28	1·20	1·02	1·05	1·05	1·00	1·10	1·00
2. Width of crown, maximum ...	0·56	0·60	0·40	0·60	...	0·60	0·58	0·51	0·50	0·48	0·50	0·56	0·40
3. Height of crown at cleft	0·30	0·50	0·50	0·45	...	0·43	0·42	0·32	...	...	0·33	0·36	...
4. Circumference	2·60	3·05	2·70	3·25	2·90	3·05	3·00	2·50	2 60	2·50	2·40	2·70	2·40

The length of the molar series is given in the measurements of the lower jaw, page 5.

Milk Dentition. Upper.	*Felis spelæa.* Bleadon. Figured Specimen.	*Felis spelæa.* Williams and Beard, from Hutton and Sandford Hill. 1	2	3	4	5	*Felis leo.* W. A. S.	*Felis leo.* British Museum, 112 F.	*Felis tigris.* Brit. Mus., 114 G.
Canine.									
1. Antero-posterior measurement	0·49	0·40	0·46	0·45	0·40	0·42	0·36	0·29	0·39
2. Transverse measurement	0·30	0·30	0·32	0·30	0·30	0·32	0·24	0·20	0·28
3. Height of crown	0·91	0·75	0·89	0·81	0·70	0·85	0·66	0·50	0·72
4. Circumference	1·25	1·20	1·18	1·21	1·10	1·15	1·00	0·80	1·10

	Felis spelæa. Bleadon. Figured Specimen.	*Felis leo.* British Museum, 112 F.	*Felis tigris.* British Museum, 114 B.
Milk Molar 2.			
1. Length	0·14	0·15	Not in the skull.
2. Width	0·11	0·12	
3. Height	0·09	0·10	
4. Circumference	0·30	0·40	

	Felis spelæa. Hutton. Figured Specimen.	*Felis spelæa.* Hutton.	*Felis spelæa.* Sandford Hill. 1	Sandford Hill. 2	*Felis leo.* W. A. S.	*Felis leo.* British Museum, 112 F.	*Felis tigris.* Brit. Mus., 114 G.
Milk Molar 3.							
1. Length	1·00	1·06	0·93	0·93	0·91	0·87	0·92
2. Width of anterior lobe	0·27	0·35	0·30	0·26	0·25	0·22	0·21
3. Ditto of posterior lobe	0·33	imp.	0·30	0·28	0·30	0·24	0·21
4. Height of crown	0·50	0·54	0·50	0·50	0·46	0·42	0·40
5. Circumference	2·35	2·40	2·30	2·28	2·05	2·00	2·00

Milk Dentition. Upper.	*Felis spelæa.* Hutton. Figured Specimen.	*Felis leo.* W. A. S.	*Felis leo.* Brit. Mus., 112 F.	*Felis tigris.* British Museum.
Milk Molar 4.				
1. Length	0·28	0·25	0·25	0·25
2. Width	0·50	0·50	0·43	0·40
3. Height	0·23	0·18	0·18	0·15
4. Circumference	1·37	1·10	1·10	1·00

	Felis spelæa.	*Felis leo.*	*Felis tigris.*
Length of milk molar series	1·56	1·52	1·52

Milk Dentition. Lower.	*Felis spelæa.* Bleadon. Taunton Museum. Figured Specimen.	*Felis leo.* Young unworn Tooth. W. A. S.	*Felis tigris.* British Museum, 114 G.
Incisor 3.			
1. Length of crown	0·22	0·16	0·16
2. Width of ditto	0·20	0·12	0·12
3. Circumference	0·50	0·36	0·40

	Felis spelæa. Sandford Hill. Taunton. Figured Jaw. 1	*Felis spelæa.* Sandford Hill. Taunton. Figured Jaw. 2	*Felis spelæa.* Bleadon.	*Felis spelæa.* Mendip. Taunton Museum. 1	*Felis spelæa.* Mendip. Taunton Museum. 2	*Felis spelæa.* Mendip. Taunton Museum. 3	*Felis leo.* Brit. Mus., 112 F.	*Felis tigris.* Brit. Mus., 114 G.
Canine.								
1. Antero-posterior measurement	0·50	0·48	0·55	0·50	0·48	0·44	0·33	0·42
2. Transverse measurement	0·21	0·22	0·25	0·25	0·26	0·21	0·16	0·20
3. Height	0·72	0·78	imp.	0·76	0·75	0·72	0·50	0·60
4. Circumference	1·20	1·28	1·20	1·40	1·30	1·10	0·80	1·0

MILK DENTITION. Lower.	*Felis spelæa.* Sandford Hill. Taunton.	Bleadon Cave. Taunton. 1	Bleadon Cave. Taunton. 2	Bleadon Cave. Taunton. 3	Hutton Cave. Taunton.	*Felis leo.* Brit. Mus., 112 F.	*Felis tigris.* Brit. Mus., 114 G.
Milk Molar 3.							
1. Antero-posterior measurement ...	0·53	0·60	0·70	0·60	0·51	0·50	0·50
2. Transverse, anterior lobe	0·23	0·25	0·27	0·25	0·22	0·20	0·18
3. Transverse, posterior lobe	0·26	0·28	0·27	0·30	0·26	0·21	0·22
4. Height of crown......................	0·40	0·40	0·45	0·44	0·34	0·33	0·30
5. Circumference	1·30	1·40	1·60	1·50	1·30	1·20	1·20

	Felis spelæa. Sandford Hill. Taunton Mus.	Bleadon Cave. Taunton. 1	Bleadon Cave. Taunton. 2	Hutton Cave. Taunton.	*Felis leo.* Brit. Mus., 112 F.	*Felis tigris.* Brit. Mus., 114 G.
Milk Molar 4.						
1. Antero-posterior measurement	0·68	0·80	0·85	0·67	0·67	0·70
2. Transverse measurement of anterior lobe	0·26	0·30	0·25	0·25	0·23	0·22
3. Ditto ditto, posterior lobe	0·27	0·50	0·35	0·30	0·24	0·21
4. Height of anterior lobe	0·41	0·45	...	0·38	0·39	0·35
5. Ditto of posterior lobe	0·46	0·50	0·55	0·44	0·43	0·40
6. Circumference	1·65	1·80	2·00	1·70	1·50	1·60

	Felis spelæa. Sandford Hill.	Bleadon.	Hutton.	*Felis leo.* Brit. Museum.	*Felis tigris.* Brit. Museum.
Molar series.					
Length of.....................	1·20	1·30	1·20	1·25	1·20

CHAPTER VIII.

VERTEBRÆ, STERNUM, Pls. XIV, XV, XVI.

CONTENTS.

§ 1. *Introduction.*—The vertebral column in the genus Felis is tolerably constant as to the number of the vertebræ, except as regards the tail. For the most part the numbers are—cervical 7, dorsal 13 (rarely 12), lumbar 7, sacral 3; in the tail the number varies considerably, not only in different species, but also in different individuals of the same species. In the larger old-world forms it generally exceeds 20; Cuvier[1] assigns 26 to the lion, 25 to the tiger, 24 to the panther: these probably exceed the average. The jaguar has fewer, generally under 20.

We are fortunately enabled to give figures of the more important vertebræ from the Somerset specimens at Taunton, and have been aided in our examination, and in one instance in completing the figure, by the series of casts from Gailenreuth, which have been presented by Sir Philip G. Egerton, F.R.S. to the Museum of the College of Surgeons and the British Museum. We have found a very close agreement between

[1] 'Leçons d'Anatomie comparée,' ed. 1835, vol. i, p. 180.

the German and the English specimens, and therefore have not scrupled to use them both in restoring outlines.

§ 2. *Atlas* (Pl. XIV, figs. 1, 1′, 1″).—The only British specimen that we have seen is the central portion, without the transverse processes, of a very fine and large atlas from Sandford Hill Cave, in the Taunton Museum. It is that of a full-grown, though still young animal, and closely agrees in condition and age with the larger skull in the same collection. It is somewhat larger than a cast from Gailenreuth; but as it agrees with it in other respects, we have restored the transverse process (*pl*) by copying that of the German specimen, somewhat larger than nature.

The centrum of this vertebra being the odontoid process of the axis,[1] that which is often described as the centrum is the "hypapophysis" (*hy*). It is of moderate thickness, without epiphyses, somewhat thicker centrally than proximally or distally, but showing hardly any trace of the anterior tubercle on the ventral surface, which slight trace, however, afforded origin to the first of the series of five muscles which answer to the "longus colli" in man. The hypapophysis ends proximally in a well-defined notch between the glenoid or proximal zygapophyses (*az*), and distally in a well-defined tubercle between the axial or distal articulations. This tubercle gives attachment to a strong ligament, the "axo-atloid," which unites the atlas with the axis. The odontoid articulation on the inner surface of the ventral portion of the ring is well defined and slightly raised, having a slightly depressed and roughened space between it and the tubercles for the "transverse ligament" on the inside of each neurapophysis (figs. 1, 1″, *e*).

The neurapophyses are, as in the recent lion, ample, and of considerable proximo-distal length, and at their symphysis affect the form of a low neural spine that is slightly bifurcated proximally, and affords an attachment for the origin of the "rectus minor posterior capitis."

The very great projection of the proximal zygapophyses (*az*) beyond the transverse processes affords a means of distinguishing the atlas belonging to *Felis spelæa* from that of *Ursus spelæus*, or *U. arctos*. In *Ursus maritimus*, however, or the Polar bear, the same projection is visible. They are separated by a deep broad notch on the dorsal margin of the ring (fig. 1, *o*), to which the ligament that bridged over the space between the atlas and the skull was attached, and the dorsal edge of each is interrupted by a small but well-defined notch, which, however, is not constant in the recent lion (fig. 1, *b*). The distal or axial zygapophyses (*pz*) form flat broad articulations exactly as in the lion, diverging nearly at right angles from each other, and separated through the greater part of their extent by the entire width of the spinal canal; but they send prolongations along the ventral edge of the ring, so that they are only separated by the small tubercle mentioned above, which terminates distally the hypapophyses (fig. 1″, *r*).

[1] Owen, 'Homol. of Vert Skeleton,' p. 93.

The very wide and massive transverse process is composed, as usual, of the di-, par-, and pleur-apophyses, the distal and ventral portion being the latter (figs. 1′, 1″), and the proximal and dorsal the former. Between these and their attachment to the neurapophyses passes the canal for the vertebral artery (*v*), which thus perforates the base of the process in a longitudinal direction, having its distal orifice (fig. 1″, *v*) on the superior or dorsal surface, close to the external edge of the axial articulation, and its proximal in the infero-lateral surface (fig. 1, *v*). The vestibule leading to this orifice is shared also by the smaller foramen that perforates the diapophysis horizontally. The canal does not at this point as in the hyæna perforate the diapophysis vertically, but it passes round the proximal edge of the process in a dorsal direction, to the orifice of the larger foramen which perforates the upper part of the neurapophyses close to the zygapophyses, and gives a passage at once to the vertebral canal and the sub-occipital nerve (fig. 1′, *s*).

The arrangement of these canals is precisely the same in Felis, Lutra, and Canis; but the anterior canal, which is in those animals the simple deep groove above described, is arched over by an inward prolongation of the anterior edge of the diapophyses in Ursus and some other carnivora. M. de Blainville states[1] that a difference exists in this bone between the lion and tiger, which we have not been able to verify. "L'atlas offre l'orifice d'entrée du canal carotidien bien plus marginal que dans le lion." We do not know to which orifice of the vertebral artery this alludes, but we are unable to find any constant distinction in the positions of the openings of either of the foramina of this bone in either of the above animals; and allowing for such individual variations as we have met with in them, we can see no difference between the fossil and recent forms in this respect.

The roughened surface below the large ventral foramen is the principal origin of the "levator scapulæ" "transverso-scapularis" of Straus-Durckheim, and also of the proximal root of the "rectus anticus capitis major." Within this again is the lesser muscle of the same name as the last, the two acting together as flexors of the neck.

In the figures[2] given by M. de Blainville of the atlas in lion and tiger considerable differences appear to exist in the outline of the transverse processes. We presume that M. de Blainville found, as we have, that these differences were not constant, as he has not alluded to them in his text. It appears to us that the form of the bone, as seen in the English and German specimens, and that of the transverse process in the latter, is about intermediate between those of the lion and tiger as represented in M. de Blainville's plate.

We have represented the Somerset bone in three aspects, from which, perhaps, a better idea of the exact form is given than by the most elaborate description.

The great surface afforded on the dorsal aspect by this bone indicates a very great power that must have existed in the "obliquus superior" muscle, which is inserted

[1] 'Ost. Felis,' p. 28.

[2] 'Ibid.,' pl. xi.

over the whole dorsal surface of the transverse process, taking its origin from the spine of the axis. The principal office of this muscle is to shake and rotate the head through the medium of the atlas; it is connected with the tearing and worrying power of the animal. The *Hyæna spelæa* may have had greater leverage, for the transverse process is somewhat longer proportionally; but the great European lion had far greater surface, owing to the far greater proximo-distal measurement, and the muscle was probably of enormous power. The external angle of the transverse process affords the insertion to the first isosceles and the first scalene; the first originating on the diapophysis of the axis and the neurapophyses of the four next cervicals; and the latter on the diapophyses of the five posterior cervicals. These serve as lateral flexors of the head.

§ 3. *Axis.*—The only part of the axis which has occurred to us from any British locality is the odontoid process, with the anterior zygapophysis. These closely resemble the same part in lion and tiger, except in size. The odontoid process is longer and more pointed in the genus Felis than in the bear; but there is no difference that we can describe observable between the zygapophysis in any of the larger carnivora. The proximo-distal length of the neurapophysis offers a means of distinction, it being considerably longer in the Felidæ than in the Ursidæ.

Fragment from Sandford Hill, at Taunton.

	INCHES.
Length of the odontoid process	1·23
Width at base of do. do.	0·90
Height do. do. do.	0·90
Width of anterior zygapophysis	3·50

§ 4. *Third, Fourth, Fifth, Sixth, Seventh Cervicals.*—The remaining cervical vertebræ of the whole of the terrestrial carnivora are remarkably alike. The elliptical section of the centrum (*c*), with articular epiphyses more or less inclined to the spinal axis, the ample neural arch (*n*) and large lateral arterial canals, the broad flat zyapophyses (*az*, *pz*), and well-developed and widely spread diapophyses (*d*), from which descend, increasing in depth and complexity of outline from the third to the sixth, the pleurapophysial plates (*pl.*), the absence of a vertebral canal in the seventh vertebra, are characters common to the whole of the order; and it is only by a close comparison between the forms which are near to each other in size that they can be effectually differentiated.

The only cave vertebræ that are likely to be confounded with the cervicals of *Felis spelæa* are those of bear, about the size of large *Ursus arctos*.

From the ursine cervicals, the following points will be found sufficient to distinguish those of the large Felines. They are generally longer in proportion to width, particularly the third and fourth; and this is very evident in the broad upper surface of the neurapophyses (*n*); the diapophyses of the third, fourth, and fifth vertebræ are less detached and less angular in section in Felis than in bear, and form a sharper curve upwards, and thus are brought nearer to the zygapophyses. The articular epiphyses of the centrum are more sharply inclined to the spinal axis in Felis, and the inferior border of the pleurapophysis passes from the anterior orifice of the arterial canal backwards, in a more or less gentle sweep in the bear, whereas in Felis it is brought more or less forwards, forming a more or less decided anterior process before passing backwards in a waved sweep to the posterior angle.

Most of the specimens of these vertebræ of *Felis spelæa* that have passed through our hands are from Bleadon Cave, and are badly crushed and mutilated. We have, however, been able to make out the following—two fourth, one fifth, and one sixth. We have, also, one sixth cervical, which was sufficiently perfect to figure, from Sandford Hill (Pl. XIV, figs. 2, 2′, 2″, 2‴). No specimen of the third or seventh has occurred to us.

The best specimen of the fourth closely resembles that of a lion, except in size. The centrum is tolerably perfect, with the lateral canals and the greater part of the neurapophyses, both post- and the right pre-zygapophyses; but the neural spine and the di- and pleur-apophyses are gone. All its proportions are larger than those in lion. It shows slight evidence of exostosis under the epiphyses, a disease to which, as well as the recent, the fossil carnivora appear to have been subject. The second specimen, which is much less perfect, is about the size of that of ordinary lion. The single fifth from Bleadon, though a good deal crushed, is perfectly recognisable throughout. The centrum with both arterial canals, the right diapophysis with part of its pleurapophysis, and the right neurapophysis with its zygapophysis, are nearly perfect. The rest is broken away. This specimen belonged to an animal quite as large as that indicated by the largest other bones we have met with; it does not, however, differ in any other recognisable respect from the recent species.

Of the sixth vertebra, one specimen from Bleadon, much mutilated, agrees exactly with that of a rather large recent lion or tiger. The other, from Sandford Hill, appears, from the texture of the bone, to have belonged to a young but fully adult animal, rather smaller than that to which the atlas we have figured belonged, but still larger than the average lion. Its feline characters are—the somewhat greater antero-posterior length of the neurapophyses (*n*), when compared with those of the bear; the anterior edge, which connects the pre-zygapophyses (*az*), and the diapophyses (*d*), being well rounded instead of being flattened and angular, as in the bear; the diapophyses, also, stand more clearly out from the pleurapophyses (*pl.*), and the ridge forming the inferior edge of this process is directed forwards towards the anterior angle of the pleurapophysis, instead of downwards and backwards to the posterior angle, as in the bear. The anterior border of the pleurapophyses, though broken, projects too much forward to be restored as the same part in any of the larger bears. The posterior angle of the same process closely resembles the same part in tiger, of which animal we have seen specimens with the neural spine (*ns*), of precisely the same form as our fossil. The sweep of the curve formed by the di- and neur-apophyses is more open than usual in *Felis*, and in this the fossil resembles bear, as also in the greater inclination of the zygapophysial articulations; but we have met with feline (and especially tigrine) vertebræ which have quite as great an inclination.

We have already indicated the principal muscles which connect the head with the neck in Felis, as also those which belong to the atlas.

The posterior portion of the "longus colli" in man is represented in Felis by a powerful muscle, which has its origin on the centra of the six anterior dorsal vertebræ, and its insertion on the strong ligament called the "cord of the sixth cervical," which connects the anterior with the posterior process of the pleurapophysis of that vertebra. Other heads unite the centrum of the first dorsal with the pleurapophyses of the third, fourth, and fifth cervicals. The anterior part of the "longus colli" is represented by a series of small muscles, which pass diagonally inwards from the anterior edges of the cervical pleurapophyses to the centra of the vertebræ anterior to those from which they take their origin. The "rectus anterior capitis" may be considered to represent the first of this series. These muscles are the principal direct flexors of the head, and their power may, to a certain extent, be estimated from that of the pleurapophyses to which they are attached. They are aided indirectly by others, acting also as lateral flexors, which are analogous to the scalene muscles in man, and are divided by Straus-Durckheim into two series; the "isosceles," equivalent to the "anterior scalene," and the "scalene," equivalent to the "middle and posterior scalene" in man. The former unite the diapophyses of each vertebra with the pleurapophyses of those posterior to them, and the latter uniting in the first place the diapophyses together, thus representing the "cervicalis descendens" in man; and secondly, these processes, with the ribs, answering, as far as the neck is concerned, to the "scalenus anticus," "posticus," and "medius," in man, but succeeded in the back of Felis by others, which are simply a continuation of the series passing from the ribs, as far back as the eighth pair, to the diapophyses of the cervical vertebræ.

The "inter-transversales colli" are stout muscles which pass from one diapophysis to that immediately succeeding it, and similarly the "intercostals" pass from one pleurapophysis to another. All these aid as lateral flexors.

There are other muscles which have both their origin and insertion in the diapophyses of the vertebræ. They form one series in the cat; the anterior portion of them, which pass from the diapophyses of the different vertebræ to those preceding them, and also to the anterior dorsals, equivalent to the "transversalis colli" of man; and the second portion more particularly belonging to the back, are equivalent to the "latissimus dorsi" in human anatomy. The "interspinales" are between the neural spines, and are necessarily very slight, the attachments being only the knife-like edges of these parts of the vertebræ. The "spinalis dorsi," taking its origin on the neural spines of the last two dorsals and the first three lumbars, is inserted in the same part of the last two cervicals and the first eight dorsals. This muscle belongs to the same order as the "splenius," which we have described in our account of the head, and with it and the "transversalis colli" and "interspinalis" constitutes the principal "extensors," or lifters of the neck.

The rotation of the neck is performed by the "multifidi spinæ," which, originating in the prezygapophyses of the five last cervicals, are inserted in the neural spines of the vertebræ preceding those from which they arise; their arrangement is somewhat complicated.

The "serrati" muscles do not appear to be connected directly with the neural spines, but with aponeurosis common to these and to other muscles. The "serratus major" is thus connected with the last five cervicals, and its heads are inserted on the spine of the scapula, which it retracts. In the same way the "acromio-circularis" of Straus-Durckheim, answering to the posterior portion of the trapezius in man, is connected by the cervical ligament with the spine of the axis, it being inserted on the spine of the scapula about the middle of its length. Passing backwards, this is followed by the "rhomboid," which is in the same way indirectly connected with the spines of the other cervicals; the two with the "transverso-scapularis," or "levator anguli scapulæ," described in our account of the "atlas," act together as elevators of the scapula.

§ 5. *Dorsal Vertebræ* (Pls. XV, XVI, figs. 1, 2.)—The dorsal vertebræ of the carnivora may be divided into four distinct forms—the first or cervical form, the second or dorsal proper, that to which the dorsal and lumbar neural spines converge, and those which resemble the lumbar vertebræ, and are often called rib-bearing lumbars. In some carnivora, such as the hyæna, these last three classes merge one into the other; in Felis the differences are very marked.

In Felis the first dorsal closely resembles the last cervical; but it is distinguished at sight from it by the much shorter diapophyses terminated by the pleurapophysial articulation, as also by the articulation for the necks of the first and second ribs on the centrum, and by the longer neural spine. The centrum is also wider, as it affords space in the width for the rib articulations above mentioned. From the corresponding vertebra of the bear it is easily separated by the much greater inclination of the epiphysial articulation to the axis of the spine, and by the greater comparative length of the centrum; the prezygapophysial interval is also much narrower, and the mass formed by the union of the prezygapophysis and the diapophysis is much smaller. The slight metapophyses of the ursine vertebra are also absent. The neural spine is also less upright, and the pleurapophysial articulation on the post-epiphyses are larger, flatter, and more on the same level with the rest of the articulation than in the case of the bear.

Two specimens of this vertebra have occurred to us, which we refer to *Felis spelæa;*

the one is a good deal larger than that of ordinary lion, and consists of the centrum, the neurapophysis with the root of the neural spine, the right prezygapophysis with post-zygapophysis and the roots of the diapophyses: the other is more mutilated, and does not differ in size from the corresponding vertebra in lion.

The second dorsal in Felis is intermediate in form between the first and the remainder of the typical dorsal series. The centrum (*c*) is elliptical in section, and the prezygapophyses (*az*) are widely separated, as in the cervicals, but the postzygapophyses (*pz*) are nearer together under the neural spine, as in the other dorsals. We have one specimen of this vertebra from Sandford Hill in the Taunton Museum. It is all but perfect, and we have devoted an entire plate (Pl. XV) to its illustration.

We can detect no difference whatever between it and that of the lion or tiger, except size and the length of the neural spine (*ns*); but the amount of inclination of the latter is exactly the same as in the larger Feles. In comparing several skeletons of these species, we have not the neural spine of exactly the same form in any two; in most the form is slightly sigmoid, the bend backwards near the summit being very decided.

The large mounted skeleton of the lion in the College of Surgeons has the neural spine of this vertebra precisely of the form of that of our fossil. It is, however, slightly shorter. We have also met with vertebræ of the jaguar[1] and leopard which closely resemble it in general appearance.

The greater length of this spine would indicate greater carrying power in the *Felis spelæa* than in ordinary lion and tiger. There is also another slight difference; at the posterior base of the spine (Pl. XV, fig. 1″) there is a deep and somewhat large hollow in the fossil. This occurs occasionally in all the dorsal vertebræ of carnivora, and we have found precisely the same formation in the jaguar, and it is evidently only varietal in importance.

In comparing the vertebra with the corresponding one of the bear, we find that the centrum of the latter is proportionally much wider and shorter. The diapophysial articulation (*d*) for the tubercle of the rib is much larger, the posterior parapophysial articulation (fig. 1′, *pe*) for the head of the rib is much flatter, larger, and more even with the epiphysial articulation. The diapophyses (figs. 1, 1′, 1″, *d*) are much wider, and with the prezygapophyses (*az*) form a much larger mass, furnished like the first dorsal, with metapophyses, which do not appear in Felis. The prezygapophyses are also flatter, and do not turn upwards at any part towards the neural spine, as is the case in this vertebra; and, as in all the Felis we have met with, the post-zygapophyses (*pz*) are also flatter, further apart, and afford a less firm lock with the third vertebra in bear than in Felis. The posterior edges of the diapophyses are formed by sharp ridges between the pleurapophysial articulations and the post-zygapophyses; but this ridge in our specimen, as in all recent Feles, forms a short concave curve, where as in bear the edge forms a long, straight, or rather convex ridge.

[1] See also plate of skeleton of jaguar, De Blainville, 'Ost. Felis,' pl. iii.

The next eight constitute in Felis the dorsal vertebræ proper or characteristic. The general form is the same throughout. The cylindrical centra, with flat epiphyses, are at right angles to the spinal axis, the parapophysial articulations for the heads of the ribs sit well on the side of the anterior epiphyses. The short, strong, but not over-massive diapophyses with the flat articulations for the tubercles of the ribs and the well-defined metapophyses projecting inwards and upwards from the head of the diapophyses, the flat prezygapophyses but slightly inclined to each other and to the spinal axis, lying on the top of the neurapophyses, and the equally flat post-zygapophyses lying well under the posterior base of the neural spine, and but slightly separated from each other, are characters common to the whole series of these vertebræ. The neural spine is also well developed, but decreases in height and increases in inclination from the third to the tenth, and by this means the vertebræ can be distinguished from each other, as well as by the length of the centra, and also of the neurapophyses where they join the centra, and by the projection of the prezygapophyses in front of the centra; of these, the first two increase, while the last decreases backwards. Unless we have bones from the same animal, it will be always a matter of doubt whether a given vertebra is, say, the seventh or eighth, or the eighth or ninth; for these characters vary within small limits in different individuals. The form of the neural spine also varies, but it is generally more or less sigmoid in outline, though often nearly straight.

In comparing these vertebræ with those of the Bear, the latter are much shorter, and somewhat deeper, the zygapophyses are wider apart, and the diapophyses longer, and the metapophyses in general less developed. The anterior base of the neural spine is flatter, and the inclination of the spine is generally greater, but the latter appears to be variable in the Bear.

Of this part of the vertebral column of *Felis spelæa* we have only two vertebræ, both from Bleadon. One of them is sufficiently perfect to figure (Pl. XVI, fig. 1, 1′). It consists of the centrum with the neurapophyses, and a portion of the neural spine, the zygapophyses, and the left diapophysis, of which the metapophysis is broken. It agrees closely in all respects with the seventh dorsal of the Lion, except that the inclination of the spine is about that of an average specimen of the eighth. The last character, however, being variable, we consider it a seventh dorsal. The other is a good deal rubbed and broken, and both diapophyses are gone, but in other respects it is much in the same condition as the last. As the neurapophyses are slightly longer, we consider it to be an eighth. Both specimens much exceed those of an ordinary Lion in size.

Of the third form of the dorsal vertebræ, the eleventh, we have a single specimen, nearly perfect, from Bleadon (Pl. XVI, fig. 2, 2′, 2″, 2‴). This is the vertebra to which the neural spines of the lumbar and dorsal vertebræ converge, and by some is called the last true dorsal. It is distinguished by the extreme shortness of the neural spine, by the great backward projection of the post-zygapophyses, by the length of the centrum, by the great size of the metapophyses, which project backwards so as to indicate a passage to the development of the anapophyses on the suceeeding vertebra. In other respects it resembles the other true dorsals. It differs from the corresponding bone of the Bear in the much greater length and smaller depth of its centrum, and the smaller size of the neural spine. The prezygapophyses are also flat, and lie on the top of the neurapophyses in the Lion, whereas they are inclined to each other, and lie more on the metapophysis in the Bear. The neural notch is also deeper in the former than in the latter; the centrum is keeled in Bear, but is rounded in Lion. Our specimen agrees with that of Lion, excepting that the whole specimen is proportionally somewhat wider. It is of very large size.

The length of the centrum, which is so apparent in all the vertebræ of Felis when compared with Ursus, is still more decided as we approach the lumbars. The fourth class of dorsals, lumbo-dorsals, or rib-bearing lumbars, as they are sometimes called, approach the lumbars proper closely in form. They are provided with strong perpendicular metapophyses and horizontal backward projecting anapophyses so disposed that the postzygapophyses projecting far beyond the centrum, lock between the metapophyses of the succeeding vertebra, which are again locked by the anapophyses of that preceding. There is but one costal articulation, *i. e.* the parapophysial on the side of the centrum, close to the anterior epiphyses. There is no trace of a diapophysis on the first of these or the twelfth, but on the second or thirteenth a minute tubercle above the parapophysis shows the trace of the lumbar form of this process. We have one imperfect specimen of the second of this form of vertebra from Sandford Hill Cave without epiphyses, and otherwise much broken. The diapophysial tubercle can be just traced; we can find no distinguishing mark between it and that of large recent Feles.

§ 6. *Lumbar Vertebræ* (Pl. XVI, fig. 3, 3′, 3″, 3‴).—Although the lumbar vertebræ of the smaller Feles resemble those of some other carnivora of similar size, we know of none that can be compared with those of the larger forms, such as Lion, Tiger, and *Felis spelæa*. Perhaps, generally speaking, the tendency in the two latter is to somewhat greater length of centrum than in the Lion; but we have met with lumbars of the Lion in which the proportions are identical with those of the largest and longest Tiger, and differing in nothing but size from those of the largest *Felis spelæa*.

The long centra, with elliptical section and flat epiphyses, the broad, flat-sided neurapophyses from the lower edge of which descend and project forward the strong diapophyses gradually increasing in length from the first to the sixth, are characters which, taken together, at once distinguish the large feline lumbars from any of similar size.

In addition, the metapophyses supporting the flat prezygapophyses are well developed on all the lumbars. The postzygapophyses, which are very narrow on the first, gradually increase in width to the sixth, and are very wide on the seventh, which articulates with the sacrum. The anapophyses passing under and locking with the metapophyses of the succeeding vertebræ, are largely developed in the first, but decrease in size backwards, till on the sixth they are represented by minute tubercles that disappear on the seventh. The neural spines resemble those of many other carnivora, being narrower at the summit than at the base, with flat, enlarged, nail-headed summits and sharp edges. We have been enabled to trace more or less of these characters in every lumbar vertebra of *Felis spelæa,* except the first, of which we have not met with a specimen.

Of the second we have seen two: one, that of a young but full-grown animal, is without epiphyses, and is otherwise much mutilated; the other (Pl. XVI, fig. 3, 3′, 3″, 3‴), is almost perfect, with the exception of the neural spine. It is distinguished by the size of the dia- and anapophyses, and by the absence of the keel on the ventral aspect of the centrum, which is well developed on the three next vertebræ. This vertebra, as well as the next four, also possesses a well-marked ridge, with deep lateral depressions along the floor of the neural canal, and in the centre of these are foramina for the vessels which supply the bone.

Of the third we have a specimen, without epiphyses, neural spine, and posterior zygapophyses. The inclination and size of the diapophyses, and the presence of the inferior keel, show this to be a third lumbar.

The fourth is represented by a specimen also without epiphyses, the left postzygapophyses, the neural spine, and the ends of the diapophyses. Enough, however, of the latter is left to determine by the amount of the inclination downwards and forwards, that it is a fourth lumbar; it is provided with a very distinct keel, and the left anapophysis is also clearly seen. All the above specimens are from Sandford Hill Cave.

Of the fifth lumbar we have, as far as we can judge from their mutilated condition, three specimens, all simply centra, from Bleadon; one of them is about the size of that of an ordinary Tiger, and the others are of the largest size. They are distinguishable by their great length and by the slight development of the keel, which only extends to half the length of the vertebra.

The sixth lumbar is represented by two specimens; one from Sandford Hill and the other from Bleadon. Both are in nearly the same state, excepting that the former has no epiphyses; of both the neurapophyses and zygapophyses are nearly perfect, with portions of the diapophyses, and the anapophysial tubercle is seen on both. Neither of them possesses any keel, which is also absent from the corresponding vertebræ of Tiger. It is, however, frequently present in the anterior part of that of the Lion. The postzygapophyses of the Sandford Hill specimen are narrow, but in the specimen from Bleadon Cave they are of the normal width. The inclination and size of the roots of the diapophyses exactly agree with those of the sixth lumbar in the Lion.

The seventh is represented by a large specimen from Bleadon; it exactly agrees with Lion in everything but size. It is easily distinguished from the others by being much shorter, by the slight inclination of the epiphyses, and by the width of the postzygapophyses which articulate with the sacrum, and by the width and depth of the neural notches. It has no vestige of a keel on the ventral, and but a slight one on the neural surface of the centrum. The corresponding vertebræ of the Bear are easily distinguished by the extreme shortness of their centra. This shortness indeed characterises the whole of the chain of vertebræ, except the cervicals.

§ 7. *Sacral vertebræ.*—Of the three vertebræ of which the sacrum of *Felis spelæa* was composed, we have only met with the last, and to it a portion of the centrum of the second with its postzygapophyses still adheres. In Felis generally the first sacral vertebra much resembles the seventh lumbar in form, as far as the anterior portion goes, but it is much wider, and the metapophyses are but slightly developed; the diapophyses are much modified into the large massive anchylosis for the ilium, which extend as high as the prezygapophyses. It is firmly anchylosed to the second vertebra, the diapophysis of this also taking part in the iliac anchylosis. The second resembles the first in general form, but it is much smaller; the metapophyses and neural spine project above the surface of the neurapophyses, being a continuation of the lumbar series. The third is remarkably like the second sacral, with the exception that the diapophyses altogether disappear, and the postzygapophyses are distinct, as in the lumbars; very large anapophyses also project backwards and outwards.

Our specimen, which is that of a young adult animal, is from Sandford Hill Cave, and is in the Taunton Museum; it is nearly perfect, except the end of the anapophyses and the neural spine. The metapophyses and their relation to the rest of the vertebra and the neural canals on each side of them are clearly seen. We can find no difference between it and that of a Lion. We have given a figure of it in our large plate of the ossa innominata from Sandford Hill Cave, which possibly may have belonged to the same animal.

§ 8. *Caudal vertebræ* (Pls. XIV, fig. 3; XVI, figs. 4—8).—We have no means of exactly ascertaining the number of these vertebræ in *Felis spelæa*, but most probably it was the same as in Lion and Tiger, and varied from twenty-three to twenty-five. They are very numerous in the caverns of Somersetshire, which have supplied us with the materials for the following description:

The five first caudals in the larger Feles closely resemble each other, and to a considerable extent the last sacral. In the living animal they are within the body, the remainder of the series being exserted. Their centra are short and concave on the ventral surface, with elliptical section and slightly convex epiphyses. The neurapophyses enclose a neural arch of considerable size, but which diminishes rapidly distally. The metapophyses, projecting upwards and proximally beyond the centrum, support well-defined but flat prezygapophyses, locking with the postzygapophyses of the preceding vertebræ, which are also well defined, and project beyond the centrum. Strong, flat anapophyses, somewhat resembling those on the third sacral, extend backwards and slightly downwards. Those on the second are the largest; those on the first expand proximally in some specimens into flat diapophyses, which are represented by small flat tubercles on the three next vertebræ. On the first there is a rudiment of a neural spine, which subsides into a slight ridge on the rest. Hypapophysial tubercles appear on the ventral aspect of the anterior end of the second vertebra, and are continued on the rest to the end of the tail; corresponding tubercles also appear on the distal end also; these support in the living Feles on a variable number of the anterior caudals, small, triangular or rather boat-shaped bones, the caudal hæmapophyses, none of which have occurred to us in a fossil state.

These first five are distinguished from each other by the increasing length of the centra, the diminution of the neural arch, and of the size of the zygapophyses, as well as by the more circular form of the anterior epiphyses, each of these characteristics becoming more marked distally.

Of these vertebræ we have one third, one fourth, and two fifths, all from Bleadon, and one fifth from Sandford Hill. They are all rather larger than the corresponding vertebræ of average Lion, but offer no other distinguishing mark; the above general description will, therefore, suffice. We have figured the fourth (Pl. XVI, figs. 4, 4′). It will give a fair idea of the general form of these vertebræ, keeping in mind the differences indicated above, and the fact that the anterior zygapophyses and epiphyses are worn, and the post-zygapophyses lost. It is the first of a series, which, with the exception, perhaps, of the seventh, eleventh, and thirteenth, reaches to the fourteenth, and so closely correspond in size, condition, and character, that they may have all belonged to one animal.

The next three, or the first exserted vertebræ, form also a series; they differ from the first five in the greater length of the centra, the section being more or less circular anteriorly, and elliptical distally, with epiphyses highly convex; the neurapophyses are very short, and the neural canal correspondingly small, the metapophyses are more at right angles to the centrum, and less divergent vertically than on the first five, and the prezygapophyses are very small, and project less forwards, the articulations of these are also very small, and disappear on the eighth, the postzygapophyses are also minute and project less on each succeeding vertebra, till on the eighth they do not extend beyond the distal epiphysis. The notch over the neural canal between the pre-zygapophyses becomes longer, and exposes more of the neural canal distally. This appears to be more the case in the young than in the old animals.

Flat diapophysial tubercles are developed on the sixth vertebra, and are continued to the end of the tail, the anapophyses become smaller, and gradually subside to very small tubercles on the most distal vertebræ. The hypapophysial tubercles are very distinct anteriorly on the ventral surface of the centra.

We have met with three of the sixth, three of the seventh, three of the eighth, from Bleadon, and two from Sandford Hill, one of the latter being that of a young adult animal, the epiphyses being not yet firmly anchylosed. We have figured a seventh caudal from Bleadon, a perfect specimen of very large size (Pl. XIV, figs. 3, 3′, 3″, 3‴). We are doubtful about an imperfect seventh belonging to the series mentioned above, because of its large size.

With the eighth vertebra the neural canal ceases, and is represented on the rest of the vertebræ by a shallow groove on the dorsal surface of the centrum, the sides of the groove passing into diverging metapophysial and united postzygapophysial tubercles, which do not in any case project over the epiphyses. The centra of these vertebræ are more or less cylindrical, the strong di-an-apophysial ridges on the sides, the neurapophysial on the dorsal and the muscular ridges on the ventral surface, making them more or less angular at various points. The ninth is generally the stoutest (Pl. XVI, fig. 5), and the tenth (fig. 6) and sometimes the eleventh (figs. 7, 7′, 7″) is the longest of these vertebræ, which diminish in size rather rapidly to the end of the tail. The last vertebra appears sometimes to be cartilaginous in the recent Feles. The epiphyses are anteriorly nearly circular, and distally more or less quadrangular and highly convex. The metapophyses are flat plates subsiding into rounded tubercles distally, diverging and pointing slightly forwards on the ninth, but becoming more upright distally. The diapophyses and anapophyses have been described above, the hypapophysial tubercles are distinct throughout the series. The position of the vertebræ can be only fixed by comparison with a known series, and the variations of proportion of the parts are such that this comparison cannot produce absolute certainty, and the uncertainty is made greater by the great variation in size, which may be estimated from our figures of the tenth and eleventh vertebræ, the tenth being taken from the series above mentioned, which is slightly larger than that of the average lion, and the eleventh from another series of much more gigantic proportions. From the smaller series we have figured the ninth, tenth, twelfth, thirteenth, and fourteenth (Pl. XVI, figs. 5—10). We have also a series of large size from the ninth to the thirteenth, one other ninth and an eleventh besides a fifteenth, a sixteenth, a seventeenth, an eighteenth, and a small vertebra near the extremity of the tail. These determinations of place are, of course, subject to the uncertainty above expressed. The general description applies equally to all. The only difference he can see between them and those of the Lion is, that the metapophyses appear to be somewhat less divergent, but this appears to be variable, not only in Lion, but also in *Felis spelæa*. The proportions also are somewhat longer than in the Lion in most cases, but some vertebræ of the position, of which we have no doubt whatever, appear to be somewhat shorter.

Measurements of Atlas. (In Inches.)	*Felis spelæa.* Sandford Hill	*Felis leo.*
1. Minimum height of neural arch	1.27	1.00
2. Width of neural arch at tubercles for transverse ligament	1.15	0.98
3. Zygapophysial length	3.32	2.75
4. Maximum width of prezygapophysis (external)	3.26	2.58
5. Width of the same at the edge of the glenoid articulation	2.54	2.20
6. Width of the postzygapophyses	3.40	2.70
7. Minimum proximo-distal length of neurapophyses	1.59	1.30

Table of Measurement of Vertebræ. (In Inches.)	Fourth Cervical.			Fifth Cervical.		Sixth Cervical.		
	Felis leo.[1]	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis spelæa.* Sandford Hill,
1. Length of centrum	1.44	1.44	1.62	1.40	1.68	1.45	...	1.50
2. Anterior depth of centrum	0.86	0.92	1.12	0.86	1.15	0.88	1.10	0.95
3. Posterior depth of centrum	0.92	0.94	1.18	0.97	...	1.04	...	1.05
4. Anterior width of centrum	1.36	1.45	1.65	1.36	1.60	1.38	...	1.40
5. Posterior width of centrum	1.44	1.52	...	1.50	...	1.40	...	1.44
6. Minimum height of neural arch	0.50	0.78	0.64	0.50	0.65	0.55	0.70	0.69
7. Minimum width of neural arch	0.84	0.92	0.95	0.95	1.00	1.08	0.94	1.09
8. Anterior width of pleurapophysis	2.30	...	...	2.45	...	3.32	...	...
9. Posterior width of pleurapophysis	3.60	...	...	3.55	...	2.45	...	2.50
10. Length of pleurapophysis	1.15	...	...	1.50	...	2.28	...	...
11. Maximum width of diapophysis	3.69	...	...	3.60	4.80	3.90	...	4.00
12. Zygapophysial length	2.50	...	2.54	2.24	2.85	2.12	2.33	2.00
13. Anterior zygapophysial width	3.03	...	...	2.95	3.60	2.71	3.22	2.35
14. Posterior zygapophysial width	2.75	...	3.04	2.72	...	2.75	...	2.70
15. Height of neural spine	0.90	...	...	0.87	...	1.16	...	1.40

[1] The vertebræ of the lion used in their measurement are those of a specimen of average size in our own possession.

	First Dorsal.			Second Dorsal.		Seventh Dorsal.		Eighth Dorsal.	
	Felis leo.	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Sandford Hill.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.
1. Length of centrum................	1.30	1.30	1.44	1.28	1.34	1.25	1.54	1.30	1.62
2. Anterior depth of centrum	1.00	1.05	1.28	1.00	1.18	1.00	1.27	1.06	1.20
3. Posterior depth of centrum	1.00	1.05	1.28	0.95	1.05	1.00	1.27	1.05	1.17
4. Anterior width of centrum	1.70	2.05	2.43	1.85	1.94	1.30	1.60	1.31	1.70
5. Posterior width of centrum	1.60	1.82	2.42	1.70	1.94	1.70	2.18	1.75	1.82
6. Minimum height of neural arch...	0.62	0.55	0.70	0.60	0.63	0.57	0.70	0.65	
7. Minimum width of neural arch ..	1.00	1.00	1.22	0.85	0.94	0.60	0.83	0.64	
8. Anterior pleurapophysial width...									
9. Posterior pleurapophysial width									
10. Length of pleurapophysis									
11. Maximum width of diapophysis	3.57	...	...	3.25	3.35	2.55	3.20	2.50	
12. Zygapophysial length...............	1.90	...	...	1.90	2.25	2.05	2.50	2.00	
13. Anterior zygapophysial width ...	2.65	2.73	3.02	2.24	2.25	0.92	1.25	0.90	
14. Posterior zygapophysial width ...	2.25	...	...	1.55	1.67	0.92	1.05	0.85	1.30
15. Height of neural spine	2.50	...	...	3.30	4.30	3.50	...	3·45	

	Eleventh Dorsal.		Thirteenth Dorsal.		Second Lumbar.			Third Lumbar.	
	Felis leo.	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Sandford Hill.	*Felis leo.*	*Felis spelæa.* Sandford Hill.	*Felis spelæa.* Sandford Hill.	*Felis leo.*	*Felis spelæa.* Sandford Hill.
1. Length of centrum	1·35	1·70	1·50	...	1·90	2·15	...	1·95	...
2. Anterior depth of centrum	1·22	1·45	1·00	...	1·03	1·35	...	1·15	1·28
3. Posterior depth of centrum	0·92	1·35	1·10	...	1·03	1·30	1·30	1·15	...
4. Anterior width of centrum	1·26	1·65	1·45	1·92	1·58	1·93	1·90	1·64	2·00
5. Posterior width of centrum	1·63	2·20	1·75	...	1·74	1·92	...	1·74	...
6. Minimum height of neural arch	0·50	0·66	0·50	0·61	0·50	0·52	0·62	0·54	0·64
7. Minimum width of neural arch	0·58	0·83	0·68	0·91	0·75	0·78	0·87	0·75	1·10
8. Anterior pleurapophysial width	...	...	...	...	...	...	...	...	...
9. Posterior pleurapophysial width	...	...	...	...	...	...	...	...	...
10. Length of pleurapophysis	...	...	...	...	...	...	...	...	...
11. Width of diapophysis	2·50	3·25	1·85	...	2·90	3·64	...	3·42	...
12. Zygapophysial length	2·30	2·58	2·75	2·74	3·05	3·33	...	3·00	...
13. Anterior zygapophysial width	1·25	1·44	0·85	1·34	1·00	1·27	1·25	1·35	1·43
14. Posterior zygapophysial width	1·05	1·43	0·80	1·20	1·28	1·24	...	1·35	...
15. Height of neural spine	1·89	1·56	1·40	...	1·44	...	...	1·60	...
16. Width of metapophysis	...	...	1·70	1·84	1·95	2·00	1·65	2·20	1·98
17. Width of anapophysis	...	...	1·95	2·35	1·90	2·06	...	1·35	...
18. Distance from ana- to metapophysis	...	...	2·50	2·81	2·75	2·90	...	1·55	...

	Fourth Lumbar.		Fifth Lumbar.		Sixth Lumbar.			Seventh Lumbar.	
	Felis leo.	*Felis spelæa.* Sandford Hill.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Sandford Hill.	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.
1. Length of centrum	2·03	...	2·20	2·96	2·25	...	2·40	1·95	2·10
2. Anterior depth of centrum	1·25	1·53	1·36	1·60	1·40	1·30	1·30	1·29	1·42
3. Posterior depth of centrum	1·25	...	1·20	1·54	1·30	1·40	1·25	1·29	1·33
4. Anterior width of centrum...... ..	1·65	2·04	1·72	2·15	1·95	2·10	2·05	1·95	2·09
5. Posterior width of centrum	1·83	2·00	1·90	2·33	1·92	2·20	2·05	1·95	2·20
6. Minimum height of neural arch...	0·55	0·55	0·55	...	0·46	0·50	0·50	0·40	0·50
7. Minimum width of neural arch ...	0·85	1·10	1·00	1·22	0·92	1·12	1·20	1·00	1·08
8. Anterior pleurapophysial width...	...	...	...	...	...	...	...	...	...
9. Posterior pleurapophysial width...	...	...	...	...	...	...	...	...	...
10. Length of pleurapophyses	...	...	...	...	...	...	...	...	...
11. Width of diapophyses	4·10	...	4·90	...	5·60	...	...	5·70	...
12. Zygapophysial length...............	3·10	3·53	3·20	...	2·90	3·65	3·30	2·65	...
13. Anterior zygapophysial width ...	1·40	1·45	1·45	...	1·36	1·57	1·44	1·55	...
14. Posterior zygapophysial width ...	1·30	1·35	1·40	...	1·50	1·20	1·72	2·66	3·10
15. Height of neural spine	1·30	...	1·84	...	1·84	...	...	1·74	...
16. Width of metapophyses	2·22	...	2·05	...	2·10	2·00	...	2·18	...
17. Width of anapophyses	1·90	...	1·80	...	1·70	2·02	2·00	...	...
18. Distance from ana- to metapophyses	2·58	...	2·43	...	2·00	2·45	2·30	...	...

	Third Sacral.		Third Caudal.		Fourth Caudal.		Fifth Caudal.		
	Felis leo.	*Felis spelæa.* Sandford Hill. Figured.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon. Figured.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.
1. Length of centrum	1·00	1·30	1·20	1·35	1·26	1·50	1·40	1·60	1·67
2. Anterior depth of centrum.........	0·67	0·80	0·78	0·80	0·76	0·86	0·76	0·80	0·87
3. Posterior depth of centrum	0·85	0·75	0·76	0·80	0·72	0·83	0·70	0·74	0·80
4. Anterior width of centrum	1·00	1·18	1·00	1·05	0·94	0·95	0·85	0·90	1·05
5. Posterior width of centrum	1·10	1·05	1·10	1·15	1·10	1·10	1·00	1·05	1·20
6. Minimum height of neural arch	0·25	0·35	0·21	0·22	0·15	0·17	0·20	...	0·20
7. Minimum width of neural arch ...	0·60	1·22	0·35	0·40	0·25	0·25	0·25	...	0·25
11. Width of diapophyses...............	...	...	2·08	2·40	1·70	2·25	1·45	1·30	...
12. Zygapophysial length...............	1·70	1·82	1·76	...	1·75	...	1·90	...	...
13. Anterior zygapophysial width......	1·10	0·80	0·96	0·80	0·75	0·90	0·70	...	0·80
14. Posterior zygapophysial width ...	0·85	1·18	0·70	...	0·70	...	0·60	...	...
15. Height of neural spine	0·75	...	...	...	...	...	...	...	...
16. Width of metapophyses	1·25	1·14	1·32	1·20	1·20	1·20	1·27	...	1·30
17. Width of anapophyses...............	3·15	...	2·45	2·40	2·35	2·80	2·15	...	...
18. Distance from ana- to metapophyses	1·75	...	2·00	...	2·10	2·25	2·00	...	...
19. Minimum circumference............	...	...	3·50	3·45	3·10	3·50	2·80	2·85	3·20

	Sixth Caudal.			Seventh Caudal.			Eighth Caudal.			
	Felis leo.	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Sandford Hill.	*Felis spelæa.* Bleadon.	*Feli leo.*	*Felis spelæa.* Sandford Hill.	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.
1. Length of centrum	1·70	1·75	2·00	1·80	1·95	2·00	2·15	2·00	2·20	2·00
2. Anterior depth of centrum	0·75	0·75	...	0·85	...	0·89	0·88	0·80	0·85	0·85
3. Posterior depth of centrum	0·80	0·76	0·83	0·80	0·70	0·78	0·85	0·75	0·88	0·75
4. Anterior width of centrum	0·90	0·88	...	0·90	...	0·98	0·90	0·85	1·00	0·87
5. Posterior width of centrum	1·00	1·00	1·10	1·00	...	1·12	0·95	1·10	1·20	1·09
6. Minimum height of neural arch	0·16	...	0·18	0·10	0·12	0·10	0·07	0·10	0·08	...
7. Minimum width of neural arch	0·19	...	0·21	0·14	0·15	0·18	0·12	0·12	0·12	...
11. Width of diapophyses	1·12	1·20	...	1·30	1·20	1·50	1·32	1·42	1·25	1·20
12. Zygapophysial length	2·00	...	...	2·03	...	2·40	1·83	1·75	...	2·27
13. Anterior zygapophysial width	0·63	0·80	0·65	0·64	0·70	0·80	0·50	0·50	0·50	0·50
14. Posterior zygapophysial width	0·52	...	...	0·40	...	0·40	0·35	0·30	...	0·20
15. Height of neural spine	...	...	...	...	...	...	...	...	...	...
16. Width of metapophyses	1·20	1·40	1·10	1·13	0·90	1·30	0·87	0·82	0·82	0·85
17. Width of anapophyses	1·90	1·90	...	1·64	1·70	2·00	1·45	1·42	1·78	1·80
18. Distance from ana- to metapophyses	2·05	2·30	...	2·15	2·15	2·50	2·25	1·95	2·24	2·21
19. Minimum circumference	2·80	2·85	3·20	2·65	2·60	3·20	2·40	2·30	2·75	2·70

	Ninth Caudal.				Tenth Caudal.			Eleventh Caudal.	
	Felis leo.	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon. Figured.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon. Figured.
1. Length of centrum..................	2·15	2·12	2·60	2·25	2·30	2·65	2·40	2·10	2·45
2. Anterior depth of centrum	0·90	0·78	1·10	0·88	0·90	0·90	0·90	0·75	0·90
3. Posterior depth of centrum	0·80	0·70	0·84	0·70	0·70	0·85	0·80	0·60	0·90
4. Anterior width of centrum.........	0·75	0·85	1·10	0·75	0·80	0·90	0·80	0·70	0·95
5. Posterior width of centrum	0·90	0·93	1·20	0·90	0·90	1·00	0·93	0·80	1·00
6. Minimum height of neural arch...	...	...	...	...	...	...	...	...	...
7. Minimum width of neural arch...	...	...	...	...	...	...	...	...	...
11. Width of diapophyses................	1·20	1·25	1·80	1·10	1·25	1·20	1·40	1·15	1·50
12. Zygapophysial length..............	...	..	...	...	...	...	...	...	...
13. Anterior zygapophysial width ...	...	...	...	...	...	...	...	...	...
14. Posterior zygapophysial width ...	...	...	...	...	...	...	...	...	...
16. Width of metapophyses	0·80	0·80	0·85	0·65	0·60	0·80	0·70	0·70	0·30
17. Width of anapophyses	1·20	1·40	...	1·35	1·15	1·60	1·18	1·00	1·35
18. Distance from ana- to metapophyses	2·00	1·80	2·40	2·00	2·10	2·40	2·20	1·95	2·40
19. Minimum circumference............	2·40	2·20	2·85	2·15	1·90	2·50	1·90	1·75	2·30

	Twelfth Caudal.				Thirteenth Caudal.			Fourteenth Caudal.	
	Felis leo.	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.
1. Length of centrum	2·10	2·30	2·30	2·10	2·00	2·20	2·25	1·80	1·95
2. Anterior depth of centrum	0·80	0·90	0·80	0·75	0·70	0·80	0·80	0·60	0·60
3. Posterior depth of centrum	0·75	...	0·80	0·60	0·62	0·70	...	0·55	0·55
4. Anterior width of centrum.........	0·70	0·80	0·82	0·70	0·60	0·85	0·80	0·54	0·68
5. Posterior width of centrum	0·70	...	0·80	0·70	0·60	0·75	...	0·50	0·60
11. Width of diapophyses...............	1·10	...	...	1·10	1·15	1·25	0·10	0·84	1·05
16. Width of metapophyses............	0·52	...	0·70	0·50	0·65	0·60	0·60	0·54	0·55
17. Width of anapophyses	0·96	...	1·25	1·00	0·85	1·20	...	0·70	0·75
18. Distance from ana- to metapophyses	2·05	...	2·30	2·00	1·95	2·15	2·10	1·70	1·90
19. Minimum circumference	1·60	2·15	2·25	1·80	1·50	1·80	1·85	1·30	1·50

	Fifteenth Caudal.		Sixteenth Caudal.		Seventeenth Caudal.		Eighteenth Caudal.		Twentieth, or Twenty-first Caudal.	
	Felis leo.	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.	*Felis leo.*	*Felis spelæa.* Bleadon.
1. Length of centrum	...	...	1·55	1·95	1·45	1·75	1·20	1·40	0·70	1·00
2. Anterior depth of centrum	0·50	0·60	0·50	0·55	0·48	0·55	...	...	...	...
3. Posterior depth of centrum	...	...	...	...	0·49	0·50	...	...	...	...
4. Anterior width of centrum	...	...	0·52	0·60	0·46	0·50	...	...	...	...
5. Posterior width of centrum	...	...	...	...	0·43	0·53	...	...	...	...
16. Width of metapophyses............	0·45	0·50	...	...	...	...	...	...	...	...
18. Minimum circumference	1·20	1·30	1·12	1·40	1·08	1·30	1·00	1·10	0·80	0·75

§ 10. *Literature.*—We know of the following figures of the vertebræ of *Felis spelæa.* M. Schmerling, 'Oss. Foss. de Liége,' a mutilated atlas, tom. ii, pl. xvii, fig. 14; a first dorsal, pl. xviii, fig. 1; a sixth lumbar, figs. 2 and 3; an entire sacrum, pl. xvi, fig. 1; a fourth caudal, pl. xviii, fig. 4; an eighth caudal, fig. 5; and one of the smaller caudals, fig. 6. These are all of large size. The under side of a second sacrum, of the size of that of the lion, is in the figure of the entire pelvis, in pl. xix, fig. 2.

MM. Marcel de Serres, Dubrueil, and Jean Jean ('Oss. Foss. de Lunel Viel') figure the tenth dorsal (?), pl. viii, fig. 7; the second and third lumbars, fig. 8; the entire sacrum, under side, fig. 9; a second sacrum rather smaller than that of the lion, fig. 15; a fourth caudal, fig. 13; and a smaller cylindrical caudal, fig. 14.

§ 11. *Sternum.*—The number of sternebers in the genus Felis, including the manubrium and xiphoid, is eight, as is usually the case with the Carnivores generally. Some species, however, such as the Glutton, have nine. We do not describe the manubrium or xiphoid, as we have met with no fossil specimens of either. The intermediate sternebers are more or less rectangular in form, flat, or slightly concave on the ventral surface, flat or slightly convex vertically on the sides, and rounded on the inferior or thoracic surface, which is traversed by a slight, irregular keel, bifurcating distally like the letter Y. They are smaller in the middle than at their ends, which are roughened for the cartilaginous epiphyses, to which the ribs are attached. Sometimes the epiphyses are wanting, and, as in a lion in our own possession, two or more sternebers may be anchylosed together. They are distinguished from each other by their proportions. The anterior or second is the longest, most compressed, and deepest, and the seventh, or that next the xiphoid, is the shortest, widest, and most depressed. The intermediate bones present a regular gradation from the one to the other of these forms.

There is a very great variation observable in the size and form of these bones when two or more individuals are compared together, even of the same species of *Felis;* and they seem to be abnormally affected by captivity. Those of the lion for the most part are more depressed than those of the tiger, and the latter more so than those of the jaguar. It is, therefore, difficult if not impossible to ascertain with absolute accuracy the exact position of any given feline sterneber unless the whole series from one animal is perfect.

We cannot, therefore, accurately determine any of the fossil sternebers. We have met with four perfect and one imperfect feline sternebers in the Taunton Museum; they were obtained from Bleadon Cave. They do not exactly resemble those of any lion or tiger with which they have been compared, being longer than in those animals, and the shortest presenting the same proportion as the longest of those of the tiger. Three of them assume the proportions of the third, fourth, and sixth of a small jaguar in our possession, though they exceed the corresponding bones of a large tiger in size; the remaining two, of somewhat smaller dimensions, also assume the proportions of the fourth and fifth of the jaguar. Their large size, indeed, is the only point that separates them from those of that animal. They are distinguished from those of the bear by the greater compression, more rounded section, and smaller length in the latter animal. The texture of the bone also affords a character by which they may be distinguished, being much more compact in the cave lion than in the bear. We have given a figure of the sterneber which we consider to be the third (Pl. XVI, fig. 10, 10[1]). Among the bones of the lion which Sir Philip Egerton, F.R.S., and Lord Enniskillen, F.R.S., obtained from Gailenreuth Cave, was a feline sterneber exactly agreeing with our figure.

The following measurements show the relations that they bear to those of lion and jaguar.

	Third Sterneber.			Fourth Sterneber.			
	Felis spelæa. Bleadon.	*Felis leo.* W. A. S.	*Felis jaguar.* W. A. S.	*Felis spelæa.* Bleadon.	*Felis spelæa.* Bleadon.	*Felis leo.* W. A. S.	*Felis jaguar.* W. A. S.
Length	1·70	1·30	1·05	1·50	1·40	1·30	1·00
Maximum anterior depth	1·10	1·00	0·60	1·20	1·00	1·05	0·55
Maximum anterior width	0·90	1·05	0·50	1·05	0·78	1·10	0·50
Maximum posterior depth	1·20	0·90	0·55	1·15	0·98	1·10	0·50
Maximum posterior width	1·10	1·30	0·50	1·00	0·85	1·10	0·53
Minimum circumference	2·48	2·60	1·12	2·70	2·50	2·60	1·30

	Fifth Sterneber.			
	Felis spelæa. Bleadon.	*Felis spelæa.* Bleadon.	*Felis leo.* W. A. S.	*Felis jaguar.* W. A. S.
Length	1·50	1·50	1·20	0·92
Maximum anterior depth	1·10	1·00	0·90	0·52
Maximum anterior width	0·80	...	1·05	0·50
Maximum posterior depth	1·00	1·00	0·85	0·50
Maximum posterior width	1·10	...	1·30	0·56
Minimum circumference	2·90	...	2·50	1·28

CHAPTER IX.

Scapula. Pl. XVII.

CONTENTS.

§ 1. *Introduction* (Pl. XVII).—The original of the figures in this plate is the least mutilated of a pair of scapulæ which, from their condition, we consider to have belonged to the same animal as many of the bones in the Taunton Museum belong, such as the skull (Pls. VI, VII, VIII, IX), the jaws (Pl. X), the radius (Pl. II, fig. 1), and many others, which will be enumerated at the end of this Monograph. The condition of the epiphyses and muscular impressions proves that, although the animal had reached its full growth, it died before the ossification was completed in all parts. With the exception of a mutilated fragment from Bleadon Cavern, and an equally imperfect piece of one belonging to a whelp from the Mendip Cave, we know of no other British specimens: it appears to be equally rare on the Continent. Its rarity may perhaps arise from its fragile character.

In fig. 1 we have represented the glenoid cavity (*a*), the distal edge of the spine (*c*), the acromial process (*f*), with the overlapping lamina, which we term, from the name of the muscle to which it gives attachment, the delto-acromial process (*g*). The extent also is shown to which axillary border (*i*) extends beyond the plane of the inferior and posterior edge of (*a*), as well as the base of coracoid process (*d*), the point of which is broken away. Fig. 2 represents the superior or outer surface. The anterior and upper or vertebral portion of the bone, and the upper third of the spine, are broken away, leaving the glenoid cavity (*a*), the lower part of the spine (*f* and *g*), the axillary border (*i*), up to the insertion of the teres major muscle, and the greater part of the infra-spinal surface (*e*), n a very perfect state.

§ 2. *Description. Glenoid Cavity.*—(*a*). The inferior angle of the scapula is truncated to form the glenoid cavity, which is slightly concave transversely, deeply so longitudinally, oval in outline, with the long diameter lying parallel to the median line. In the figured specimen the periphery is nearly even with the surface of the cavity; but in an older fragment from Bleadon it is slightly raised, so as to form a rim somewhat thicker behind than before. It gives attachment to a ring of fibro-cartilage, that considerably deepened the cavity for the humerus, and afforded a greater freedom of motion to the fore limb than if it had been completely ossified. On the upper or outer edge is a depression which destroys the completeness of the oval (*n*), corresponding with the deltoid process of the humerus: this depression is a point of difference between the scapulæ of Lions and Bears. The anterior contour of the oval is broken by the prolongation of a ridge, passing from the base of the coracoid (*d*). This ridge and the process supporting it descend further in Felis than in Ursus, rendering the glenoid cavity far more concave longitudinally in the former than in the latter. The broadly oval form also differentiates the feline glenoid from the narrow and elliptical one of Ursus, and from the triangular and smaller one of Hyæna.

Coracoid.—(*d*). The body of the coracoid completely soldered to the scapula forms a portion of the broad obtuse process (*b*), on the anterior edge of the glenoid cavity. Its point is broken in the specimen figured, but its position is marked by the ridge passing from it to the edge of the glenoid cavity. The process (*b*) affords attachment to the tendon of the biceps muscle.

Neck.—The coracoidal and glenoidal portions of the bone are separated from the rest by a well-defined constriction or neck, the existence of which affords a good character for determining feline scapulæ from those of Bears.

Dorsal or superior surface.—The superior surface is divided into two subequal parts by the spine (*c*), the upper of which is the supra-spinal (*m*), the lower the infra-spinal fossa (*e*). The portion of the scapula figured is very slightly concave in the first of these, and slightly convex in the second, and so far resembles that of a Lion in our own possession. Its fragmentary condition prevents any minute comparison with that of the Lion and Tiger. In the two Lions in the College of Surgeons the convexity of (*e*) varies in degree, while in the Tiger it is barely perceptible.

Spine (*c*).—The spine more prominent than that of Bear, springing at right angles to the body of the bone, and passing obliquely backwards from the neck to the anterior angle of the vertebral or upper border, divides, as above stated, the two fossæ. It slightly increases in height from the acromion to the middle of the delto-acromial process, and thence declines to the periphery of the bone. This latter portion, however, is broken in the figure. The acromion (*f*), which in the figured bone is imperfectly ossified, is rounded, very slightly inclined forwards, and does not articulate with the rudimentary clavicle, which is also without a sternal articulation. In the old animal it would overhang but a small part of the glenoid cavity, and it does not extend down to a plane passing through its anterior and posterior edges. In the Bears it projects beyond this, and in the Hyænas it does not overhang any portion of the glenoid cavity. Behind the acromion the spine gradually throws off a laminar process (*g*) at right angles to itself, scalene-triangular in outline that overhangs the infra-spinal fossa, and affords attachment to the transverso-scapular and delto-acromial muscles. This delto-acromial process affords an excellent means of determining the scapula of the Carnivores. In the Subursines, Glutton, Badger, and the like, it is nearly of the same form as in Felis; in Canis and Hyæna it is much smaller and less strongly defined, while in the Bear it is replaced by a broad massive process extending nearly equally on both sides of the spine. The development and form is closely connected with the rapid and free movement of the fore limb. The spine gradually recovers its verticality at a point about two inches from the acromion.

The infra-spinal fossa (*e*), bounded anteriorly by the spine, and posteriorly by the axillary border (*i*), is a broad smooth triangular surface, slightly concave inferiorly, slightly convex above, occupied for the most part by the infra-spinatus muscle. The degree of curvature varies in the Lions, and is reduced to nothing in the Tigers. The strong axillary border (*i*) is well rounded on the outer surface, sharp on the extreme edge, and concave on the inner surface. It bears impressions for the attachment of muscles through its whole length, though from its having belonged to a comparatively young animal they are hardly so sharply defined as in the older bones. They form an irregular line of small tubercles (*i*) running from the neck of the bone and dying away as they reach the level of the insertion of the teres major muscle. They represent the linea obliqua of human anatomy, which is extremely prominent in the Bear and recent Lion: while it is rounded in the Tiger. It gives attachment to the teres minor muscle: that of the teres major oocupies precisely the same position in the figured scapula as in Lion and Tiger, being situated on the inner edge of the upper portion of the axillary border, and must not be confounded with the strongly-marked impression, at nearly the same level on the outer border, which belongs to the superior portion of the teres minor (*h*).

Internal surface.—The internal surface is for the most part smooth, and without strongly marked ridges. The lower two thirds are longitudinally convex, while the upper third is slightly concave; from the glenoid cavity to the insertion of the teres major the convexity gradually increases, so as to form a well-defined border to the smooth and nearly flat area, which extends to the part immediately underlying the spine, which is concave. We do not figure this surface, because it presents no characters of importance.

§ 3. *Measurements.*—The superior size of the Spelæan Lion, as compared with the living Lion and Tiger, is shown in the following table.

The long diameter of the glenoid cavity of a spelæan scapula from the caverns of Liège, given by Dr. Schmerling is 2·6 inches, the short 1·8 inches.

TABLE OF MEASUREMENTS.

Measurements of Scapulæ.	*Felis spelæa.* Figured.	*Felis spelæa.* Sandford Hill.	*Felis spelæa.* Bleadon.	Lion. W. A. S.	Lion. Col. Surg.	Lion. Col. Surg.	Tiger. Col. Surg.
Length of scapulæ	...	...	...	10·00	11·30	9·00	9·00
Circumference at neck	6·55	6·60	7·00	5·70	5·78	4·80	5·00
Length of glenoid cavity	3·00	...	3·00	2·25	2·20	1·90	2·10
Width of glenoid cavity	2·30	2·28	...	2·10	1·80	1·40	1·40
Length of axillary border to insertion of teres muscle (*h*)	6·30	...	...	5·30	...	...	...
Entire length of teres muscle	...	...	...	8·50	8·90	7·50	5·30
Breadth at impression for teres (*h*)	0·40	...	...	0·30	0·00	5·30	...
Height of spine from surface	2·25	...	...	2·00	...	...	...
From acromion to surface of glenoid cavity	1·10	1·00	0·90	0·60	...	...	...

CHAPTER X.

Humerus. Pl. XVIII, figs. 1, 2, 3.

CONTENTS.

§ 1. *Introduction.*—The well-known inverse proportion which is found to exist in all animals between the lengths of the humeri and metacarpals is well exemplified in the comparison of the larger with the smaller Feles. In the smaller animals of the genus the metacarpals are comparatively short, and the humeri long: in the larger, both are of moderate length, and, as may be expected, of immense strength.

The fossil humeri of Felis are only known in Britain by fragments. At Gailenreuth, however, the perfect bone has been found by Sir Philip Egerton and Lord Enniskillen, and a cast of it is preserved in the British Museum. The well-known figure also of the humerus found by Dr. Schmerling in the cavern of Liége enables us to estimate proportions of the entire bone in *Felis spelæa.* This we have copied in light tint in our figure (fig. 1), and on it we have represented in a darker tint the distal portion of a slightly darker specimen from Bleadon Cave (fig. 1, *c′m*); and on this again we have drawn a large part of a shaft from Oreston Cave, in the British Museum (*d, e*), which offers some peculiarities to be described presently; and finally, in full tint, we give the proximal articulation (*a, a′*), and the distal ends (*f, f′, m*) of large specimens from Bleadon. In this way we have completed, so far as the materials at our disposal allow, a figure of the posterior aspect of the humerus from British specimens.

The figure of the anterior aspect of the distal end (fig. 2) is taken from a specimen in the possession of the Rev. H. H. Winwood, found in the river-gravel at Larkhall, near Bath, and that of the distal articulation (fig. 3) is from the largest specimen we have met with from Sandford Hill Cavern.

M. de Blainville states that the humeri of the Tiger are wider distally than those of the Lion; but the variations in this respect in the skeletons of the animals which we have examined in the British collections is so great that we cannot admit the specific value of this distinction, and therefore we cannot assert that the average specimens of the fossil humeri approach one species more than another. Singularly enough, however, the two most perfect shafts we have seen differ considerably from those of any recent Felis in their extreme antero-posterior compression, especially that from Oreston (fig. 1, *c*, *d*).

The compression of the Gailenreuth specimen is not so evident. In the large fragment (*c*, *c'*) we have figured from Bleadon, and in that of Dr. Schmerling (fig. 1, light tint), there is no evidence of it whatever, and the many fragments we have met with show that the general proportions of the shaft were those of the recent Lion or Tiger. Some are intermediate between the compressed and the ordinary form, and connect the two extremes together. In the absence, therefore, of any other evidence of a second large species of Felis in the Pleistocene deposits of Britain and Germany, we refer the compressed humeri to a somewhat abnormal form of the spelæan Lion. The comparison of a large series of bones of the same species, either recent or fossil, shows that no particular bone is cast in a crystalline form, but that the variations increase in proportion to the number examined. How far this may go on without transgressing the limits of a species depends obviously upon the judgment of the naturalist. If he believe that a species has an actual existence in nature, he will look upon these variations as of specific value, because they depart from the typical form, which he will take to be as invariable as the figure of a crystal. If, on the other hand, he view a species as a mere arbitrary summing up of points of agreement devised by man for the classification of the varied forms of life, he will consider that the variations are simply the result of a more minute inquiry, and he will extend the limits of his species to cover a very large amount of variation. Few naturalists have recognised the amount of variation from a specific type, observable in many individuals, on account of the immense labour required in the investigation. As we hold the latter of these views, we consider that the compressed humerus is a mere variation from the ordinary spelæan form.

§ 2. *Description.*—The lateral aspect of the humerus is somewhat sigmoid, the proximal end being bent slightly backwards, the distal slightly forwards. It is more or less compressed proximally, and depressed distally, flat internally, and highly convex externally; the proximal articulation (fig. 1 *a*, *a'*) is of considerable size, highly convex posteriorly and internally, slightly concave close to the greater tuberosity (*b*). Its generally convex outline is intercepted anteriorly close to the bicipital groove by a roughened space devoid of synovial membrane, even with the surface of the articulation; posteriorly it overhangs the shaft, internally it is bounded by the lesser tuberosity of a reniform mass, longer than broad, and extending from behind diagonally upwards to the level of the highest part of the articulation, to which was attached the tendon of the subscapularis muscle. Externally it is bounded by the greater tuberosity (*b*), a massive ridge much more elevated than in the Bear, but less so than in the Hyæna. To the external edge of the latter were attached the tendons of the supra- and infra-spinatus muscles, to the internal and anterior edge the tendon of the muscle called by Strauss-Durkheim the sterno-trochiterian,[1] which represents a portion of the pectoralis major in man, though it differs considerably from that muscle in position and office. To the posterior portion of the same tuberosity was attached the small rotundus minor, that along with the infra-spinatus acts as the rotator of the limb in an outward direction. Immediately within the free edge of the tuberosity is a supplementary process directed inwards, with its greatest diameter downwards forming the outer edge of the bicipital groove, which is deep and large, and bounded on the inner side by the projecting anterior portion of the lesser tuberosity. These edges are joined in the living animal by a very strong ligament, forming a closed canal furnished with a synovial membrane, through which plays the upper tendon of the single muscle analogous to the biceps of human anatomy.

A sharp ridge (*h*) bounds the lesser tuberosity inferiorly and posteriorly, and forms the internal edge of the posterior proximal surface of the bone. A rounded ridge descends from the articulation on the outer side of the same surface, forming, together with *h*, a broad and deep depression, into which is inserted the first head of the anconeus medius of Strauss-Durkheim, a muscle which has no analogue in man, but which in Felis aids the triceps medius in the extension of the fore-arm. The flat internal surface on the upper half of the shaft affords a broad attachment for the aponeurosis of the two branches of the latissimus dorsi, between them for the teres muscle, and above the latter for the coraco-brachial muscle. The deltoid space is a large triangular roughened surface on the convex outer portion of the bone, the base being formed by the greater tuberosity, and the apex situated at a distance from the proximal end of rather more than two fifths of the entire length of the bone, being the result of the union of the anterior and posterior deltoid ridges. Of these the former is the proximo-anterior edge of the bone, and affords attachment to the pectoralis major; the latter, situated on the antero-external surface at a lower level, afford insertion to the brachialis muscle. These ridges after their fusion pass downwards for a short distance, and turning outwards gradually die away on the external surface of the bone. To the upper and posterior portion of the deltoid space is attached the delto-spinal, to the anterior and lower the delto-acromial muscles. Immediately behind the proximal end of the posterior deltoid ridge there is a slightly roughened surface, which affords attachment to the head of the triceps externus. The proximal portion of the Feline humerus may be differentiated from that of the Bear by the presence of the following characters in the latter animal:—The deltoid space is much larger, the ridges much more strongly developed, the tuberosity is smaller, and the shaft is not so

[1] 'Anat. du Chat,' vol. ii, p. 337. He terms the greater tuberosity the trochiter and the lesser the trochin.

compressed. The distal end can generally be recognised by the large perforation of the inner condyloid crest at a slight distance above the articulation (figs. 1, 2 *i*). This character, however, is also found abnormally in some few of the humeri of Bears that are found side by side with *Felis spelæa*. The part, therefore, must be described minutely, to prevent the two species from being confounded. Immediately below the deltoid ridge the spelæan shaft is cylindrical, and then throws out the broad flat externo-condylian (figs. 1, 2, *m*, *e*) ridge on the postero-external aspect that extends to the external condyle. It affords insertions, as in Man, to the heads of the following muscles: anteriorly to the extensor carpi radialis longior and brevior, the first and second radials, which are not fused together as in Man; posteriorly to the extensor communis digitorum, and laterally to the supinator brevis; superiorly to the supinator longus, and posteriorly and on the inner side of the ridge passing diagonally upwards from the crest to the anconeus externus. The condyles are of moderate size, the external (figs. 1, 2, 3 *l*) projecting but slightly beyond the articulation, and the internal (figs. 1, 2, 3 *l'*) being by far the more prominent of the two; it is, however, far less prominent than in the Bear, and proportionally even than in Man.

The internal condylian crest is, as we have before stated, pierced by a large foramen (figs. 1, 2 *i*), directed diagonally forwards and downwards for the passage of the ulnar nerve and artery. The abutments, as it were, of the bony arch are generally found in the Bears, and sometimes in the Hyæna, the key of the arch in that case being formed by a ligament. In the former animal, however, where the arch is completed by a deposit of osseous matter, it is much nearer the distal end of the bone, and is much thinner than in *Felis spelæa*. This difference, together with the greater breadth of the distal end and the large size of the internal condyle, will sufficiently distinguish the distal portion of the humerus of Bear from that of the larger Feles.

The anconeus internus is inserted on the posterior portion of the arch. The large space occupied by the insertions of the three muscles bearing this name, indicates the enormous power of extension of fore-limb, which enables the larger Feles to use their paws with such destructive effect.

The external condyle affords insertions to the following muscles: the extensor minimi digiti, and the external ulnar; the internal to the sublimis, the pronator teres, the palmaris longus, ulnaris externus, and profundus muscles.

The articulation (figs. 1, 2, 3 *f*, *f'*) somewhat resembles that of the Bear, but it is broader transversely and thicker, and the trochlear portion (figs. 1, 2, 3 *f*, *l*, *k*) is less excavated. The latter is distinguished from the capitellar portion (figs. 1, 2, 3 *f*, *k*) by the transverse convexity of its surface. The internal bounding ridge (figs. 2, 3 *f'*) is sharp and high, but less so than in the Bear. The postero-external (figs. 1, 3, 0) is very thin and sharp, and slightly undercut. The olecranal fossa (fig. 1 *p*) is of great depth and size, especially on the external side, but the coronoid (fig. 3 *d*) fossa is hardly defined, the surface of the shaft passing in an easy sweep to the edge of the articulation. The whole arrangement of the articulations of the humerus in Felis indicate the power of using the fore limb with great force in a great variety of directions.

§ 3. *Measurements.*—The variations in size of the humeri of *Felis spelæa, F. leo,* and *F. tigris* are shown in the following table:

TABLE OF MEASUREMENTS.

MEASUREMENTS OF HUMERUS.	*Felis spelæa.*											*Felis leo.*			*Felis tigris.*
		Taunton Museum.													
	Schmerling's figure. Belgium.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	Sandford Hill Cave.	Oreston Cave.	Gailenreuth Cave. Sir P. Egerton. Cast, Bt. Mus.		(Winwood) Larkhall, near Bath.	W. A. S.	*Leo Barbarus*, 112 A.	112 K. Asiatic Lioness.	British Museum, 114 K.
Extreme length	13·75	...	...	...	...	...	...	...	...	...	...	13·0	13·3	11·2	11·50
Minimum circumference	...	...	5·50	...	...	...	...	...	...	...	...	4·10	4·4	3·9	3·90
Transverse measurement of proximal articulation	...	4·10	...	...	...	...	...	...	...	4·30	...	3·00	2·7	2·2	2·30
Vertical ditto	...	4·60	...	...	...	...	...	...	...	...	...	3·40	3·5	3·4	3·30
Transverse measurement of distal articulation	...	...	...	2·80	2·55	2·57	3·00	...	...	2·70	2·40	2·40	2·4	1·9	1·90
Vertical ditto	...	...	...	4·00	3·50	3·50	4·30	...	...	2·70	...	2·30	2·3	2·0	2·20
Depth at distal end of deltoid ridge.........	...	...	...	...	...	...	...	2·02	3·36	...	...	2·00	1·85	1·65	1·4
Transverse measurement at same point	...	...	...	...	...	...	...	1·15	1·40	...	...	1·20	1·14	0·95	0·92

CHAPTER XI.

Femur, Pl. XVIII, figs. 4, 5.

CONTENTS.

§ 1. *Introduction.*—The femur of *Felis spelæa* very closely resembles that of the Lion and Tiger, and, so far as we can judge from the fragments, it bore the same proportion to the pelvis and tibia that it does in those two animals, being much longer than the tibia, a proportion that is reversed in the smaller felines. As we have met with no perfect spelæan femur in Britain, we have adopted the same artifice as in the humerus. We have used as the groundwork of our figure the cast of a perfect spelæan femur from Gailenreuth Cave, the original of which is in the collection of Sir Philip Egerton, F.R.S. It is drawn in a light tint. In a somewhat darker tint we have represented a large portion of the shaft of a British specimen, and in full tint a considerable portion of the head, which, equally with the above, exactly corresponds in size with the cast, and a distal end which is rather smaller, and in this way we have built up the bone from fragments found in Britain. A small portion of a still larger distal end and the entire distal end of a smaller specimen are with others in the Taunton Museum. They are all from Bleadon Cavern. Since the figure was drawn we have found a nearly perfect shaft in the Jermyn Street Museum, obtained from the brickearth of Hartlip, in Kent, and slightly smaller than the specimen from Gailenreuth. A very fine specimen also of the shaft, slightly smaller than the femur from Gailenreuth and that from Bleadon, which we figure, has been found in the gravels of Barnwell, a suburb of Cambridge, and is preserved in the British Museum.

§ 2. *Description.*—The head (fig. 4, *a a'*) of the bone is hemispherical, and larger than the neck, which it overhangs distally (fig. 4, *a*). On its postero-internal surface is a very shallow depression, much less strongly marked than in most animals, for the ligamentum teres. The neck connecting the head with the shaft is short and massive, and resembles in form the frustrum of a compressed conoid, the proximal surface being horizontal, while the distal points diagonally upwards at an angle of forty-five degrees. The shaft is nearly straight, cylindrical, and slightly enlarged at the ends, and when compared with that of the Bear is far more massive. It gives the idea of immense strength combined with great lightness.

A stout ridge runs from the posterior edge of the head, parallel to the distal surface of the neck, to the smaller trochanter, or "trochantine" as it is termed by Straus-Durckheim, which is an oval process with its long axis parallel to the neck. To its smooth summit is attached the psoas muscle, the iliacus internus in the Cat being merely a second head of the latter. From the outer and lower base of the trochantine a sharp edge turns diagonally upwards, and forms the external edge of the great trochanter, and affords attachment to the quadratus. The trochanter is formed on the same plan as in Man, but is proportionally larger and higher; it is separated from the neck behind by the great trochanterian cavity in which the tendons of the obturator muscles are inserted. Its external summit is chamfered and hollowed for the attachment of the pyriformis; to its rounded outer summit (fig. 4, *b*) is attached the gluteus medius, and anteriorly to the massive tuberosity (fig. 4, *c*) the gluteus maximus.

The adductores longus and magnus are in the Feles extensor muscles of the thigh, and therefore require an attachment posterior to the lateral position they occupy in Man. Consequently the sharp ridge forming the outer lip of the linea aspera in Man is, as it were, removed to the extreme outer edge of the posterior surface of the bone, and the two above-named muscles, termed in their new position curvatus and arquatus by Straus-Durckheim, occupy the greater part of the posterior surface. The inner lip of the linea aspera is represented by a slightly roughened surface passing diagonally across the bone, and affords attachment in its upper part to the adductor brevis and the pectinæus.

The outer lip of the linea aspera is roughened and enlarged immediately below the lateral tuberosity of the great trochanter, so as to form a rudimentary third, which affords attachment to the gluteus maximus. Inferiorly it may be traced to the external angle of the outer tuberosity above the outer condyle.

This external position of the linea aspera causes the origin of the vastus externus to be entirely on the anterior and external surfaces, and it consequently occupies the whole of the upper part of this surface of the bone and the anterior edge of the linea, while the part corresponding internally is occupied by the vastus internus; between them are the origins of the crural proximally and the subcrural distally. The second head of the triceps cruris attached in Man to the outer lip of the linea aspera has no analogue in Felis.

The distal extremity of the femur differs remarkably from that of Man. The two condyles (fig. 5, *l l'*) are subequal, the internal (figs. 4, 5, *l*) being somewhat the larger, and reaching slightly further down. The intercondylian anterior articulation (figs. 4 5 *f*) for the patella is square in outline, and is defined by a high and well-marked ridge; it occupies almost the median line of the shaft. The lateral surfaces of the process on which it stands are very nearly symmetrical (fig. 5, *g g′*), the external (fig. 5, *g*) forming a slightly more acute angle with the patellar articulation; the condyles extend further behind than in Man, and their lateral surfaces (figs. 4, 5, *l l′*) are roughened for the attachment of the lateral ligaments, and externally (figs. 4, 5, *l*) for the attachment of the extensor digitorum or cnemodactylus of Straus-Durckheim.

The condyles are separated by a very deep depression (fig. 5, *h*) for the crucial and other ligaments, passing slightly inwards, and rendering the inner condyle slightly smaller than the outer.

Immediately above the condyles the posterior surface of the shaft is flattened, and on its lateral edges are the internal and external tuberosities (fig. 4, *mn*), affording origin to the gastrocnemii muscles. In the angles between the condyles and the shaft are two small depressions (figs. 4, 5, *n*) for the lodgment of the sesamoid bones, called the external and internal crithoids, which, with a third below the external, are usually termed fabellæ. The two former are in the tendons of the gastrocnemii, and the latter in that of the popliteus.

The position of the nutritive artery varies, sometimes piercing the shaft in the middle of the lesser linea aspera, sometimes in the greater.

A fine specimen of the spelæan femur was discovered by Dr. Schmerling[1] in the caverns of Liége, and is figured in his great work. It agrees in every respect with the German and English specimens. The figure is produced by M. de Blainville[2] in his 'Ostéographie.'

§ 3. *Measurements.*—The following table shows the variations in the size presented by the femora of *F. spelæa*, *F. leo*, and *F. tigris*.

TABLE OF MEASUREMENTS OF FEMUR IN FELIS SPELÆA, F. LEO, AND F. TIGRIS.

MEASUREMENTS OF FEMUR.	*Felis spelæa.*							*F. leo.*			*F. tigris.*
	From Gailenreuth. Sir P. Egerton.	Taunton Museum.				Belgium. Schmerling's fig.	Barnwell Gravel. Brit. Mus.	W. A. S.	*Leo Barbarus.* 112 A, Brit. Mus.	Asiatic Lioness. 112 K, Brit. Mus.	*F. tigris.* 114 K, Brit. Mus.
		Bleadon.	Bleadon.	Bleadon.	Bleadon.						
1	16·65	...	...	...	...	16·60	...	14·40	14·5	12·4	14·2
2	5·00	...	...	...	4·80	...	4·2	3·90	4·2	3·4	3·3
3	3·00	3·10	...	...	...	...	...	2·50	3·0	2·3	2·0
4	3·00	3·10	...	...	...	...	...	2·50	3·0	2·3	2·3
5	3·20	...	3·20	3·00	...	3·40	...	3·00	2·8	2·6	2·5
6	6·30	...	5·80	6·00	...	...	...	4·60	4·8	4·5	4·3

[1] Oss. Foss. de Liége, tom. ii., Pl. xvi, fig. 2.

[2] Felis, Pl. xviii, fig. *b*.

§ 4. *Definition.*—On comparing the femora of the Cave Lion with those of other animals associated with it in Pleistocene deposits, the following points of difference may be enumerated. The straightness and cylindrical form of the shaft, and the symmetrical form of the distal end, distinguish it from that of the Cave Bear. In the Hyæna it is also symmetrical, but the great difference in size prevents the two being confounded together. In the latter animal, moreover, it is rather more bent and the patellar articulation is not so sharply defined. The large development of the third trochanter in the Horse is a point by which the most slender bone may be distinguished at a glance.

CHAPTER XII.

Tibia, Pl. XIX, figs. 1, 1′, 1″, 2, 2′. Fibula, Pl. XIX, figs. 3, 4. Patella, Pl. XIX, figs. 5, 5′.

CONTENTS.

§ 1. *Tibia* (Pl. XIX, figs. 1, 1′, 1,″ 2, 2′).—The tibiæ of all the digitigrade Carnivora are remarkably alike in general form, and offer constant differences characteristic only of genera or widely dissociated species. They present variations of proportion in animals of the same, as great in degree as in the closely allied but distinct species, such as Lion and Tiger, and are therefore of comparatively small value in classification. We have met with several specimens of this bone in the caverns of Somerset; the one (figs. 1, 1′) is perfect, with the exception of the proximal epiphysis, and belongs to a young animal; the other (figs. 2, 2′) consists of the proximal articulation of an adult; the former was obtained from Sandford Hill, the latter from Bleadon.

In the larger Feles generally the tibia is shorter, both proportionally to the femur and in relation to its own minimum circumference, than in the smaller forms. In Lion, Tiger, and *Felis spelæa,* it is considerably shorter than the femur; in the domestic and wild Cats, considerably longer. The articulations, as we have elsewhere remarked, are frequently larger in Tiger than in Lion, but the variations in this respect are so great that we agree with M. de Blainville in considering them of no specific value.

§ 1 *a. Description.*—The tibia of the larger Feles is a strong bone of slightly double curvature, bent gently forwards distally, and backwards proximally, cylindrical distally, but expanding into a prismatic form proximally; so that the proximal vertical diameter of the shaft is more than double the minimum near the distal end. The prism is so disposed that the narrowest side (fig. 1′ *b*) forms the posterior face of the bone, while the two broader meet in the strong anterior crest (figs. 1, 1′ *a*), which curves gently outwards and may be traced in the adult as far down as the distal end. The head (figs. 2, 2′ *c, d*) of the bone is partially occupied by the two slightly concave semilunar facets for articulation with the femur separated from each other by the small bifid eminence termed the spine (figs. 2, 3′, *e*). They are deepened in the living animal by the semilunar cartilages that form an elastic or variable socket, and, with the adipose ligament in front, make up a broad articulation for the support of the hind quarters of the animal, which would otherwise rest on mere points. At the intersection of the nearly plain tibial facets and the highly convex femoral condyles, these cartilages are firmly fixed to both tibia and femur by strong ligaments. The facets are separated posteriorly by a deep notch (fig. 2′ *f*), in which is implanted the posterior crucial ligament, and are strengthened laterally by the external and internal tuberosities (fig. 2, *g*, *h*), affording attachment to the external and internal lateral ligaments. On the under side of the external tuberosity is a small oval articulation (fig. 2, *g*), for the head of the fibula, and under the posterior edges of the same tuberosity is a groove for the semi-membranosus muscle. In front of the spine, and forming a small shallow indentation in the anterior surface of the external facet, is a roughened space of triangular form (figs. 2, 2′, *l*) that extends inwards, so as to cut off the internal facet from the base of the crest. It affords attachment to the adipose cushion or ligament, filling the space between the tibia, the fore part of the distal articulation of the femur, and the patella. A strong and massive anterior tuberosity forms the antero-external boundary of the external facet (figs. 2, 2′, *m*). The proximal end of the crest is covered by a projecting and slightly roughened mass called the tubercle (figs. 2, 2′, *n*), which extends considerably downwards in the larger Feles, and in the two bones at Taunton of *Felis spelæa*, is nearly parallel to the posterior surface of the shaft. It affords attachment to the patellar tendon, which, through the medium of the patella, is the principal tendon of the muscles which act at once as the extensors of the tibia and flexors of the femur. Many of these muscles are also partially attached to the head and sides of the tibia, such as the rectus internus and sartorius, forming one muscle, the fascialis, the rectus anticus, vastus internus, and semi-tendinosus while others, viz., the arquatus, of Straus-Durckheim, the equivalent of the adductor magnus in Man, the popliteus and semi-membranosus and triceps cruris, act as the extensores cruris and flexores tibiæ, and leave their marks in the ridges and grooves on the posterior face of the bone. The posterior angles of the prismatic portion of the shaft are termed the extero- and intero-posterior crests (fig. 1′, *o*, *p*), the latter of which is traversed by a minute ridge, which is the line of attachment of the inter-osseous membrane that binds the tibia to the fibula. Near this and at a distance from the proximal end of about one third of the entire length, is the small foramen for the passage of the nutritive artery and nerve. The outward sweep of the crest (fig. 2, *m*) forms on the external surface a large concavity (fig. 2, *q*), affording origin to the large tibialis anticus, which acts as a flexor of the foot and extensor of the toes. A considerable portion of the length of the shaft is occupied by the origin of the flexor longus digitorum on the inner side, the tibialis posticus running in a parallel direction on the external surface close to the inter-osseous membrane.

The shaft increases in size as it approaches the distal articulation (figs. 1, 1″, *r*, *s*), which is of somewhat trapezoidal form, wider than deep in a vertical direction, divided diagonally by a strong ridge into two concave depressions for the reception of the condyles of the astragalus. The inner of these is by far the deeper, because the internal malleolus (fig. 1, 1″, *r*) descends much further than the internal (figs. 1, 1″, *s*). The internal malleolus is rough and massive, and traversed posteriorly by a small groove (fig. 1″, *t*), running downwards and forwards, which is converted into a canal by an investing ligament, and receives the tendons of the tibialis posticus, and the flexor longus digitorum. The external edge of the outer facet (figs. 1, 1″, *s*) is rounded off to receive the small internal and lateral articulation of the fibula.

§ 1 β. *Measurements.*—The only difference to be found between the tibiæ of the *Felis spelæa* and the living Lion and Tiger is the massive proportions of the former. The specimen (fig. 1) is perfect, with the exception of the proximal epiphysis. Had the latter been present it would have been of nearly exactly the same length as that of the lion in our own possession, whereas the following table of measurements shows how much they differ in bulk. Other fragments in the Taunton Museum corroborate this evidence, and the most slender of the larger specimens is more massive than any leonine or tigrine bone which we have seen. Others, however, differ very little from the proportions of those in the two latter animals, and the whole form a graduated series without any break. In the large spelæan tibiæ the tuberosities are somewhat larger, and the tubercle for the patellar tendon passes further down on the crest, so as to form an attachment proportional to the massiveness of the limb.

Comparative Measurements.

	Felis spelæa.							*Felis leo.*			*F. tigris.*
	Taunton Museum.										
	Figured specimen. Sandford Hill Cave.	Figured specimen. Bleadon Cave.	Bleadon Cave.	Sandford Hill Cave.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	W. A. S.	112 K, British Museum.	112, British Museum. Asiatic Lioness.	114 K, British Museum.
1. Maximum length	...	...	...	...	...	...	...	12·50	11·80	11·6	11·4
2. Minimum circumference	4·80	...	...	4·25	4·50	3·90	4·50	3·28	3·00	3·2	3·3
3. Transverse measurement of proximal articulation	...	3·60	3·20	...	...	...	...	3·00	2·70	2·9	2·9
4. Vertical ditto	...	2·80	2·60	...	...	...	...	2·20	1·80	1·6	1·6
5. Transverse measurement of distal articulation	3·00	...	...	...	...	...	...	2·30	2·08	1·9	1·9
6. Vertical ditto	1·90	...	...	...	...	...	...	1·30	1·21	1·2	1·2

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THE

BRITISH

PLEISTOCENE MAMMALIA.

BY

W. BOYD DAWKINS, M.A., F.R.S., G.S.,

AND

W. AYSHFORD SANFORD, F.G.S.

PART III.

BRITISH PLEISTOCENE FELIDÆ.

FELIS SPELÆA, Goldfuss. *FELIS LYNX*, Linnæus.

(Pages 125—176; Plates XX—XXII, XXIIa, XXIIb, XXIII.)

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§ 1 γ. *Definition from other Pleistocene tibiæ.*—The tibia may be distinguished from all other bones associated with it in Pleistocene deposits, by the following points :—From any of the Deer or Ox tribe, by the oblique direction of the astragaline facets ; from the Horse, by the slenderness of the shaft. It approaches that of the Hyæna very closely, but in the latter animal the crest is longer, both proximally and distally, so that the head is flatter and the whole shaft more decidedly prismatic. Its size, also, would at once stamp its character. In the Bear the shaft is decidedly prismatic throughout, the distal articulation is much wider, and the astragaline depressions shallower. The internal malleolus does not descend so far, while the whole epiphysis extends much further externally. The crest also is much smaller, as well as the patellar tubercle; the extero-anterior tuberosity is much lower, and the depression for the adipose ligament does not cut off the internal facet from the patellar tubercle, but passes down straight over the latter; the semilunar facets are flatter, and the posterior attachments for the muscles are far more distinctly marked.

We know of no figures of any fossil tibiæ of *Felis spelæa*.

§ 2. *Fibula* (Pl. XIX, figs. 3, 4).—We have met with fragments only of the fibula of *Felis spelæa*, one of which consists of the shaft, and the other of a perfect distal end ; both were obtained from Bleadon Cave, and are figured in Pl. XIX, figs. 3, 4.

§ 2 α. *Description.*—As we have never met with the proximal end of the bone that afforded origin to the soleus muscle, we omit all notice of it; analogy would show that it was identical in form with that of the living Lion. The shaft of the bone (fig. 3) at the proximal end is triangular in section, and its posterior surface is shown in the figure (*a*). The roughened surface affords point of origin to the peronæus longus. The shorter of the remaining two sides or the anterior is the fibular origin of tibialis posticus, which is attached to this bone in Felis. Below, the shaft becomes cylindrical, having a sharp high ridge (*b*) on the internal surface, which is the line of attachment for the fibulo-tibial inter-osseous membrane. On the posterior side of this ridge, about the middle of the bone, is the origin of the flexor longus pollicis, and lower down that of the flexor longus digitorum. It curves forward near the distal end and forms a sharp wedge-like tubercle, on the outer side of which (fig. 3, *e*) is the origin of the peronæus tertius. At the inner angle of the distal end there is a roughened surface, which is developed in the adult into a second sharp ridge, that also runs spirally backwards half round the bone, so as to form the posterior distal edge. On the outer side of this, a little below the middle, is the origin of the peronæus brevis (fig. 3, *d*). The two ridges above described are opposite to each other at the distal end, and form a flat blade-like expansion, on the inner side of which is a slight polished elevation, which is the distal articulation with the tibia.

The extensor communis digitorum or cnemodactylus of Riolan is not attached to the proximal end of the tibia in Felis, but passes upwards to the external face of the condyle of the femur.

In fig. 4 we have represented the distal end of a left fibula which resembles in every respect, save that of size, the corresponding portion of the leonine or tigrine bone. It presents externally a deep groove between two tuberosities, which, in the living animal, is converted by a ligament into a canal for the tendon of the peronæus longus (fig. 4, *a*). The posterior tuberosity forms the external malleolus, behind which is a second groove (fig. 4, *c*), deep and narrow, for the tendons of the peronæi brevis and tertius. Internally we find a small concave articulation close to the epiphysial division, by which the bone is attached laterally to the tibia, and below this is a flat surface which articulates with the outer side of the astragalus, and behind this, again, is a depression for one of the ligaments which bind the fibula to the tarsus.

From the immature state of the shaft we have been unable to institute a rigid comparison between it and those of the recent Feles.

Dr. Schmerling[1] gives a rough and slight figure of a portion of a fibula, and states in the text that the upper portion is broken away; his figure, therefore, must be that of the external and posterior aspect of the distal end, together with about two thirds of the shaft; with this exception, we have met with no figure of the bone.

§ 2 β. *Measurements.*—In the following table the superior massiveness of the spelæan fibula is shown over those of the Lion and Tiger.

Comparative Measurements.

	Felis spelæa.		*Felis leo.*		*F. tigris.*
	Taunton Museum.				
	Figured shaft. Sandford Hill.	Figured distal articulation. Sandford Hill.	W. A. S.	112 K, British Museum.	114 L, British Museum.
1. Maximum length	...	...	11·15	11·55	10·0
2. Minimum circumference	1·25	...	0·85	1·12	1·10
3. Transverse measurement of proximal articulation	...	...	0·35	0·75	0·45
4. Vertical ditto	...	...	1·30	1·30	1·05
5. Transverse measurement of proximal articulation	...	0·65	0·60	0·57	1·50
6. Distal ditto	...	1·23	1·10	1·26	0·45

[1] 'Oss. Foss. de Liége,' vol. ii, pl. xvi, fig. 4, p. 80.

§ 3 *a*. *Patella* (Pl. XIX, figs. 5, 5′).—The patella of *Felis spelæa*, of which many specimens are preserved in the Taunton Museum from the caves of Sandford Hill and Bleadon, exactly resembles that of the Lion and Tiger in form, but surpasses them in size. As in the recent Feles, it varies considerably in size and proportion. In shape it resembles a flattened pear, the small end being that to which the great ligament is attached which unites the bone to the anterior crest of the tibia. Many anatomists consider that in this bone we have the analogue, in the hind limb, of the olecranon of the ulna, a point that will be found fully discussed in the 'Cyclopædia of Anatomy and Physiology.'[1] The outer or anterior surface (Pl. XIX, fig. 5′) is roughened for the attachment of the tendons of the muscles, which we have elsewhere pointed out as the extensors of the leg and the flexors of the thigh, including the "paracural" of Straus-Durckheim, which has no analogue in man. The upper part of the proximal or posterior surface (fig. 5) is entirely occupied by the slightly convex articulation which fits the intercondylian or anterior facet of the femur; its edges slightly extend beyond the body of the bone.

The only patella liable to be confounded with that of *Felis spelæa* is that of the Bear; it may, however, be easily distinguished by its more oval form, and by the greater comparative extent of its femoral articulation.

§ 3 *β*. *Measurements.*—The variation in size is seen in the following table of measurements of the patella in *Felis spelæa*, *F. leo*, and *F. tigris*:—

	Felis spelæa.				*Felis leo.*			*F. tigris.*
	Taunton Museum.							
	Bleadon Cave. Figured specimen.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	W. A. S.	629, Coll. Surg.	626, Coll. Surg.	101, Coll. Surg.
Maximum length	2·90	3·00	2·80	2·50	2·40	2·42	1·85	1·94
Maximum circumference	4·73	5·00	4·58	4·37	4·00	4·1	3·7	3·4
Transverse measurement of proximal articulation	1·85	2·00	1·80	1·70	1·55	1·58	1·4	1·3
Vertical ditto	1·90	1·95	1·95	1·85	1·50	1·25	1·1	1·33

[1] Article "Skeleton," p. 664 et seq.

CHAPTER XIII.

Carpus, Pl. XX, figs. 1, 1′, 2, 3, 4, 5, 5′.

CONTENTS.

In describing the bones of the carpus we shall consider the anterior or dorsal surface as that which is naturally so in all quadrupeds; the palmar and inferior or posterior as synonyms denoting the same portion of the bone.

The carpus in the genus Felis is composed of seven bones, besides the small one which has no independent existence in human anatomy, called by Straus-Durckheim the 'phacoid.' The scaphoido-lunare, the cuneiform, and pisiform, compose the upper or proximal row; the trapezoid, the trapezium, the magnum, and unciform, the lower or distal. Of these we have only met with the scaphoido-lunare, the unciform, and pisiform, in *Felis spelæa.*

1. *Scaphoido-lunare* (Pl. XX, figs. 1, 1′, 2).—1 α. *Description.*—The scaphoido-lunare is by far the largest and most important bone in the carpus; it extends throughout the whole width of the joint, and forms almost the sole means of attachment between the fore paw and the forearm. It is very massive and is roughly quadrangular in plan, with a large and strong tubercle projecting from the postero-internal angle (fig. 1′, *e*); it is broader than long, and much thicker externally than internally. The proximal or radial articulation (figs. 1, 2, *a*, *b*), which covers the whole of that surface of the bone with the exception of that portion which is opposite the tubercle is convex, traversed intero-posteriorly by a depression (figs. 1, 2, *b*) running from behind forwards and inwards. On its external edge is a very small articulation for the upper edge of the pisiform, which just touches it at that point (figs. 1, 2, *c*).

The tubercle (fig. 1′ *e*) is a somewhat pyramidal or conical mass, projecting diagonally inwards from the intero-posterior angle of the bone. It presents on its antero-internal surface a round flat articulation (fig. 1′, *e*) for the phacoid bone, to which is attached the adductor pollicis muscle instead of to the tubercle itself, as in man. It affords attachment to a large number of ligaments, the principal of which is the annular or armillary, which is attached by some of its lower fibres. It would serve but little purpose were we to enumerate them all, for they are extremely difficult to separate; they have been reckoned and described to the number of twenty-six by Straus-Durckheim.[1] They bind the radius to the carpus, and the bones of the carpus the one to the other.

The distal surface of the bone is entirely articular, and is divided by well-marked ridges into three well-defined articulations, the internal being a slightly concave parallelogram (figs. 1, 1′, 2, *f*) set diagonally outwards and downwards for the head of the unciform; the second (figs. 1, 1′, 2, *g*), being more concave than the preceding and wider posteriorly than anteriorly for the reception of the head of the magnum; and the third, (figs. 1, 1′, 2, *h*), being triangular and divided by a broad diagonal elevation into two slightly concave surfaces for the reception of the heads of the trapezium and trapezoid.

We have met with no scaphoido-lunare of Lion or Tiger which equals in size several of those in the Taunton Museum belonging to *Felis spelæa*, but we have figured one from Bleadon Cave (Pl. XX, fig. 2), which in no respect differs from those of either of the above animals. The larger spelæan specimens are somewhat thicker proportionally than the smaller, as well as the leonine and tigrine. That figured from Sandford Hill Cave, (Pl. XX, fig. 1), apparently belongs to the individual that has furnished us with a great many of the originals of our plates.

§ 1 β. *Measurements.*—The following table shows the variation in size between the leonine, tigrine, and spelæan scaphoido-lunaria.

COMPARATIVE MEASUREMENTS.

	Felis spelæa.			*F. leo.*	*F. tigris.*
	Taunton Museum.				
	Largest. Bleadon Cave.	Figured specimen. Sandford Hill Cave.	Figured specimen. Smallest. Bleadon Cave.	W. A. S.	Coll. Surg.
1. Maximum length	1·75	1·33	1·12	1·12	1·12
2. Minimum circumference	6·80	6·75	5·75	5·20	...
3. Transverse measurement of proximal articulation	2·30	2·10	1·87	1·80	1·8
4. Vertical ditto	1·40	1·60	1·13	1·45	1·2
5. Transverse measurement of distal articulation...	2·08	1·96	1·65	1·64	1·42
6. Vertical ditto	1·53	1·41	1·30	1·10	0·93

[1] Op. cit., vol. ii, p. 84 et seq.

§ 1 γ. *Definition from that of Ursus.*—The scaphoido-lunare of the Bear may be distinguished at a glance from that of *Felis spelæa,* the tubercle being much larger, cylindrical and projecting directly backwards, and the articulation for the magnum being parallel to the side of the bone instead of running diagonally across it, as in the latter animal.

§ 2. *Pisiform* (figs. 3, 4), α. *Description.*—The pisiform of *Felis spelæa* strongly resembles in plan that of all the other Feles we have examined, those of the different species being only distinguishable by their size. Even in the same species it presents small variations of shape and proportion. It may be considered, generally speaking, as a long three-sided pyramid, bevelled off proximally and distally for articulation, with the cuneiform and the styloid process of the ulna, the apex swelling into a tuberosity (figs. 3, 4, *b*), for the attachments of the tendon of the ulnaris muscle, of those for the bending of the fifth digit, of the common flexor of all the digits, and of the transverse adductor of the first. It is firmly attached to its fellow carpals, to the metacarpals, and forearm, by a large number of ligaments, and thus it forms a powerful *point d'appui* for the motions of the fore foot, analogous to the shaft of the calcaneum in the hind foot. The articulations may be distinguished as the proximal or ulnar (fig. 4, *a*), which is known by its semilunar form, and the distal or cuneiform, which presents the plan of a rectangular parallelogram with rounded angles (fig. 3, *c*). Both are nearly flat, and unite in a sharp and nearly straight edge.

It may be known from the corresponding bone of the Bear by the possession of the following points :—By its greater length, by the flatness of the ulnar articulation as contrasted with the concavity of that of the Bear, and by the straightness of the edge separating the articulations, which is concave in the latter.

We have met with several specimens from the caves of Bleadon and Sandford Hill, some of which are but little larger than the living Lion and Tiger, while others (see fig. 4) are much larger than those of any of the living Feles. The original of fig. 4 probably belonged to the same skeleton as the large scaphoido-lunare figured in the same plate.

§ 2 β. *Measurements.*—The variations in the size of the pisiform in *Felis spelæa, F. leo,* and *F. tigris* are shown in the following table :—

COMPARATIVE MEASUREMENTS.

	Felis spelæa. Taunton Museum. Bleadon Cave. Figured.	*Felis spelæa.* Taunton Museum. Sandford Hill Cave. Figured.	*Felis spelæa.* Taunton Museum. Bleadon Cave.	*Felis spelæa.* Taunton Museum. Bleadon Cave.	*Felis leo.* British Museum.	*Felis leo.* W. A. S.	*F. tigris.* British Museum.
1. Maximum length	1·95	1·92	1·80	1·77	1·29	1·52	1·55
2. Minimum circumference	2·10	2·10	2·00	1·90	1·35	1·50	1·35
3. Transverse measurement of proximal articulation	1·05	0·95	0·96	0·93	...	0·95	...
4. Vertical ditto	0·50	0·53	0·50	0·43	...	0·46	...
5. Transverse measurement of distal articulation	1·00	1·00	0·82	0·74	0·75	0·80	0·75
6. Vertical ditto	0·75	0·75	0·76	0·50	0·35	0·43	0·44

§ 3. *Unciform* (figs. 5, 5′,) *a. Description.*—The unciform of *Felis spelæa* is a small, somewhat wedge-shaped bone, not distinguishable from that of the recent Lion and Tiger except by its massiveness. The head of the wedge occupies the anterior or dorsal aspect of the bone, and a very slight tuberosity is the only trace of the claw-like process which gives the name to the bone in man.

The proximal or scaphoidal articulation (fig. 5, *a*) is much narrower than the distal, the sides being nearly parallel. It is much longer from front to back than broad; convex anteriorly and slightly concave posteriorly, it ends on the palmar surface in a semicircular boundary. The distal or metacarpal articulation (figs. 5, 5′, *b*) partakes of the wedge-shape of the bone. It is deeply concave, and receives the heads of the fourth and fifth metacarpals. The inner articulation (figs. 5, 5′, *c*) for the magnum is shaped something like the letter L, placed so that the stem coincides with the anterior edge of the bone. It is nearly flat. The remaining articulation, or the cuneiform (figs. 5, 5′, *d*), is for the most part slightly convex, and occupies the anterior part of the external surface. The anterior or dorsal surface assumes the form of an irregular pentagon (fig. 5), roughened and indented between the lateral articulations for the attachment of several interosseous ligaments. The thin end of the wedge, occupying the palmar surface, is a tubercle (fig. 5′, *e*) for the attachment of the adductor of the fifth digit; the opponens of the same digit not being attached, as in man, to this bone, but to the magnum.

This bone strongly resembles that of the Bear, but is easily distinguished by the greater squareness of the latter, as well as by the flatter distal articulation. We know of no other bone with which it can be compared.

§ 3. β. *Measurements.*—The variations in size of the unciform in *Felis spelæa*, *F. leo*, and *F. tigris* are shown in the following table:

COMPARATIVE MEASUREMENTS.

	Felis spelæa.			*F. leo.*	*F. tigris.*
	Taunton Museum.				
	Bleadon Cave.	Bleadon Cave.	Sandford Hill Cave. Figured.	British Museum.	British Museum.
1. Maximum length	1·40	1·32	1·14	0·92	1·07
2. Minimum circumference	3·03	3·04	3·47	2·18	2·60
3. Transverse measurement of proximal articulation	0·64	0·62	0·50	0·41	0·30
4. Vertical ditto	1·29	1·13	1·22	0·76	0·94
5. Transverse measurement of distal articulation...	1·03	0·90	0·88	0·62	0·64
6. Vertical ditto	1·20	1·10	1·20	0·80	0·98

CHAPTER XIV.

METACARPALS. Pls. XIX, fig. 6; XX, 6, 7; XXI, 1—5.
PHALANGES. Pl. XXI, figs. 6—14.

CONTENTS.

§ 1. *Metacarpals.* α. *Introduction.*—As metacarpal bones of the genus Felis have to perform very much the same functions in all the species, they present but few characters of value in classification, the variation in the proportions observable in different individuals of the same being frequently as great as in the closely allied species. For the most part, however, the metacarpals of *Felis spelæa,* from the bone-caverns, are stouter and stronger than those of the living Lion and Tiger; but, on the other hand, some of them are even smaller in every dimension than the average-sized bones of the two latter animals; the large series also from the caves of Somerset proves that there is a gradual passage from the most massive to the most slender spelæan form; size cannot, therefore, be considered of specific value. We are fortunate in being able to give figures of a complete set from the cavern of Sandford Hill (Pl. XXI, figs. 1, 2, 3, 4, 5), which belonged to an individual in the prime of life. They are remarkable for their straightness and stoutness, and the fourth presents a variation which we shall describe in its due place. We have also figured the proximal end of a fourth metacarpal of the small form from Bleadon Cave (Pl. XX, fig. 6), and a remarkably small fifth from the hyæna-den of Wookey Hole (Pl. XX, fig. 7). A gigantic second metacarpal from the lower brickearths of Crayford is also figured (Pl. XIX, fig. 6).

The metacarpals when united form a compact transverse arch, the convexity being dorsal, and the concavity palmar; the latter transmits the tendons of the flexor and adductor muscles to their points of insertion in the phalanges.

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§ 1. β. *First Metacarpal* (Pl. XXI, fig. 1).—The first metacarpal for the hallux or thumb, in its shortness and the obliquity of its articulations, differs from all the rest of its fellows. The proximal articulation with the trapezium occupies the end of the bone, and extends diagonally outwards and downwards on the dorsal surface, forming a shallow, pulley-shaped joint by which the thumb is freely moved in a transverse direction. On the internal edge there is a very small facet (*b*), which is in apposition with the phacoid bone in the recent Felidæ. Externally also there is a small facet, which rests on the internal edge of the second metacarpal. The united action of these articulations and of the ligaments which bind this bone to the carpus, prevent any rotatory action; and thus the thumb cannot be opposed, as in man, to the other digits. The shaft is short, stout, and slightly bent towards the outside, and traversed on its dorsal aspect by a groove running from the extero-inferior edge of the proximal articulation diagonally outwards and forwards, and receiving the tendons proper to the bone for the common extensor digitorum. The palmar surface is concave, and much roughened for the attachment of a large number of ligaments. The distal articulation (*d*) is very oblique, and faces inwards and downwards, so that the action of the phalange is still more transverse than it otherwise would be, and its tearing and grasping power is much increased. Immediately above it in the middle of the palmar surface is a small well-marked tubercle which affords attachment to the ligament, uniting the bone to the first phalange of the second digit, and to the adductor brevis pollicis muscle. The majority of the tendons of the muscles that regulate the motion of this joint are attached, not to the bone itself, but to a large internal sesamoid, occupying the intero-inferior angle (*e*) of the bone.

§ 1. γ. *Second, Third, Fourth, Fifth Metacarpals* (Pls. XIX, fig. 6; XX, figs. 6, 7; XXI, figs. 2, 3, 4, 5). The proximal end of the second metacarpal forms a wedge-like mass slightly shifted, as it were, outwards for a quarter of its width. In front it is rectangular; behind, on the palmar surface, it throws out a small tubercle which is the thin end of the wedge. The proximal or trapezoidal articulation (Pls. XIX, fig. 6; XXI, fig. 2, *a*) is triangular in outline; concave transversely, and nearly flat vertically. On the upper and outer edge of the palmar tubercle is a small flat surface (Pl. XXI, fig. 2, *b*), which articulates with the postero-internal facet of the os magnum, and immediately above is the somewhat triangular surface set at right angles to the trapezoidal articulation which is in contact with the antero-internal facet of the same bone. At the antero-internal angle of the trapezoidal articulation is a small concave surface (fig. 2, *c*), which receives the convex external facet of the trapezium, and, extending from it backwards as far as the palmar tubercle, is a broad slightly concave surface for contact with the first metacarpal. Immediately under the articulations for the os magnum are two concave surfaces, the anterior being the larger and deeper (fig. 2, *d*), which overlap corresponding surfaces on the inner side of the third metacarpal. Between them is a large ligamentary cavity. On the dorsal or anterior surface of the proximal end runs diagonally a shallow groove (Pl. XXI, fig. 2, *e*), to the upper part of which is attached the trapezoidal ligament. The whole of the head of the bone is roughened for the reception of the ligaments binding the bone to the carpus and its fellow metacarpals. The shaft presents a triangular section proximally, and is nearly circular in the middle and distally. At the point where it joins the distal articulation it is flattened in front, and develops a slight palmar ridge behind.

The distal articulation of the four outer metacarpals (Pls. XIX, fig. 6 ; XX, fig. 7; XXI, figs. 2, 3, 4, 5, *f*) bear a strong resemblance to each other; like those of the metatarsals they are bulb-shaped, and divided from the epiphysial line of the shaft by deep dorsal and lateral depressions (*g*) ; on the palmar or inferior surface they develop a short ridge in the median line (Pl. XX, fig. 7), which fits into the palmar notch of the first phalanges. On either side of it lies a sesamoid bone to which are fixed nearly all the tendons of the adductor and flexor muscles, for the movement of the metacarpals. At the point where the shaft joins the distal end is a tuberosity (Pl. XXI, figs. 2, 3, 4, 5, *i*) which catches the sides of the phalangeal articulations, and prevents these bones from bending backwards beyond an angle of about 60°, and thus forms a firm fulcrum for the support of the weight of the body.

The distal terminations of the metacarpals may easily be distinguished from each other by the positions of the tuberosities, and by the form of the distal articulations. The distal articulation of the fifth is, as it were, cut off on the outer side (Pl. XXI, fig. 5, *f*), while that of the second (fig. 2 *f*) is cut off on the inner side : the third and fourth are symmetrical, the former having the inner, and the latter the outer, tuberosity larger, and set lower on the bone. These articulations are epiphysial.

The proximal articulation of the third metacarpal (fig. 3) is set nearly at right angles to the end of the shaft, the dorsal face expanding considerably more than the posterior; it is vertically convex, transversely concavo-convex. On its inner side is a broad oval surface (fig. 3, *a*) set on a tuberosity for articulation with the overhanging portion of the second metacarpal (fig. 2, *d*) ; these two articular surfaces are divided from each other by a well-marked ridge (*c*). On the external side are two concave surfaces (fig. 3, *e*), which overhang and articulate with the fourth metacarpal : they are not so deeply concave, and are more confluent than those of the second. The proximal dorsal surface of the fourth (fig. 4) strongly resembles that of the third, but it is rounder and less excavated ; the articulation also is altogether different, the facet for the unciform (fig. 4 *d*) being simply convex vertically and flat transversely, while that for the third metacarpal and the os magnum forms a continuous surface (fig. 4 *a*), partially interrupted on the inner side by a ligamentary notch (Pl. XX, fig. 6). It is slightly convex both vertically and transversely, and usually forms one curvilinear surface with the unciform articulation, being divided from it by a slight ridge. This form from Bleadon is shown in Pl. XX, fig. 6. In that figured in Pl. XXI, fig. 4, these surfaces (*d*, *a*) are set at a considerable angle to each other ; these two bones represent the extreme variation in the form of the proximal articulation. In the recent Felidæ also a similar amount of variation may be observed. The articulation for the fifth metacarpal (fig. 4 *e*) is much less concave than those of the second and third; the proximal edge is much thickened and flattened, the palmar is small. The form of the third and fourth metacarpals is much stouter than that of the others, and the arch-like curvature is less and the dorsal surface is more flattened.

The fifth metacarpals of the Carnivora resemble each other so closely that it requires some attention to distinguish between forms of nearly the same size. In the Feles generally, they have a tendency to be triangular in section, to be more tapering, and to arch more decidedly in a palmar and outward direction than any of the others. The proximal articulation for the unciform (Pl. XX, fig. 7 *a;* XXI, fig. 5 *a*) forms a continuous surface with that of the fourth metacarpal, and like it is convex only in a vertical direction; it covers the whole of the end of the bone. The inter-metacarpal articulation (Pls. XXI, fig. 5 *b;* XX, fig. 7 *b*) is a flattened surface, segmental in form, set at right angles to that for the unciform, and interrupted inferiorly by a large ligamentary notch (Pl. XX, fig. 7 *e*), in front of which rises an articular eminence (Pls. XX, fig. 7 *d;* XXI. fig. 5 *d*), which fits into a corresponding hollow in the fourth metacarpal. Externally the head presents a large tuberosity (Pl. XXI, fig. 5 *e*), which affords attachment to the strong ligaments that bind the bone to the unciform, cuneiform, and pisiform. On the palmar surface also there is a large tuberosity (Pl. XX, fig. 7 *f*).

Nearly all the ridges on the metacarpals are for the attachment of ligaments; the only direct muscular attachments being those for the very small muscles connected with the flexion of the digits.

We have not attempted a more detailed description of these bones because of the great variation in the form of their articular surfaces, which renders it almost impossible to lay hold of characteristics common to a large series. The few points of difference that we have given are constant in all those of *Felis spelæa* and Lion which we have examined.

§ 1. δ. *Measurements.*—In the following table of measurements we have given the extreme variations of size and proportion in *Felis spelæa* as compared with corresponding bones of lion and tiger. The gigantic size of the second metacarpal from Crayford (Pl. XIX, fig. 6) is visible also in the metatarsal, fig. 7 of the same plate, and in an upper canine which was discovered after our plates were engraved. All these probably belonged to the same individual, and are far larger than any other remains of the animal that have yet been found.

Measurements of Metacarpals.

First Metacarpal.	*Felis spelæa.*					*Felis leo.*		*F. tigris.*
	Bleadon. Figured specimen.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	British Museum.	W. A. S.	British Museum.
1. Maximum length	1·89	1·20	2·05	1·78	1·95	1·33	1·65	1·61
2. Minimum circumference	2·40	2·15	2·44	2·38	2·38	2·08	1·90	1·78
3. Transverse measurement of proximal articulation	0·80	0·70	0·90	0·80	0·88	0·56	0·65	0·70
4. Vertical	1·25	0·90	1·12	1·00	1·03	0·53	0·75	0·92
5. Transverse measurement of distal articulation	0·90	0·80	0·87	...	0·84	0·64	0·75	0·75
6. Vertical	1·20	0·86	0·96	0·87	...	1·20	1·20	0·65

Second Metacarpal.	*Felis spelæa.*							*Felis leo.*		*F. tigris.*
	Sandford Hill Cave. Figured specimen.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	Ilford Brickearth.	Crayford Brickearth.	British Museum.	W. A. S.	British Museum.
1. Maximum length	4·22	4·58	...	...	...	4·20	5·9	3·55	4·00	3·84
2. Minimum circumference	2·20	2·25	2·24	2·33	...	1·90	2·2	1·35	1·54	1·58
3. Transverse measurement of proximal articulation	0·98	0·84	...	1·08	1·15	0·81	0·8	0·72	0·78	0·80
4. Vertical	1·20	...	1·31	1·45	...	1·12	1·1	0·95	1·00	1·09
5. Transverse measurement of distal articulation	1·10	...	...	...	...	0·78	1·0	0·62	0·75	0·75
6. Vertical	1·95	...	...	...	...	1·50	2·0	1·30	1·54	1·60

MEASUREMENTS OF METACARPALS—*continued.*

THIRD METACARPAL.	*Felis spelæa.*		*Felis leo.*		*F. tigris.*
	Sandford Hill Cave.	Bleadon Cave.	British Museum.	W. A. S.	British Museum.
1. Maximum length	4·90	5·03	4·00	4·45	4·35
2. Minimum circumference	2·20	2·50	1·28	1·57	1·61
3. Transverse measurement of proximal articulation	1·50	1·29	0·70	1·30	0·80
4. Vertical	1·20	1·44	0·80	1·20	0·91
5. Transverse measurement of distal articulation...	1·25	1·11	0·85	0·90	0·80
6. Vertical	2·10	2·30	1·30	1·60	0·39

FOURTH METACARPAL.	*Felis spelæa.*					*F. leo.*
	Sandford Hill Cave.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	W. A. S.
1. Maximum length	4·83	5·50	...	...	...	4·40
2. Minimum circumference	2·08	2·12	2·28	2·00	...	1·55
3. Transverse measurement of proximal articulation	1·20	0·96	1·08	0·93	...	0·85
4. Vertical	1·40	1·96	2·02	...	...	1·40
5. Transverse measurement of distal articulation...	1·20	1·02	...	...	1·05	0·80
6. Vertical	1·95	1·95	...	...	1·95	1·65

FIFTH METACARPAL.	*Felis spelæa.*					*Felis leo.*		*F. tigris.*
	Sandford Hill Cave.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	Bleadon Cave.	British Museum.	W. A. S.	British Museum.
1. Maximum length	3·98	4·12	4·00	...	...	3·21	3·70	3·24
2. Minimum circumference	1·95	1·90	1·77	1·75	2·18	1·35	1·60	1·50
3. Transverse measurement of proximal articulation	0·60	0·63	0·60	0·63	0·60	0·49	0·43	0·49
4. Vertical	1·80	0·90	1·77	1·75	2·13	1·30	1·30	1·49
5. Transverse measurement of distal articulation	1·12	0·85	0·74	0·87	...	0·65	0·81	0·75
6. Vertical	1·90	1·68	1·62	...	...	1·31	1·60	1·46

§ 2. *Phalanges. a. First Phalanges.*—The first phalange, or phalangiole, of the first digit, or thumb, is very short and of greater width than depth. The proximal articulation (Pl. XXI, fig. 6, *a*) is set obliquely to the dorsal face of the bone, so that the internal descends lower than the external edge. By this arrangement the first can be opposed to the other digits as in the Quadrumana, though the first metacarpal has no movement whatever of revolution. The palmar edge of the articulation is notched (fig. 6, *b*) to receive the elevation on the same surface of the metacarpal, so that it gives but little hindrance to the action of the flexor muscles. On each side of this are two small eminences for the adductor and abductor medii, the flexor brevis pollicis not being differentiated in the genus Felis. The extensor longus is attached by an intermediate cartilage to a similar eminence on the dorsal surface, the tendon also passing on to the claw phalange. The distal articulation is terminal, and sits evenly on the bone; it is convex vertically, and slightly so transversely, so that a slight movement of rotation is allowed to the claw phalange; it is much wider on the palmar than on the dorsal surface: immediately above the palmar edge is a deep depression for the reception of the flexor tuberosity of the claw phalange when the flexor muscles are in action. The small lateral expansion of this articulation prevents the retraction of the claw so completely in this digit as in the others, but as it is raised from the ground it is in no danger of being blunted by accidental contact; its position also on the inner side would prevent its being in the way of the animal. We have met with four specimens of this bone from Sandford Hill and Bleadon Caves; they vary in size from that of the ordinary Lion to that of the same proportions as the other large bones we have described.

The first phalanges of the remaining digits (figs. 7, 8, 9, 10) are very similar in their general character; the shafts being nearly cylindrical and slightly arched, and much smaller than the wide proximal articulations (*a*); the latter are deeply notched on the palmar edge (*b*) to receive the palmar ridge of the metacarpal. The palmar surface also is furnished with small eminences for the insertion of abductor and adductor muscles and bear on either side two well-marked tuberosities to which are attached the ends of a strong ligament, the infra-phalangiole annular, through which, as through a pulley, pass the tendons of the flexor profundus and the flexor sublimis on their way to the claw phalange: the distal articulation is shaped like a pulley, and extends higher up on the palmar than on the dorsal surface, and bears a depression on the dorsal edge for the tuberosity of the second phalange.

The first phalange of the third and fourth digits (figs. 8 and 9) resemble each other so closely that it would be impossible to determine to which of these two digits an isolated bone belonged; that of the second digit is very much the stouter, and slightly the shorter, and is curved outwards, while that of the fifth is very much more slender, and is bent considerably inwards. All are easily distinguished from those of the hind paw by their greater slenderness and by their cylindrical section. The large size of the proximal articulation and the tapering form of the bone in the Bear, and the small size of those in the

Hyæna, are points by which the first phalanges of those animals may be separated from those of *Felis spelæa*. We know of no others that can be confounded with them.

§ 2 β. *Second Phalanges.*—The second phalanges of all the Feles are characterised by their triangular section, and by the outward projection of their distal articulation; the latter allows the claw phalange when retracted to fall back outside the axis of the bone, so as to raise the point of the claw over the articulation, and thus protect it from injury. Those of *Felis spelæa* (Pl. XXI, 11, 12, 13, 14) closely resemble their homologues of the hind limb, but are longer and more bent externally. The proximal articulation (*a*), which, following the section of the shaft, is triangular, is composed of two slight concavities divided by a median ridge; it is deeply excavated on the palmar ridge by a notch and pit, in which is inserted the tendon of the flexor sublimis muscle. On its dorsal edge is a small flattened tuberosity (*b*), forming the apex of the triangle for the attachment of the tendon of the extensor communis. The bone tapers gradually down to the distal end of the shaft. The distal end is a somewhat rectangular mass, of nearly double the width of the shaft and projecting outwards (*d*) from the axis of the shaft, and giving the whole bone a curved outline. The articulation closely resembles that on the first phalange of the thumb, which performs similar functions. It affords a means of differentiating the digits of the same paw, that of the second phalange of the second digit forming an obtuse angle with the inner edge of the bone, that belonging to the third a nearly right angle, that belonging to the fourth being slightly acute, while that belonging to the fifth is more acute and very much shorter in its transverse diameter. Like the first phalanges these bones are much longer and more slender than those of the hind paw.

We have been unable to detect any difference of form between the phalanges of Lion, Tiger, and *Felis spelæa*. We have met with no British specimens of the third phalanges sufficiently perfect to describe, with the exception of Pl. V, fig. 14: they only differ from each other in size, those of the fore being in the main larger than those of the hind paw.

§ 2 γ. *Measurements.*—The following table of measurements shows that the superiority of size observable in the other bones of *Felis spelæa* as compared with those of Tiger and Lion is carried out in every bone of the fore paw.

Measurements of Phalanges.

	First Phalanges.			Second Phalanges.		
	Felis spelæa.	*F. leo.*	*F. tigris.*	*Felis spelæa.*	*F. leo.*	*F. tigris.*
	Sandford Hill.	W. A. S.	British Museum.	Bleadon.	W. A. S.	British Museum.
First digit.						
1. Maximum length	1·42	1·25	1·15	...	...	...
2. Minimum circumference	2·60	2·00	1·6	...	...	...
3. Transverse measurement of proximal articnlation	0·92	0·80	0·7	...	...	...
4. Vertical	0·70	0·55	0·4	...	...	...
5. Transverse measurement of distal articulation	0·90	0·65	0·48	...	...	...
6. Vertical	1·00	0·90	0·8	...	...	...
Second digit.						
1. Maximum length	2·04	1·78	1·9	1·52	1·25	1·5
2. Minimum circumference	2·00	1·70	1·5	1·60	1·50	1·2
3. Transverse measurement of proximal articulation	0·95	0·72	0·7	0·72	0·60	0·6
4. Vertical	0·60	0·50	0·5	0·50	0·50	0·4
5. Transverse measurement of distal articulation	0·70	0·60	0·5	0·80	0·63	0·6
6. Vertical	0·72	0·80	0·8	0·63	0·60	0·7
Third digit.						
1. Maximum length	2·42	2·00	2·2	2·00	1·30	1·6
2. Minimum circumference	2·00	1·80	...	1·80	1·35	...
3. Transverse measurement of proximal articulation	1·00	0·85	0·88	0·82	0·64	0·65
4. Vertical	0·70	0·55	0·45	0·70	0·45	0·4
5. Transverse measurement of distal articulation	0·70	0·65	0·55	0·80	0·54	0·55
6. Vertical	0·80	0·90	0·8	0·70	0·50	0·8
Fourth digit.				Sandford Hill.		
1. Minimum length	2·20	1·85	2·05	1·75	1·30	1·5
2. Minimum circumference	2·00	1·74	1·6	1·70	1·25	1·2
3. Transverse measurement of proximal articulation	0·98	0·85	0·75	0·84	0·60	0·75
4. Vertical	0·69	0·45	0·4	0·61	0·45	0·35
5. Transverse measurement of distal articulation	0·70	0·60	0·43	0·70	0·50	0·5
6. Vertical	0·70	0·65	0·6	0·55	0·50	0·5

MEASUREMENTS OF PHALANGES—*continued.*

FIFTH DIGIT.	FIRST PHALANGES.			SECOND PHALANGES.		
	Felis spelæa.	*F. leo.*	*F. tigris.*	*Felis spelæa.*	*F. leo.*	*F. tigris.*
	Sandford Hill.	W. A. S.	British Museum.	Bleadon.	W. A. S.	British Museum.
1. Maximum length	1·97	1·75	1·65	1·70	1·10	1·22
2. Minimum circumference	1·60	1·50	1·4	1·70	1·25	1·2
3. Transverse measurement of proximal articulation	0·75	0·75	0·6	0·70	0·60	0·6
4. Vertical	0·55	0·50	0·42	0·55	0·40	0·5
5. Transverse measurement of distal articulation	0·60	0·60	0·5	0·65	0·50	0·5
6. Vertical	0·70	0·65	0·5	0·55	0·50	0·5

CHAPTER XV.

LIMB BONES OF THE WHELP. Pl. XXII.

CONTENTS.

§ 1. *Description.*—M. Gervais, in his 'Zoologie et Paléontologie Française,'[1] states that M. de Serres and his coadjutors in the work[2] on the fossil mammals of Lunel Viel have figured and described bones as leonine, which he considers to belong to young *Felis spelæa,* "before it had lost its milk teeth," and that Dr. Schmerling had indicated the presence of lion in the Belgian caves "without giving more certain proof of its existence." The bones from Lunel Viel (exclusive of the head) consist of the sacrum, the proximal half of a femur, both of which are figured, and an ulna that is only described; while those from Belgium consist of a nearly entire pelvis, and a perfect radius and ulna. All these, however, seem to be of by no means so young an age as M. Gervais supposed. In the figures given by M. de Serres[2] and Dr. Schmerling,[3] there is no trace of lines of separation between the sacral vertebræ; while in a third sacral that passed through our hands, and is now in the Taunton Museum, and which had belonged to an animal very much larger than the average-sized Lion, the anchylosis was not yet completed. It is clear, therefore, that the former must have belonged to older animals than the latter. In our figures also of the radius and tibia (Pls. II, fig. 1, XIX, 1, 1'), the anchylosis is imperfect, so that the proximal epiphysis is lost in each case, although the full size and proportions have been reached. The limb bones from Belgium and Lunel Viel present epiphyses firmly anchylosed to the shaft, and strongly marked muscular ridges, and they therefore belonged to not merely full grown but to tolerably aged animals.

In Britain we have met with several bones of the spelæan whelp from the caves of

[1] Edition 1859, p. 227.

[2] 'Oss. Foss. de Lunel Viel,' pl. viii, figs. 15, 16, p. 107.

[3] 'Oss. Foss. de Liége,' tom. ii, pl. xix, figs. 1, 2, p. 90.

Bleadon, Hutton, and Sandford Hill. An ulna from the latter cave must from its extreme shortness have belonged to a very young animal. In Mr. Beard's collection, now in the Taunton Museum, are two right fibulæ, the larger of which we figure (Pl. XXII, fig. 9), with some doubt as to its correct determination. Its ridges, which are slightly developed, and the distal lateral articulations for the tibia, are of the same form as in the older Lion. So far as we can tell, from the limited means at our disposal, it is of the size of a Lion's whelp six weeks old. In the same collection there are both ends of a left radius which correspond exactly with those of a young Lion of three months. They most probably were obtained in Hutton Cave, which has furnished two young humeri, one of which is figured (Pl. XXII, fig. 1), a large portion of a right scapula, both ulnæ (one figured, figs. 2, 3), both femora (figs. 7, 8), a left tibia, calcaneum (fig. 10), a fifth metacarpal (fig. 4), and some first and second phalanges (figs. 5, 6), including a part of the first digit of the fore paw. All these bones in size and proportions agree with those of a Lion's whelp of three months. From Hutton also were obtained the maxillary and lower jaw, which have already been figured (Pl. XIII, figs. 1, 3), and described. The whole of them most probably belonged to one individual. The calcaneum and some phalanges of an older animal from Bleadon are also preserved in the Taunton Museum. All these bones coincide with those of the adult which we have figured and described in the course of this Monograph. They are, however, much more cylindrical, and present fainter muscular impressions, and are considerably shorter.

§ 2. *Measurements.*—The following measurements are all that the condition of the bones would admit of being taken. Humerus: minimum circumference, 3·05; do., 3·04. Ulna: minimum circumference, 2·20; length of humeral articulation, 2·00; length of radial articulation, 1·15; depth of radial articulation, 0·40. A second specimen agrees with the preceding while in a third the minimum circumference is 2·20, and the length of the humeral articulation, 1·70. Radius: minimum circumference, 1·40. Femur: minimum circumference, 2·78; do., 277. Tibia: minimum circumference, 2·60. Fibula: minimum circumference, 0·50; do., 0·60.

Table showing the variations in the size of calcanea of Felis spelæa, from youth to old age.

	Adult. Pl. IV, fig. 2.	Young. Pl. XXII, fig. 10.	Young.
1. Total length	5·60	...	...
2. Minimum circumference	4·73	3·00	...
3. Maximum vertical measurement	2·36	1·40	1·08
4. ,, transverse ,,	2·38	1·50	0·68
5. From inner articulation to outer end of bone, articulation included	3·95	...	...
6. Transverse measurement of sigmoidal articulation	0·92	0·50	0·36
7. Transverse measurement of cuboidal articulation	1·32	1·00	...
8. Vertical ditto	1·17	1·00	...
9. Transverse measurement of inner astragaline articulation	0·81	0·60	0·50
10. Vertical ditto	0·74	0·60	0·50

The minimum circumference of the phalange of the first digit is 1·85; of the rest, 1·10, 1·42, 1·30, 1·46; and of the second phalange, 1·29.

CHAPTER XVI.

Felis spelæa, Goldfuss, specifically identical with Felis leo, Linnæus.

CONTENTS.

§ 1. *Introduction.*—In the preceding chapters we have analysed the differences observable in skeletons of Lion, Tiger, and *Felis spelæa,* not founding our comparison on one skeleton merely of either of the former animals, but comparing and noting the variations in the form and proportion of the bones of all the individuals preserved in the museums of London and Oxford. One fertile source of error in the work of previous observers has been avoided—the use of the bones of animals kept in menageries, which are invariably affected in direct proportion to the length of the confinement of their possessors, and to the extent to which the natural habits have been restrained and curbed by domestication. They are so deformed, and, if the cub has been born in captivity, so small and puny, that they are absolutely useless as a means of comparison. Before we proceed to sum up the bearing of the evidence on the recent affinities of *Felis spelæa,* we intend to quote the opinions of the naturalists in chronological order, following to a certain extent the method of M. de Blainville and Baron Cuvier.

§ 2. *Various opinions held by naturalists.*—The first evidence of the discovery of *Felis spelæa* is afforded by a figure[1] of an unequal phalange, appended to a paper on the Dragons of the Carpathians, written by Dr. John Hain in 1672. It is most important, because it brings the range of the fossil animal into the Hungarian Basin of the Danube. Leibnitz, in 1749,[2] figured a fragment of skull obtained from the cavern of Schartzfeldt. The plate contains four rudely executed figures, of which the upper may represent the

[1] Recognised by Cuvier ('Oss. Foss.,' t. iv, p. 449, 2nd edit., 1822), and ascribed by him to Dr. Vollgnad ('Ephém. Nat. Cur.,' an. iv, dec. 1, obs. clxx, p. 227). The latter, however, merely gives an outline of a paper published in the preceding year by Dr. Hain ('Miscell. Nat. Cur. Medico-Physic. Germ.,' An. III, Obs. CXXXIX. "De Draconibus Carpathicis").

[2] 'Protogæa,' pl. xi, fig, 1, p. 62.

parietals and part of the occipitals of a Lion, while those underneath may be the fore part of the upper and lower jaws, of the same animal; but it is very possible that the originals may have belonged to the Bear. The whole are referred to in the text as "vera elephantium ossa," the upper part of the head being taken for the "tibia" of the Elephant. The fragment of skull is compared by Soemmerring[1] with the skulls of Lion and *Ursus spelæus.* He considers that it differs in no respect from the former animal; but he adds that in most of the points relied upon it resembles other species of the genus Felis. He gives a more exact figure than that of Leibnitz.

In 1774 Esper[2] published an account of the mammals found in the Margraviat of Bareith, in which he figures an upper jaw from Gailenreuth. He obtained also detached teeth and bones. He believes them to belong to an unknown animal, more closely allied to the Lion than any other species. Rosenmüller,[3] in 1804, states that he is about to publish a work on an unknown fossil animal of the genus Felis, and he adds that its bones differ in some respects from the Lion. Dr. Goldfuss[4] published, in 1810, a small work on the environs of Muggendorf, in which a nearly perfect skull from the cave of Gailenreuth was figured and described under the name of *Felis spelæa,* which was adopted by Cuvier, and became the recognised specific name of the animal. In 1821[5] he republished his determination of the species, and gave a full-sized figure of the skull, which he considered to belong to an extinct species, more closely allied to the Panther than to Lion or Tiger.

Drs. Pander and D'Alton[6] state, in 1822, that *Felis spelæa* differs specifically from *Felis leo,* and refer to their figures in support of this conclusion. The figures, which are those of a skull and lower jaw, exhibit no sutures. The second premolar of the upper jaw is bifanged, as in the skull from Sandford Hill Cave (Pl. XI, fig. 1). There are no measurements of the skull given in the text, nor is any information afforded as to the museum in which it is preserved.

Baron Cuvier, in the second edition of the 'Ossemens Fossiles,'[7] published in 1823, does not pronounce a decided opinion on the relation of *Felis spelæa* to the large existing members of the genus, because he was unable to make a personal inspection of the type specimens described by Dr. Goldfuss; but he states his belief that the real affinities of the animal are neither with the Lion nor the Tiger, but with the Jaguar (*Felis onca*), giving as his principal reasons the gentle curve of the profile and the form of the lower jaw.[8]

[1] 'Magasin pour l'Histoire Nat. de l'Homme' de M. C. Grosse,' t. iii, cah. 1, No. 3, p. 60; Cuvier, op. cit. We cannot verify this reference.

[2] 'Description des Zoolithes, &c., dans la Margraviat de Bareith,' folio, Nuremburg,' 1774, tab. ix, xii, p. 53.

[3] 'Abbildungen und Beschreibung der fossilen Knochen des Höhlenbären,' folio; fig. 1, pp. 11, 19; Weimar, 1804.

[4] 'Die Umgebungen von Muggendorf,' Erlangen, 1810.

[5] 'Nova Acta Physico-Medica Acad. Cæs.-Leop. Cur.,' tom. x, p. 489, tab. 45, 1821.

[6] 'Die Skelete der Raubthiere,' tab. viii, *a, b, c, d,* 1822.

[7] Tom. iv, pp. 451—455.

[8] See '*Felis spelæa,*' cap. i; cap. vi, § 20.

Our great cave-explorer, Dr. Buckland,[1] in 1823, was the first to ascribe the spelæan remains to the fossil Tiger, without, however, giving any reasons for his conclusion.

His rival, Dr. Schmerling, in 1833, in his *résumé* of the species of Felis in the caverns of Liége,[2] considers that *Felis spelæa*, was allied to the Lion, but of a distinct species. He figures, however, bones from the same locality as belonging to the existing Lion; but confuses them with those of the *Felis antiqua* of Cuvier, which was not a Lion, but a Panther (*F. Pardus*).

MM. Marcel de Serres, Dubreuil, and Jeanjean,[3] writing in 1839, insist on the specific distinctness of *Felis spelæa* from the recent Lion, assigning as the principal difference the shortness of the muzzle. Like Dr. Schmerling, they identify a second species with the latter animal.

M. de Blainville, in 1841,[4] rejects the view advanced by Marcel de Serres and Dr. Schmerling, that the smaller bones ascribed to the Lion belong to a species differing from *Felis spelæa*, on the ground that they were probably not those of an adult. He, however, offers no opinion on the exact affinities of *Felis spelæa*.

M. Pictet,[5] in 1844, uses nearly the same words as Marcel de Serres and his fellow-workers in his notice on *Felis spelæa*. He does not recognise the smaller remains as those of *Felis leo*.

M. Gervais,[6] in the first edition of his 'Paléontologie,' published in 1848, regards the animal as a Lion (*Felis leo major*), without assigning any reasons for his conclusion.

Professor Owen,[7] 1842, adopted Dr. Buckland's opinion, and terms the animal a "spelæan Tiger," although he recognises the want of evidence sufficient to put the question of its species beyond dispute. He reproduced his views in 1846, in the 'British Fossil Mammals.'[8] In 1859, however, he published, in the 'Philosophical Transactions,'[9] a figure of a skull with the nasal processes restored as in the Lion. It is clear, therefore, that he recognises the leonine nature of the animal, for his figure shows that characteristic which is of specific value in determining Lion from Tiger.

Dr. Falconer is quoted by the eminent French palæontologist M. Lartet,[10] in 1864, as holding the view that *Felis spelæa* was identical in species with the Tiger inhabiting the north of China and the region of the Altai, and that it was driven out of Europe "par le développement progressif des sociétés humaines." In 1858[11] he enumerated "Cave Lion" among the remains from Kent's Hole.

1 'Reliquiæ Diluvianæ,' p. 261, 1823.

2 'Oss. Foss. de Liége,' tom. ii, p. 93, 1833.

3 'Oss. Foss. de Lunel-Viel,' p. 101, 1839.

4 'Ostéographie,' article "Felis," p. 115, 1841.

5 'Paléontologie,' vol. i, p. 186, 1st ed., 1844; vol. i, p. 228, 2nd ed., 1853.

6 'Zoologie et Paléontologie Françaises,' vol. i, p. 123, 1st ed., 1848; vol. i, p. 227, 2nd ed., 1859.

7 'Report of British Association,' 1842.

8 'British Foss. Mam.,' 1846.

9 'Philosophical Trans.,' pl. xii, "Memoir on Thylacoleo," 1859.

10 'Revue Archéologique Cavernes du Périgord,' p. 21, 1864.

11 'Palæontological Memoirs,' vol. ii, p. 457, 1868.

§ 3. *Conclusion.*—This diversity of opinion as to the actual affinities of *Felis spelæa* flows from two causes—the imperfection of the fossil remains, and the fact that the variations in the form and size of living feline species were not recognised. In the present Monograph we have attempted to arrive at the truth by a strict analysis of the evidence afforded by the Mendip Caves, which has never been submitted to the judgment of other naturalists. In assigning a specific value to differences between Lion and Tiger, we have realised the great amount of variation in size and form within the limits of a species, insisted upon by our great philosophic naturalist, Mr. Charles Darwin. Our labours have resulted in our being unable to admit that any other differences than the following are constant in the Lion and Tiger.

In the Lion the frontal processes (*i*, Pls. VII—X) of the maxillaries extend as far back as a transverse line passing through the naso-frontal suture; their apices are pointed. The inner bounding line of the nasal aperture, viewed in front, forms an even curve. The frontal ends of the nasal bones are flat. In the frontal bones the inter-orbital space is flatter and wider than in the Tiger. The temporal length of the frontals is smaller, and consequently the post-orbital process is placed further back, and the extension of the sagittal crest on the bone is less in the adult skulls. The comparatively shorter space between the posterior palatal foramen (Pl. VIII, *j*) and the orbital edge of the palate relative to the basal length of the skull is also to be reckoned characteristic. In the lower jaw (Pl. I, *a*) the ramal process is invariably present.

In the Tiger the frontal processes of the maxillary bones never extend so far back as a transverse line passing through the naso-frontal suture; their apices are truncated; the internal bounding line of the nasal aperture, when viewed in front, presents a double curvature. The frontal portions of the nasals are bent downwards, so as to form a median depression at their symphysis. The post-orbital processes have a larger frontal development (see page 56), and cause the inter-orbital surface to be more concave and narrower than in the Lion. The greater temporal length of the frontals causes the long-waisted appearance of the skull, and the greater development of the sagittal crest on the frontals of the adult. The posterior palatal foramen is further removed from the orbital edge of the palate relatively to the basal length of the skull. The ramal process is invariably absent from the lower jaw. These are the only points of difference that we find constant in the large series of leonine and tigrine skeletons in Oxford and London. The bones of the trunk and the extremities presenting such variations in size and form that we are unable to recognise any to be constant.

What, then, is the position of *Felis spelæa* in relation to these two animals, for the form of the lower jaw and of the skull forbid its comparison with the Jaguar?[1] The result of a minute comparison of its skeleton with those of the two former animals leads us to the following conclusions:—First, that *Felis spelæa* is more leonine in character than the recent Lion, and more divergent from the tigrine form. If the remains of the

[1] See Chapters I—VI.

three animals were placed in serial order, *Felis leo* would occupy the middle place, the points of difference between Lion and Tiger being exaggerated in *Felis spelæa*. Secondly, that while it is undoubtedly true that *Felis spelæa* was on the whole a larger and stouter animal than the existing Lion, some individuals are even smaller than some of the larger Lions of the present day, the series of spelæan remains not presenting greater contrasts in size than those of the recent Lion. And lastly, that there is not one character by which the animal can be distinguished from the living Lion. It must therefore be admitted that *Felis spelæa* is specifically identical with the Lion now living on the face of the earth. And this being the case, it becomes a serious question as to whether the term *Felis spelæa* should not be struck out of palæontological catalogues. Since, however, it has occupied a space in scientific nomenclature for more than fifty years, it is perhaps more convenient to term the animal *Felis leo*, var. *spelæa*, thus indicating that variety of the Lion that inhabited the caves of Northern and Western Europe during the Post-glacial epoch. Its range in Britain, and the causes of its extermination in Western Europe, will be considered in the next two chapters, and evidence will be adduced that will bring the sojourn of the animal in Europe down to a time not far distant from the Christian era.

CHAPTER XVII.

Range of Felis leo, var. *a*, spelæa.

CONTENTS.

§ 1. *Distribution in Britain.*—In the previous chapters we have proved that *Felis spelæa* is specifically identical with the existing Lion. We have now to show the distribution of its remains in Great Britain, so that we may approximately arrive at its relative numbers in various districts during the Post-glacial period. It is undoubtedly true that there is no direct evidence on this point, for the remains that have been found are merely those that have survived a series of accidents. Those in the brickearths and gravel-pits owe their preservation to the chance, first of all, of the animals being drowned, of their bodies having escaped the all-devouring jaws of the Hyæna, of their having been deposited in the ancient river-bed, and not having been swept out seaward, to be devoured by the fishes. To these must be added the chance of the gravel-pit or brickfield being formed in that precise spot, of their being discovered, and, lastly, of their not being destroyed by the ignorant workmen. Those also that have been found in the caves have had to run the gauntlet of a similar series of accidents. The absence, therefore, of its remains does not prove that the animal did not dwell in any particular district, but merely that it does not happen to have been discovered. But, nevertheless, the chances of preservation being equal over the whole British area, the relative numbers of the animal that dwelt in its various parts can be fairly estimated by the varying numbers of the remains found. In undertaking this task we fully recognise the imperfection of the geological record. We will begin with North Britain, and work our way southwards.

The Cave Lion is conspicuous by its absence from the whole of Scotland, Northumberland, Cumberland, and Westmoreland. In the North Riding of Yorkshire its teeth have been obtained from the bone-cave of Kirby-Moorside,[1] along with the remains of the Cave Hyæna and Wolf. Two canines and a metacarpal also were found by Dr. Buckland in the Hyæna-den of Kirkdale,[2] as well as a calcaneum that is now in the York Museum, associated with relics of the leptorhine Rhinoceros of Owen, the Mammoth, Bison, Reindeer, and others. In the river-deposit also of Bielbecks a very fine series of animals, consisting of Ursus, Bison, Wolf, and Cave Lion, were disinterred by the Rev. W. Vernon, F.R.S., in 1829, the leonine remains being a fragment of maxillary, both rami of the lower jaw, the ulna, radius, femur, and metatarsals, all of which belong to one individual.[3] The numerous caves in the Mountain-limestone of Lancashire and Derbyshire, strange to say, have not furnished a single fragment that can be attributed to the Lion, although they have been diligently explored by various observers; nor have the Midland Counties furnished the least trace of its existence as far south as the meridian of Oxford.

In the Eastern Counties it is very rare. The Post-glacial gravels of Barnwell have yielded a lower jaw that is preserved in the Natural History Collection at Cambridge, and a femur that is now in the British Museum. In Suffolk its remains have been found in the gravel-bed pierced by the tunnel at Ipswich, along with those of the Roedeer, Bison, Irish Elk, tichorhine Rhinoceros, Mammoth, Grizzly Bear, and others.[4] In North Essex the energetic collector Mr. John Brown, of Stanway, obtained a humerus from Clacton, now in the British Museum, and some other remains which Professor Owen quotes from Walton.[5]

The River-deposits of the great valley of the Thames have furnished its remains in comparative abundance. Its teeth occur at Hurley Bottom,[6] in Berkshire, along with the bones of the tichorhine Rhinoceros and *Hippopotamus major*. The great sheet of gravel, also, on which London stands, has yielded several isolated teeth to various collectors. From the great brick-pit at Ilford, on the north side of the Thames, one metacarpal has been obtained by Dr. Cotton, and two rami respectively by Mr. Antonio Brady and Mr. R. D. Darbishire, along with the remains of *Elephas antiquus*, Mammoth, Red-deer, Beaver, and other mammals. In the corresponding sheet of brickearth on the opposite side of the river, extending from Erith to Crayford, a lower jaw and an os innominatum[7] (Pl. III, fig. 1) were found by Mr. Swayne; a canine, two lower jaws (Pl. I, fig. 3), a humerus, metacarpal, metatarsal, and a phalange, by Dr. Spurrell; a gigantic canine by Professor Morris; and a lower jaw by Mr. Grantham. In the same county

[1] Museum of College of Surgeons.

[2] British Museum.

[3] All these remains are preserved in the York Museum.

[4] In the collection of R. Fitch, Esq., F.G.S., of Norwich.

[5] 'Brit. Foss. Mam.,' p. 152. We have been unable to find out where these remains are preserved.

[6] Oxford Museum.

[7] Now in the British Museum.

the Post-glacial brickearth of Otterham, near Sittingbourne, has furnished upper pre-molar 3 and a large upper sectorial to Mr. Hughes, F.G.S.; and a similar deposit near Hartlip, in the same neighbourhood, a femur to Mr. Bland.[1] A very careful search throughout South Kent and the whole of Sussex has not revealed a trace of the former existence of the Lion in the heart of the dense Wealden Forest, that from the nature of the ground must have overshadowed those districts during the Post-glacial epoch. In going westward we meet with the animal again in the low-level river-deposits of Fisherton, in a lower jaw, found by Dr. Blackmore, and now in the Salisbury Museum. The low-level gravels also of Loxbrook, in the valley of the Avon, near Bath, have furnished a remarkably fine humerus (Pl. XVIII, fig. 2) to the energy of the Rev. H. H. Winwood, F.G.S. In the collection of the Right Hon. Earl of Enniskillen, at Florence Court, is a canine from the cave on Durdham Down, near Bristol, explored by Mr. Stutchbury. Remains of the leptorhine Rhinoceros of Owen and *Hippopotamus major* from the same cave are preserved in the Bristol Museum.

But the district that, of all others, has furnished the most enormous quantity of the remains of the Cave Lion, and is entitled, therefore, to rank as its metropolis in Britain, is the western half of the Mendip range of hills in Somerset. Throughout the area extending from the ancient city of Wells westward to the new watering-place of Weston-super-Mare the Mountain-limestone is traversed by numerous caves that have afforded most valuable evidence as to the character of the ancient Post-glacial Fauna in the west of England to the Rev. D. Williams, Mr. Beard, and ourselves. Among the animals the Cave Lion stands out the most prominently.

We found in Wookeyhole Hyæna-den twelve teeth (Pl. XI, fig. 9; Pl. XII, figs. 9, 13, 15), an ulna (Pl. II, fig. 9), astragalus, and metacarpal (Pl. XX, fig. 7). Dr. Boyd also obtained a magnificent upper canine (Pl, XI, fig. 6).[2] All the remains were more or less gnawed, and bore indisputable traces of the animals to which they belonged having fallen a prey to the Hyænas.

The Feline remains from Bleadon, Sandford Hill, and Hutton Caves, explored by Messrs. Williams and Beard, are preserved in the Taunton Museum, where they constitute, perhaps, the most magnificent series in the world. They are as follows, in various conditions, some being perfect, others fragmentary.

[1] Both these are in the Museum of the Geological Society of London.

[2] In the Oxford and Taunton Museums, and in the collections of Mr. James Parker, Mr. Sanford, and Mr. Willett.

Bleadon Cave.

Adult.

	Numbers.
Maxillaries	10
Squamosal (Pl. IX, figs. 2, 3)	1
Lower jaws	12
Vertebræ (Pl. XIV, fig. 3; and Pl. XVI, figs. 1, 2, 4, 5, 6, 7, 8, 9, 10)	50
Sternebers (Pl. XVI, fig. 10)	5
Scapula	1
Humeri (Pl. XVIII, fig. 1)	8
Ulnæ (Pl. II, fig. 5)	14
Radii (Pl. II, fig. 4)	8
Carpals (Pl. XX, figs. 2, 3)	8
Metacarpals (Pl. XX, fig. 6; and Pl. XXI, fig. 1)	61
Phalanges	38
Ilium	1
Femora (Pl. XVIII, fig. 4)	6
Tibiæ	9

Adult.

	Numbers.
Fibula (Pl. XIX, fig. 4)	1
Tarsals (Pl. IV)	39
Metatarsals (Pl. V, fig. 1)	18
Phalanges	59
Sesamoids	2
Permanent teeth (Pl. XI, figs. 4, 8, 10, 11, 12, 13, 14; and Pl. XII, figs. 4, 6, 7, 8, 10, 11, 12, 14)	95

Whelp.

Maxillaries (Pl. XIII, fig. 2)	2
Lower jaws	8
Metacarpal	1
Phalanges (Pl. XXII, fig. 6)	2
Calcaneum	1
Fibulæ (Pl. XXII, fig. 9)	2
Milk-teeth (Pl. XIII, fig. 8)	12

Sandford Hill Cave.

The following bones probably belong to one adult individual:

Skull (Pl. X, fig. 1).
Lower jaws (Pl. I, figs. 1, 2).
Atlas (Pl. XIV, fig. 1).
Sixth cervical vertebra (Pl. XIV, fig. 2).
Second dorsal vertebra (Pl. XV).
Second lumbar vertebra (Pl. XVI, fig. 3).
Third sacral vertebra.
Both scapulæ (Pl. XVII).
Left humerus.
Both ulnæ (Pl. II, fig. 8).
Both radii (Pl. II, fig. 1).
Right scaphoido-lunare (Pl. XX, fig. 1).
Left pisiform (Pl. XX, fig. 4).
Metacarpals 2, 3, 4, 5, of right paw (Pl. XXI, figs. 2, 3, 4, 5).
Metacarpals 2, 3, 4, of left paw.
First phalanges of right paw (Pl. XXI, figs. 6—10).
Ossa innominata.
Patella (Pl. XIX, fig. 5).
Both tibiæ (Pl. XIX, figs. 1, 2).
Right fibula (Pl. XIX, fig. 3).
Both astragali.
Scaphoid.
Both calcanea.
Left cuneiform.
Metatarsals 2, 4, 5, of right paw (Pl. V, figs. 2, 4, 5).
Metatarsals 3 (Pl. V, fig. 3), 4, of left paw.
First phalange of the fifth digit of left paw.

Other Adult Bones.

	Numbers.
Maxillaries and intermaxillaries (Pl. XI, fig. 1). Lower jaws corresponding with the above.	
Vertebræ	6
Humeri	2
Ulnæ corresponding with humeri	2
Carpal	1
Os pubis	1
Tarsal	1
Permanent teeth (Pl. XII, fig. 5)	3

Remains of Whelp.

Maxillary bones	3
Lower jaws (Pl. XIII, fig. 4)	2
Milk-teeth (Pl. XIII, figs. 5, 6, 7)	4

Hutton Cave.

BONES OF WHELP.

	Numbers.		Numbers.
Maxillary (Pl. XIII, fig. 1)	1	Sterneber	1
Lower jaws, a pair of (Pl. XIII, fig. 3)	2	A pair of femora (Pl. XXII, figs. 7, 8)	2
Scapula	1	Tibia	1
A pair of humeri (Pl. XXII, fig. 1)	2	Calcaneum (Pl. XXII, fig. 10).	
A pair of ulnæ (Pl. XXII, fig. 2)	2		

The skull and lower jaws, Pls. VI, VII, VIII, IX, were obtained either from Sandford Hill or Hutton Caves.

The accumulation of so enormous a quantity of the remains of the Lion in the caves of so small an area may be accounted for by the peculiar position of the Mendip Hills, that command fertile valleys on the north, and look out towards the south and west over a plain which, in Post-glacial times, occupied a large portion of the Bristol Channel. Around them were the feeding-grounds of incalculable numbers of the Reindeer, Bison, and Horse, of the Mammoth and tichorhine Rhinoceros, and, therefore, we might expect to find the carnivora present in very great abundance. There is evidence, indeed, that a larger number, not only of Lions, but also of Bears and Hyænas, existed in the district than have yet been proved to have lived in a similar area at any time in the past history of the earth.

To the south of this district no leonine remains have been discovered as far as the outcrop of the Devonian Limestones on the shores of Torquay and Plymouth. In the Brixham Cave two phalanges[1] were found along with flint flakes and the remains of the Hyæna, Bear, and other animals; in that of Kent's Hole, explored by the Rev. J. McEnery, an upper jaw, four teeth, and an ulna;[2] and in that of Oreston, near Plymouth, explored by Mr. Whidby, three canines, one humerus (Pl. XVIII, fig. 1), one metacarpal, and two metatarsals.[3]

Nor were they less rare on the opposite side of the Bristol Channel in South Wales. The researches of Col. Wood and Dr. Falconer have resulted only in the discovery of an upper jaw and five teeth (Pl. XI, figs. 1, 2, 5) in the Cave of Ravenscliff, three canines and a fragment of skull in that of North Hill Tor,[4] and a few fragmentary remains from those of Spritsail Tor and Long Hole;[5] from a cave on Caldy Island also a carnassial has been obtained by the Rev. F. Smith. In North Wales, a cave at Cefn, in Denbighshire, is quoted by Dr. Falconer as containing the remains of *Felis spelæa,* but we have been unable to submit them to a personal examination.

These are all the cases of the occurrence of the animal in Great Britain revealed by a careful search in every public and private museum and collection of note in the kingdom. The absence, therefore, of the animal from certain districts cannot be accounted for on

[1] In the possession of the Royal Society.

[2] In the British Museum, that of the College of Surgeons, and of the Geological Society, and in the possession of the Earl of Enniskillen.

[3] In the British Museum, that of Leeds, and that of the Geological Survey of England.

[4] 'Palæontological Memoirs of the late Dr. Falconer,' vol. ii, p. 458.

[5] Op. cit., p. 525.

the supposition that the animal remains have not been examined; and consequently the range of the animal through Britain, so far as extant evidence goes, is fairly represented, although, of course, it may be modified from time to time by future discoveries. Its metropolis was West Somerset, where it was incredibly numerous; thence it ranged throughout England as far as the North Riding of Yorkshire, being very rare in proportion to the other animals living at the time. Its absence from Scotland, Cumberland, and Westmoreland, and its extreme rarity in North Wales, may be accounted for by the fact that the mountains in those districts were crowned by glaciers during the Post-glacial epoch, which would necessarily involve a climate unfitted for the great development of the Herbivora in regions much broken up into hill and valley, and the consequent absence of the Carnivores. In Scotland, at least, there is no other hypothesis that will account for the absence of every animal that can be ascribed to the Post-glacial group, excepting the Mammoth, which has been found in a few places, and which has been proved by the Siberian discoveries to have been capable of existing in the zone of vegetation represented by the Scotch Fir. If it be objected to this view that the Reindeer flourished in countless herds in a Siberian and North-American climate at least as severe as that of the Post-glacial winter in Britain, it may be answered that in Siberia and North America, where animal life is so abundant, the country consists of plains elevated but little above the sea-level, and capable of affording good pasturage in the short arctic summer, while in Scotland, Wales, Westmoreland, and Cumberland, the broken nature of the ground could not ever have admitted of the growth of feed for a large body of Herbivores.

The animal also has not been found in Ireland, most probably because only one of the numerous caves of that country has been properly explored, the energies of collectors being directed towards the acquisition of prehistoric remains from the turbaries and alluvia.

§ 2. *Mammals associated with the Cave Lion in Britain.*—In the following table we have given a list of all the fossil animals associated with the Cave Lion in the bone-caves and river-deposits of Great Britain. The varieties *Cervus Bucklandi* of Professor Owen and *Cervus Guettardi* of Baron Cuvier are included under the general specific name of *Cervus tarandus;* and *Strongyloceros spelæus* of the former under *Cervus elaphus. Equus fossilis* is also intended to include *Equus asinus,* which, up to the present time, has not been proved to have lived in North-Western Europe during the Post-glacial epoch. *Elephas antiquus* also is intended to include *Elephas priscus,* a name which the author of the species, Dr. Falconer, gave up during the last years of his life.[1] The *Rhinoceros leptorhinus* of Owen is used as the exact equivalent of the *Rhinoceros hemitœchus* of Dr. Falconer, and of what M. Lartet[2] takes to be represented by the *R. Merckii* of Dr. Kaup. With the exception of the lists of animals from Long Hole, Northhill Tor, Spritsail Tor, and Cefn Caves, for which we are indebted to Dr. Falconer, all the species have been determined by a personal examination of the remains.

[1] 'Palæontological Memoirs,' 8vo, vol. ii, pp. 251, 592, 1868.

[2] 'Ann. des Sc. Nat.,' 5^{e} sér. Zool. et Paléont., tom. viii, p. 157, et seq.

SPECIES ASSOCIATED WITH *Felis leo* (*var. spelæa*) IN BRITAIN.

	Post-glacial Caves.														Post-glacial River Deposits.							Riv. Deposits.		
	Bleadon Cave.	Brixham Cave.	Caswell Bay.	Cefn.	Durdham Down.	Hutton.	Kent's Hole.	Kirby. Moorside.	Kirkdale.	Long Hole.	Oreston.	Sandford Hill.	Spritsail Tor. Northhill Tor.	Wookey Hole.	Barnwell.	Bielbecks.	Fisherton.	Hartlip. Otterham.	Ipswich.	Loxbrook	Walton-on-the-Naze.	Clacton.	Crayford. Erith.	Ilford.
Homo, L.		×					×							×										
Rhinolophus ferrum-equinum, Leach							×																	
Vespertilio noctula, Schreb.																								
Ursus arctos, L.	×	×			×		×		×		×	×	×	×									×	×
U. spelæus, Gold.	×	×		×		×	×		×	×	×	×	×	×							×	×?	×	
U. ferox, L.		×		×			×		×					×									×	×
Gulo luscus, Fab.	×																							
Meles taxus, L.							×			×			×	×										
Mustela erminea, L.							×		×															
M. putorius, L.										×			×											
M. martes, L.	×																							
Lutra vulgaris, Erxl.	×				×		×			×														
Canis vulpes, L.	×	×	×			×	×		×	×	×	×	×	×			×						×	
C. lupus, L.	×	×		×		×	×		×	×	×	×	×	×					×				×	
Hyæna spelæa. Gold.	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×		×			×			
Felis catus, L.	×									×													×	
F. antiqua, Cuv. (=*F. pardus*)	×					×																		
F. spelæa, Gold.	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Machairodus latidens, Owen							×																	
Megaceros Hibernicus, Owen	×	×		×		×	×		×	×			×	×	×				×	×	×	×	×	×
Cervus Brownii, Dawkins																						×		
C. tarandus, L.	×	×	×	×		×	×		×	×	×		×	×	×		×			×				
C. capreolus, L.	×	×											×				×		×					?
C. elaphus, L.	×	×	×	×			×		×	×			×	×	×	×					×		×	×
Ovibos moschatus, Desm.																							×	
Bos primigenius, Boj.	×	×	?				×				×	×		×		×	×		×		×	×	×	×
Bison priscus, Owen	×		?			×	?		×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Hippopotamus major, Desm.				×	×		×		×												×			
Sus scrofa, L.	×						×			×			×				×						×	
Equus fossilis, Owen	×	×	×	×	×	×	×		×	×	×	×	×	×		×	×	×	×	×	×	×	×	×
Rhinoceros megarhinus, Christ.											?												×	×
Rh. leptorhinus, Owen				×	×				×	×				×		×					×	×	×	×
Rh. tichorhinus, Cuv.		×	×	×			×			×	×	×	×	×	×		×	×	×	×			×	×
Elephas antiquus, Falc.	×			×	×				×	×			×								×	×	×	×
E. primigenius, Blum.	×	×			×	×	×			×		×	×	×	×	×	×	×	×	×	×		×	×
Lemmus sp., Link.	×																×							
Lepus cuniculus, Pall.		×					×		×	×														
L. timidus, Erxl.	×	×					×		×	×			×				×							
Lagomys spelæus, Owen	×	×					×																	
Spermophilus erythrogenoides, Falc.	?											?												
Sp. citillus, Pall.																	×							
Arvicola pratensis, Bell							×																	
A. agrestis, Flem.							×		×															
A. amphibia, Desm.							×		×	×			×	×									×	×
Mus musculus, L.									×															
Castor fiber, L.								×																×

§ 3. *Range in Time in Britain.*—We have now to discuss the palæontological value of the remains of the animal in determining the age of the deposits in which they are found. On a reference to the foregoing Table it will be seen that the animal occurs more or less abundantly in Bone-caves and River-deposits that are beyond all doubt of Post-glacial age, that is to say, which contain the remains of the arctic group of animals that invaded Western Europe during the great refrigeration of temperature at the close of the Pliocene epoch, such as the Mammoth, Musk-sheep, and Reindeer, and that spread over the area that had been occupied by the Glacial sea as the land gradually rose again above the waves. There are, however, in Britain certain deposits which contain the remains of Post-glacial mammals associated with those which have been considered characteristic of the Pliocenes of France, Germany, and Italy, and which, therefore, stand intermediate in the geological scale between Pre- and Post-glacial deposits properly so called. In two of these the Cave Lion has been found, in the ancient river-bed at Clacton, and in the Lower Brick-earths of the Thames Valley, at Ilford in Essex, and Crayford in Kent. We will, therefore, sum up the whole of the palæontological evidence as to their place in the geological scale.

The occurrence at Clacton of *Rhinoceros leptorhinus* of Owen (*R. hemitœchus* of Falconer), of *Elephas antiquus, Hippopotamus major,* Irish Elk, Horse, and of Urus, may be accounted for equally well by the assumption of its Pre- or Post-glacial age, for these Pliocene animals dwelt side by side in the same area with the arctic group of mammalia during the Post-glacial epoch. A new species of Deer, *Cervus Brownii,* is closely allied to the Fallow Deer, that is now found wild only in the districts adjacent to the shores of the Mediterranean. The Bison is the only animal that points in the Post-glacial direction, and this even will very probably be proved by future investigations on the Continent to have lived in France, Germany, and Italy during the Pliocene period. With its exception, therefore, there is nothing to forbid the supposition of the Pliocene age of the deposit; but, nevertheless, as the characteristic mammals of the Pliocene, so abundant in the Forest-bed of Norfolk and Suffolk, are absent, it would be hazardous to ascribe it to that age. And in the same way, since the Reindeer, Mammoth, tichorhine Rhinoceros, and other equally common and characteristic Post-glacial mammals, are also absent, it cannot be said to belong to the class of deposits containing their remains. We are, therefore, justified in assuming that it represents, in point of geological time, an epoch during which some of the more hardy Pliocene species lived under a temperature too severe for the more delicate of their congeners, and not cold enough for the invasion of the Reindeer and the allied arctic mammals.

The Lower Brickearths of the Thames Valley at Ilford and Crayford contain the remains of *Rhinoceros megarhinus,* which has not yet been found in France, Germany, or Italy in any strata later than the Pliocene age, and are therefore brought into more intimate relation with that epoch than any other of the deposits undoubtedly Post-glacial. Nevertheless, strange to say, since the Essay on the "Lower Brickearths"[1] was written,

[1] 'Quart. Geol. Journ.,' May, 1867, "On the Age of the Lower Brickearths of the Thames Valley," by W. Boyd Dawkins, M.A., F.G.S.

its author discovered the skull of a Musk-sheep at Crayford, which of all the arctic mammals now alive rejoices the most in a severe climate. How the remains of the megarhine or southern species of Rhinoceros, could lie side by side with those of the most northern in habit of the herbivora, in the same river-bed, is a problem very hard to solve. Could the two animals have coexisted under the same climate in the same area? So far as we know of the former range of the one and of the habits of its living analogue,[1] and of the habits of the other, it would have been impossible. There is, however, one view which has the merit of explaining this conflict of evidence, and which therefore is probably true. During the depression of North Germany and the greater portion of Britain, those portions of the Pliocene Continent now represented by France and the south of England were not submerged, for in that case they would present some traces of the deposit of the icebergs that were so numerous in the North Sea of the period; it is hardly within reason to suppose that all proof of submergence beneath the Glacial sea should have been removed by subaërial denudation from so large an area, while to the north of the Thames and in North Germany it is so abundant and so ample: it is, therefore, probable that the Thames Valley roughly marks the ancient coast-line of the Glacial sea in Britain, and that to the south the Pliocene land extended through France into Italy, while to the north the look-out was over a dreary expanse of sea, burdened with icebergs, like that off the coast of Newfoundland. The temperate Pliocene climate must of course have been lowered by the presence of so much melting ice as is implied by the presence of the boulder-clay, and especially in the neighbourhood of its coast-line, independently of any great change flowing from some other unknown and cosmical cause. This climatal change must have banished to a certain extent the Pliocene mammalia from the area over which it was felt; but, nevertheless, it is highly consistent with what we know of the migration of the herbivores to suppose that now and then some of the Pliocene mammals, such as *Rh. megarhinus,* may have ventured northwards as far as the shores of the great glacial sea. Again, M. Lartet[2] has proved that the Quaternary mammals invaded Europe from their ancient home in Siberia, where they dwelt during the Pliocene epoch, at the commencement of the European Quaternary period; the change in the Pliocene temperature coupled very possibly with the depression of land in North Siberia causing the animals inhabiting that area to advance westwards and to occupy the feeding grounds till then belonging to the Pliocene Fauna. This immigration very probably began at the time that North-Eastern Europe was *being depressed* beneath the waves during the Boulder-clay epoch. If this be admitted there is nothing improbable in the hypothesis that the arctic immigrants would gradually creep round the shores of the glacial sea, and here and there occupy in the winter the same pastures that afforded food to Pliocene mammals in the summer. Thus, the remains of mammals indisputably Pliocene may have been commingled in the deposits of the same stream. In this way the

[1] See 'Nat. Hist. Rev.,' No. xix, p. 339, 1865.

[2] 'Comptes Rendus,' p. 409, et seq., 1858.

presence of the Musk-sheep, the only arctic mammal found, the Mammoth, and tichorhine Rhinoceros may be accounted for in the midst of the hardiest portion of the Pliocene mammalia, the Red Deer, Horse, Urus, and others, and even with *Rh. megarhinus*, in the brickpits of Crayford.

On the whole, therefore, there is a high probability that the fresh-water deposit at Clacton and the Brickearths of the Thames Valley form the first terms of the Post-glacial series, that is to say, of a series characterised by the invasion of Western and Central Europe by the arctic group of mammals; that they are of a higher antiquity than the majority of British fluviatile deposits; and that they bridge over that interval between the Pliocene and Post-glacial or Quaternary epochs, which is sharply marked in Britain by Glacial phenomena, but which, in France and Italy, is not sharply defined. Such is the nature of the evidence on which we have founded our belief that these two deposits are more ancient than the ordinary Post-glacial brickearths and gravels, and that they consequently present the most ancient traces of the Cave Lion in Britain.

The Cave Lion has also been found in association with the Pliocene Machairodus in Kent's Hole, but the occurrence of that animal does not stamp the Pliocene age of the cave, because of the enormous number of Reindeer, Cave Hyænas, Mammoths, tichorhine Rhinoceroses, and other characteristic post-glacial mammals that were also found. Its presence can only be accounted for on the supposition that it strayed up northwards from its southern habitat very much in the same way as its congener the Tiger does now in Northern Asia. There is, indeed, nothing more improbable in the idea that the Machairodus of Kent's Hole preyed upon the Reindeer of the neighbourhood than that a Tiger specifically the same with that of India should at times prey upon the same animal in Siberia at the present day. It proves, however, one important fact, that while the Post-glacial fauna were in full possession of the British area, the Pliocene fauna, of which it is a member, occupied a zoological province further to the south.

What, then, is the range of the Cave Lion in time in Great Britain? It is found neither in the Forest-bed nor in the ancient land-surface underlying the marine Crag of Norfolk and Suffolk, whence the water-worn remains of terrestrial Mammalia were ultimately derived. It first occurs at Clacton, Ilford, and Crayford, and it subsequently lived in incredible numbers in the South of England during the occupation of the country by the arctic group of Mammals. At the close of the Post-glacial or Quaternary period it disappeared utterly, no trace of it having yet been found in any prehistoric deposit.

§ 4. *Continental range.*—Nor on the mainland of Europe has the Cave Lion been proved to have existed during the Pliocene epoch. In France it has been found in the caverns of Echenoz and Fovent (in Haut-Saône), of Gondenaus (Doubs), of Lunelviel (Hérault), of Pondres and St. Julien d'Ecosse (Garde);[1] and in that of Aurignac described

[1] Gervais, 'Paléontologie Française,' p. 123.

by M. Lartet.[1] It has also been discovered in the caves of Bruniquel and Les Eyzies and in the Rock-shelter of the Madelaine under circumstances which prove that it inhabited France while the stone-using primeval hunters lived in the country, and engraved the objects of their chase on fragments of Reindeer antler, and tusks of Mammoth. In the extreme south it is quoted by Baron Cuvier from the bone-breccia of Nice. It occurs also in the river-deposits of Tour de Boulade (Puy de Dôme), of Abbeville (Somme), of Paris (Seine), of Soute by Pons (Charénte Inférieure), and other localities. Throughout Belgium and Germany it occurs more or less abundantly, and especially in the caves, such as those of Liége, Goffontaine, Gailenreuth, Schartzfeldt, Altenstein, and Sundwig. The first case on record of its discovery is that by Dr. John Hain in the Carpathians in 1672, which is also very valuable because it is the most southern point in central Europe in which its remains have been found.

Up to the present time the animal has not been found in Spain, most probably because so few bone-caves have been explored in that country. In Italy it is proved by the discoveries of M. Ceselli[2] to have been living in the neighbourhood of Rome, while the volcanos of that district were active. In Sicily, the labours of Dr. Falconer[3] in the Grotto of Maccagnone have resulted in the proof that it inhabited the island along with Man, the Hyæna, Hippopotamus, and *Elephas antiquus*.

Thus there is proof that the animal ranged throughout France and Germany, as far south as the basin of the Upper Danube, and throughout Italy as far as the extreme point of Sicily. It has not, up to the present time, been discovered in Scandinavia, Denmark, or Prussia.

There is no reason to believe that any of the deposits in which it occurs throughout this great area are of other than Post-glacial or Quaternary date. Nevertheless, it would be rash in the present state of our knowledge of the Pliocene Felidæ of those countries to affirm that the Cave Lion was not an inhabitant of Europe during the Pliocene epoch.

§ 5. *Identity with* Felis atrox (*Leidy*), *of North America.*—In 1852,[4] Dr. Leidy figured and described a left mandible from the neighbourhood of Natchez, in Mississippi, without angle or coronoid process, and enveloped in a coating of peroxide of iron which could not be removed. Sufficient of it, however, was shown to enable Dr. Leidy to recognise its leonine affinities, and to convince him that it belonged to an animal specifically distinct from *Felis leo*, *F. tigris*, or *F. leo*, var. *a spelæa*. The two points that seemed to us in our examination of the figure to separate it from that of the Cave

[1] 'Ann. des Sc. Nat.,' 1861, p. 177.

[2] 'Correspondance de Rome du 4 Mai,' 1867.

[3] Falconer, 'Palæontological Memoirs,' vol. ii, p. 550, 1868.

[4] "Description of an Extinct Species of American Lion," 'Trans. American Philos. Soc.,' Philadelphia, n. s., vol. x, pp. 319—321, pl. 34.

Lion were the enormous depth of the ramus, and the forward position of the ramal process underneath Premolar 4, as compared with our type specimens of the mandibles of the latter animal.[1] In all other respects it was identical in form, those minor differences brought forward by Dr. Leidy vanishing away at the comparison of the large series of leonine jaws in the Taunton Museum. The subsequent discovery, however, of a lower jaw[2] of the Cave Lion in Mr. Beard's Collection from Bleadon Cave has caused us to reconsider our conclusion, since it presents exactly those characters by which we believed *Felis atrox* to differ from the Cave Lion, its ramal process occupying precisely the same abnormal forward position, and the depth of its ramus measuring 2·77 inches beneath Premolar 4, as compared with a corresponding measurement of 2·5 inches of Dr. Leidy's figure. In the latter, moreover, the thickness of the coat of peroxide of iron is not taken into account. We are, therefore, compelled to admit that specific difference has not yet been proved to exist between the American and the Cave Lion, and to believe, on the evidence before us, that the jaw in question really belongs to the latter animal. Contrary to what might have been expected, it differs more from that of the great South-American Felis, the Jaguar, in the enormous development of the ramal process, than does that of the existing Lion of the Old World.

The associated remains found at Natchez belong to Ursus, Bison, Equus, and Mastodon, as well as to representatives (now extinct) of the South American Fauna of the time, Megalonyx and Mylodon.

There is nothing *à priori* unreasonable in the idea that a geographical variety of the Cave Lion should have lived in North America during the Post-glacial or Quaternary period of that area, when we recollect that the Mammoth, Bison, and Horse, which have not yet been proved to differ specifically from those found in the Europæo-Asiatic Post-glacial series, have a similar range. There is no doubt of the specific identity of the American with the European Mammoth. *Bison Americanus* has been found in the fossil state at Big-bone Lick, Kentucky. The Bison associated with the American Lion at Natchez is considered by Dr. Leidy ('Smithsonian Contrib. to Knowledge,' 1852, vol. v, art. iii) to belong to a new species, *Bison latifrons*, Leidy; but since we cannot lay hold of even one point of difference between it and the enormous Bisons of Post-glacial Europe, we cannot think with him that Baron Cuvier was wrong in ascribing the remains to the Aurochs ('Oss. Foss.,' 4to, t. iv, p. 50, pl. iii, fig. 2). We cannot detect a specific difference in the comparison of *Equus Americanus* with the many forms of *Equus fossilis* in Europe.

So far, then, as we have any evidence at all, the animal, is a link in the chain that binds the Post-glacial Fauna of North America with that of Europe and Northern Asia, and we may fairly argue that the American Lion bore the same relation to that of the European Caves as the Waipiti to the Red Deer, the American to the European

[1] See 'Brit. Pleist. Mam.,' article "Felidæ," pl. i, figs. 1, 2 *a*.

[2] 'Cat. Taunt. Mus.,' No. 1. Felis, No. 16 and p. 7.

Bison, or the Canadian Elk to that of the Old World. Its occurrence in America is not more startling than that of the Musk-sheep in the South of France. But it extends the ancient range of the Cave Lion eastwards through Russia and the vast steppes of Northern Asia, across Bhering's Straits into the great treeless barren grounds of North America, and thence southwards into the zone of the woods, and over the great prairies of the Bison, down to the almost tropical region of the Gulf of Mexico. Subsequent investigation will, doubtless, prove its former existence in the intermediate area just as in the parallel case of the Mammoth. What we know of the living Carnivores, such as the Wolf, Fox, and Tiger, would naturally lead us to expect those found in a fossil state to have a far wider range than any of the Herbivora.[1]

[1] See 'Introduction,' p. xlix.

CHAPTER XVIII.

The Retreat of the Lion from Europe.

§ 1. *Introduction.* In the last two chapters the specific identity of the Cave Lion with that living at the present day has been summed up, and its distribution over Post-glacial Europe and America unfolded so far as the materials at our commands would allow. In conclusion, we propose to discuss its retreat from Europe. It vanished away, as we have seen, from Britain, France, Germany, and Italy before the dawn of the Prehistoric epoch, or the epoch characterised by the introduction of the Dog, Goat, *Bos longifrons*, and Sheep into Europe, as well as by the appearance of the Neolithic and bronze-using races of men.[1] It is, however, extremely probable that while those animals and peoples were spreading through Europe northwards and westwards, the Lion was retreating to the south and to the east; at all events, there is ample proof that it was living in Thrace at the commencement of the Historical period in Greece, and it is not unreasonable to suppose that its retreat from North-eastern and Central Europe was gradually brought about.

The documentary evidence on which the former existence of the Lion in Europe is based is of two distinct kinds; first, that which is indisputably true, since it presents the same grounds for being accepted as any other fact recorded in history; and secondly, that which is afforded by myths which we may expect *à priori* to have been based upon some foundation of truth that we are able to arrive at by using history on the one hand and palæontology on the other, as our analytical tests.

[1] The Prehistoric Period is defined in the Introduction to the British Pleistocene Mammalia (§§ 1, 2, 3, 4, 5), and in an essay on The Prehistoric Mammals of Great Britain ('International Congress of Prehistoric Archæology,' Norwich, 1868).

§ 2. *Evidence derived from history.* We have seen that the first mention of the Cave Lion is that recorded by Dr. Hain from the Hungarian basin of the Upper Danube. Strange to say, the very first historical notice that we possess of the animal is that incidentally recorded of its attacks on the baggage Camels of Xerxes, in an area but a short distance to the south of this, in the mountainous district of Thrace, between Acanthus and the city of Thessalonica. The following exact account is given by Herodotus of an incident in Xerxes' march through Southern Thrace and Macedonia before the battle of Thermopylæ :—" And Xerxes[1] and the army marched from Acanthus, striking inland, wishing to come to Therma (Thessalonica), and he marched through the Pæonian and Crestonian districts to the River Echeidorus, which rises in the Crestonian district, and flows through the Mygdonian country, and opens near by the marsh that is close to the River Axius. And while he was on the march in this direction Lions fell upon the baggage Camels. For the Lions, coming down by night and leaving their usual haunts, touched nothing else, neither beast of burden nor man, but killed the Camels only. And I wonder what on earth could have been the cause that made the Lions abstain from the other animals and attack the Camels only, beasts that they had never seen before nor tasted. Now, there are in these districts *many Lions,* and wild Oxen with very large horns that are objects of barter to the Greeks. Now, the boundary of the district inhabited by the Lions is the River Nestus, that flows through Abdera, and the Acheloüs, that flows through Acharnania. For neither to the east of the Nestus is there a Lion anywhere in the whole of Europe, nor to the west of the Acheloüs in the rest of the continent, but its habitat is the district between these rivers." We undoubtedly owe the knowledge that Lions dwelt in this district in the year 480 B.C. to the wonder at their strange choice of prey. The story was still fresh in the memory of the hunters of Chalcidice when it was chosen by Herodotus, in his travels some twenty-five years afterwards, to light up his wonderful narrative. The animal at that time ranged through the country south of the Balkans, through Roumania to the west of the River Carasu, and

[1] Herodotus; book vii, cap. 124-6.

Ξέρξης δὲ καὶ ὁ πεζος στράτος ἐπορέυετο ἐκ τῆς Ἀκάνθου, τὴν μεσόγαιαν τάμνων τῆς ὁδοῦ, βουλόμενος ἐς τὴν Θέρμην ἀπικέσθαι· ἐπορέυετο δὲ διὰ τῆς Παιονικῆς καὶ Κρηστωνικῆς ἐπὶ ποταμὸν Ἐχείδωρον, ὃς ἐκ Κρηστωνάιων ἀρξάμενος, ῥέει διὰ Μυγδονίης χώρης, καὶ ἐξίει παρὰ τὸ ἕλος τὸ ἐπ Ἀξιῳ ποταμῷ.

Πορευομένῳ δὲ τάυτῃ λέοντες οἱ ἐπιθήκαντο τῇσι σιτοφόροισι καμήλοισι· καταφοιτέοντες γὰρ οἱ λέοντες τὰς νύκτας, καὶ λείποντες τὰ σφέτερα ἤθεα, ἄλλου μὲν ὀυδένος ἅπτοντο οὔτε ὑποζυγιου, οὔτε ἀνθρώπου, οἰ δὲ τας καμηλους ἐκεραΐζον μόυνας. Θωϋμαζω δὲ τὸ αἴτιον ὅ,τί κοτε ἦν, τῶν ἄλλων τὸ ἀναγκάζον ἀπεχομένους τοὺς λέοντας τῇσι καμήλοισι ἐπιτιθεσθαι· τὸ μήτε πρότερον ὀπώπεσαν θήριον μήτ ἐπεπειρέατο αὐτοῦ. Ἐισὶ δὲ κατὰ ταῦτα τὰ χωρία καὶ λεόντες πολλοὶ, καὶ βόες ἄγριοι, τῶν τὰ κέρεα ὑπερμεγάθεα ἐστι, τὰ ἐς τοὺς Ἕλληνας φοιτέοντα. Οὖρος δὲ τοῖσι λέουσί ἐστιν ὅ,τε δί Ἀβδήρων ῥέων πόταμος Νέστος, καὶ ὁ δι Ἀκαρνανίης ῥέων Ἀχελῷος· οὔτε γὰρ τὸ πρὸς τὴν ἠῶ τοῦ Νέστου οὐδαμοθι πάσης τῆς ἔμπροσθεν Εὐρώπης ἴδοι τὶς ἂν λέοντα, οὔτε πρὸς Εσπέρης τοῦ Αχελῴου ἐν τῇ ὑπολόιπῳ ἠπείρῳ, ἀλλ' ἐν τῇ μεταξὺ τουτέων τῶν ποτάμῶν γίνονται.

through Thessaly as far south as the Gulf of Lepanto and the Isthmus of Corinth, having as its western boundary the River Potamo and the Pindus Mountains.

The next mention of the European Lion we find in Xenophon's 'Treatise on Hunting,' which he composed on his banishment from Athens, after he had exchanged the court and the camp for the pleasures of gardening and hunting, in his splendid retreat in Lacedæmon, about the year 380 B.C.[1]—"Now, Lions, Pardaleis, Lynxes, Panthers, Bears, and the like beasts, are caught in foreign countries in the neighbourhood of Mount Pangæum and Mount Cissus, which is beyond Macedonia, and in the Mysian Olympus, and in Pindus, and in Nyse that is above Syria, and in other mountains that are able to support such animals." Mount Pangæum is situated near the sources of the Nestus, not far from the range of Rhodope (of the Balkans), Cissus is close to Thessalonica, and therefore this passage corroborates strongly the statement given by Herodotus as to the range of the animal, the only difference being that Xenophon states that it inhabited the Despoto Dagh Mountains of Roumelia, the eastern watershed of the Nestus, instead of its being restricted to the western bank of that river. Baron Cuvier,[2] indeed, and the late Right-Honorable Sir George Cornewall Lewis[3] agree in refusing historical value to this passage, because other localities in Asia are mentioned, believing that all these animals were not found in any one of these localities. But the fact that the Lion lived in that area, both before and after Xenophon's time, coupled with the fact that the Panther, Lynx, and Bear ranged through Europe in company in Post-glacial times, renders it very probable that he was scientifically accurate when he advised their capture in that district, by placing poisoned food near their drinking places. The Lynx and Bear still live in the same neighbourhood, and the Panther still remains in Asia Minor, bereft of his congener the Lion.

The historical value of the account of the range of the Lion in Europe given by Herodotus and Xenophon is corroborated by the testimony of the great father of natural history, Aristotle, who flourished some fifty years after the time of the latter writer, and who, being a native of Stagira, lived in the very district said to have been inhabited by the Lion. He describes its European range very nearly in the same words as those used by Herodotus; but in the hundred and fifty years that elapsed between their dates the hunter and the husbandman had made great inroads on the last foothold of the Lion in Europe. The "πολλοὶ λέοντες," "the many Lions," spoken of by the one had dwindled

[1] Ξενοφῶντος Κυνηγετικός. Cap. xi, 1. Λέοντες δὲ, παρδάλεις, λύγκες, πάνθηρες, ἆρκτοι καὶ τἄλλα ὅσσα ἐστι τοιᾶυτα θήρια ἀλίσκεται ἐν ξενᾶις χωρᾶις περὶ τὸ Παγγᾶιον ὄρος καὶ τὸν Κίττον τὸ ὑπερ τῆς Μακεδονίας, τάδ' ἐν τῷ 'Ολύμπῳ τῷ Μυσίῳ καὶ ἐν Πίνδῳ, τὰ δ' ἐν τῇ Νύσῇ τῇ ὑπὲρ τῆς Συρίας καὶ πρὸς τοῖς ἀλλοις ὄρεσι, ὅσα οἷα τ' ἐστι τρέφειν τοιαῦτα.

[2] 'Oss. Foss.,' 3e édit., 4to., t. iv, p. 425.

[3] 'Notes and Queries,' second series, viii, 1895, "Lions in Greece." We are indebted for several of the references to classical works to the learning of this eminent critic.

down into the "σπάνιον γένος," "the rare animal" of the other; he adds also that the wild beasts of Europe are more courageous than those of Asia or Africa.[1]

We have no mention of the animal in Europe from this time recorded by any writer down to the year A.D. 80 or 100, when it is mentioned by Dio Chrysostom Rhetor[2] in his 'Essay on Beauty.' "The honorable," he writes, "have vanished away in time, as they say the Lions have done which formerly dwelt in Europe, for there are no longer any more; but formerly they dwelt in the district of Macedonia and in other places.[3] Philostratus, also, writing in his 'Lives of the Sophists,' about the year 220 A.D., relates that Agathion, the athlete, who lived in the time of Herodes Atticus, 104—180, A.D., complained that he could not rival Hercules because there were no Lions in Acarnania. It is therefore clear that the Lion had deserted Europe before the end of the first century after Christ; or, in other words, that the "rare animal" of Aristotle had become extinct during the four hundred years that followed his time. It is, of course, impossible to fix the exact date, just as in the parallel case of the Brown Bear in Scotland or the Beaver in South Wales.

In the literature of Rome there is nothing that would lead to the supposition that the Lion lived in Italy during the Historic period.

> "At rabidæ tigres absunt et sæva leonum
> Semina."—Georg. ii, 151.

According to the high authority of Sir Cornewall Lewis, it is not even alluded to in Italian mythology.[4]

§ 3. *Evidence afforded by Myths.* In bringing Mythology to bear upon the question of the former existence of the Lion in countries where it was extinct before the Historical Period, we are justified only by the high probability of its truth, afforded by the fossil remains on the one hand and by history on the other. The evidence, indeed, afforded by the myths is so strong that Sir G. C. Lewis has admitted its value without knowing of the corroborative witness of the fossil remains. That eminent critic sagaciously inferred

[1] Aristotle, 'Nat. Hist.,' edit. Schneider, lib. vi, 28, 1:

Σπάνιον γὰρ τὸ γένος τὸ τῶν λεόντων ἐστι, καὶ οὐκ ἐν πολλῷ γίγνεται τόπῳ, ἀλλὰ τῆς Εὐρώπης ἁπάσης ἐν τῷ μεταξὺ τοῦ Ἀχελώου καὶ τοῦ Νέσσου ποταμοῦ.

Lib. viii, 27, 6.—Ἔτι δὲ λέοντες μὲν ἐν τῇ Ευρώπῃ μᾶλλον, καὶ τῆς Ευρώπης ἐν τῷ μεταξὺ τόπῳ τοῦ Ἀχελώου καὶ τοῦ Νέσσου. Παρδάλεις δὲ ἐν τῇ Ἀσίᾳ· ἐν δὲ τῇ Ἐυρώπῃ οὐ γίνονται. Ὅλως δὲ τὰ μὲν ἄγρια ἀγριώτερα ἐν τῇ Ἀσίᾳ, ἀνδρειότερα δὲ παντα τὰ ἐν τῇ Ευρώπῃ, πολυμορφότατα δὲ τὰ ἐν Λιβύῃ· καὶ λέγεταί τις παροιμία, ὅτι ἀεὶ φέρει τι Λιβύη καινόν.

[2] 'Orationes,' edit. J. J. Reiske, Orat. 21, Περὶ Καλλοῦς, sec. 269:

Εκλελόιπασι τῷ χρόνῳ οἵ καλοὶ, ὅιον δὴ φᾶσι τοὺς λέοντας πάθειν τοὺς ἐν τῇ Ευρώπῃ· ὀυ γὰρ ἔτι αυτῶν εἶναι τὸ γένος, πρότερον δ' ἦσαν, καὶ περὶ Μακεδονίαν καὶ ἐν ἀλλοῖς τόποις.

[3] 'Vit. Apoll.,' lib. i, cap. xv.

[4] 'Notes and Queries,' second series, vols. viii, ix, "Lions in Greece."

the former existence of the animal in the Peloponnesus before the dawn of history from the following incidental notices that have been woven into the myths:

"The Nemean Lion inhabited a cave with two mouths on Mount Treton, between Mycenæ and Nemea. Its destruction was one of the twelve labours of Hercules (Paus. ii, 15, 2; Apollod. ii, 5, 1; Diod. iv, 11), who is related to have accomplished this feat by the unaided strength of his arms, and without the aid of any weapon (Eur. Herc. Fur. 15, 3; Noom. xxv, 176). Admetus, King of Pheræ, loved Alcestis, the daughter of Pelias; her father promised to give her to the man who should harness Lions and Wild Boars to the same chariot. Apollo enabled Admetus to fulfil this condition, and Admetus married Alcestis (Apollod. i, 9, 15). Adrastus, King of Argos, in obedience to an oracle which ordered him to marry his daughters to a Wild Boar and a Lion, gave Deipyle to Tydeus, and Argea to Polynices, because they bore respectively the images of those animals on their shields."[1]

The Roman writer Ælian was probably right in his supposition that the Lion had been expelled from the Peloponnesus before the days of Homer.[2]

We have already seen that the existence of the Lions has been proved historically in Thrace, Macedonia, and Thessaly. It is attested also by the voice of tradition. King Caranus,[3] the mythical founder of the Macedonian dynasty, is reported to have celebrated his victory over Ciseus, a neighbouring king, by a trophy that was overturned by a Lion that descended from Mount Olympus; and therefore, according to Pausanias, the Macedonians, deterred by the omen, never erected trophies afterwards. Lysimachus also, according to the same author,[4] a Macedonian, and one of Alexander's body-guards, was thrown into a Lion's den by the command of his master, and conquered the beast. Polydamus[5] also, the athlete, killed a great and strong Lion, without arms of any kind, on Mount Olympus. A Lioness, sent by Diana,[6] killed Phayllus, the tyrant of Ambracia, and therefore was reverenced by the Ambraciots as their deliverer. It is worthy of note that Ambracia lies to the west of the River Acheloüs, and outside the boundary laid down by Herodotus.

[1] 'Notes and Queries,' vol. ix, p. 57.

[2] Ælian, 'De Nat. Anim.,' Schneider, lib. iii, cap. i, 27.

[3] Pausanias, lib. ix, cap. xl, 4.

[4] Pausanias, lib. i, cap. ix, 5:
Ὁ δὲ Λυσίμαχος οὗτος γένος τε ἦν Μακεδὼν, καὶ Ἀγεξάνδρου δορύφορος· ὃν Ἀλέξανδρός πότε ὑπ ὀργῆς λέοντι ὁμοῦ καθείρζας ἐς οἴκημα κεκρατηκότα εὗρε τοῦ θηρίου.

[5] Pausanias, lib. vi, cap. v, 3.
Οὗτοι πολλάκις οἱ λέοντες καὶ ἐς τὴν περὶ τοὺ Ὄλυμπον πλανῶνται χωρὰν· τούτου δὲ τοῦ ὄρους ἡ μὲν ἐς Μακεδονίαν πλευρὰ, ἡ δὲ ἐπι Θεσσάλους καὶ τὸν ποταμὸν τέτραπται τὸν Πηνεῖον. Ἐνταῦθα ὁ Πουλύδαμας λέοντα ἐν τῳ Ὀλύμπῳ μέγαν καὶ ἄλκιμον θήριον κατειργάσατο οὔδενι ἐσκευάσμενος ὅπλῳ.

[6] Ælian, 'De Nat. Anim.,' Schneider, lib. xii, cap. xl:
Ἀμπρακίωται δὲ, ἐπεὶ τὸν τύραννον αὐτῶν Φαΐλλον διεσπάσατο λέαινα, τιμῶσι τὸ ζῷον αἴτιον αὐτοῖς ἐλευθερίας γεγεννήμενον.

The scene of one of the prettiest stories recorded by Ælian is laid in Mount Pangæum, the very mountain quoted by Xenophon as the haunt of Lions some five hundred years before:[1]—"Eudemus tells the tale that in Pangæum, in Thrace, a Bear attacked the lair of a Lion while it was unguarded, and killed the cubs that were small and too weak to defend themselves, and when the father and mother came home from hunting somewhere, and saw their children lying dead, they were very much aggrieved, and attacked the Bear; and she was afraid and climbed up into a tree as quickly as she could, and settled herself down, trying to avoid the attack. Now, when they saw that they could not avenge themselves on her, the Lioness did not cease to watch the tree, but sat down in ambush at the foot, eying the bear, that was covered with blood. But the Lion, as it were, without purpose and distraught with grief, after the manner of a man, rushed off to the mountains, and chanced to light on a woodcutter, who in terror let fall his axe; but the Lion fawned upon him, and reaching up saluted him as well as he could, and licked his face with his tongue. And the man took courage. And the Lion encircled him with his tail, and led him, and did not suffer him to leave his axe behind, but pointed with his foot for it to be taken up. And when the man did not understand he took it up in his mouth and reached it to him. And he followed while the Lion led him to his den. And when the Lioness saw him she came and made signs, looking at the pitiable spectacle, and then up at the Bear. Then the man perceived and understood that the Lion has suffered cruel wrong from the Bear, and cut down the tree with might and main. And the tree fell, and the Lions tore the Bear in pieces; but the man the Lion led back again, safe and sound, to the place where he lighted on him, and returned him to the very tree he had been cutting."

This simple story, tested by the light of history, implies that the Lions some time dwelt in the neighbourhood of Pangæum. It is a very fair example of the valuable evidence that may be obtained from the analysis of myths, its historical corroboration being a mere accident. To the same class belong the story of the slaughter of the Nemean Lion, the conditions of marriage imposed on Admetus by Pelias, and those imposed on Tydeus and Polynices, that we have already quoted. They respectively imply that the Lion formerly lived in Nemea, and in company with the Wild Boar in the forests of Pheræ and Argos. The mythical evidence is most important in this particular, that it proves that the range of the Lion was becoming more and more restricted before the Historic Period commenced in Greece. If we add to this the geological testimony that the animal spread through the greater part of North-western and Central Europe during the Post-glacial epoch, and that of History as to its limited range, we are enabled to realise that the animal *gradually* retreated from Europe, step by step, until at last it became extinct some time between the days of Aristotle, B.C. 340, and those of Dio Chrysostom Rhetor, A.D. 80 to 100.

[1] Lib. iii, cap. xxi.

The Lion is also mentioned in the 'Niebelungen Lied' as having afforded sport to Sir Siegfried in the famous hunt in the Forest of Worms:[1]

961.

"With that an aged huntsman a watchful limehound took,
And shortly brought the champion into a shady nook,
Where store of beasts were couching; as each sprang from his lair,
The warriors, like good hunters, fell on and caught them there.

962.

"All that the limehound started, anon with mighty hand
Were slain by noble Siegfried, the chief of Netherland.
No beast could there outrun him, so swift his steed could race:
He won from all high praises for mastery in the chase.

963.

"Whatever he attempted, he went the best before.
The first beast he encounter'd was a fierce half-bred boar.
Him with a mighty death-stroke he stretched upon the ground;
Just after in a thicket a lion huge he found.

964.

"Him the limehound started; his bow Sir Siegfried drew;
With a keen-headed arrow he shot the lion through,
But three faint bounds thereafter the dying monster made.
His wondering fellow-huntsmen thanks to Sir Siegfried paid."

This passage, however, does not prove that the Lion dwelt in Bohemia at the time it was written (A.D. 900—1300?), because the whole story, according to the high authority of Prof. Max Muller,[2] is simply the ancient myth of Hercules appearing in a Gothic dress. It is, moreover, unsupported by collateral evidence of any kind, and therefore cannot be considered of historical value.

§ 4. *Cause of disappearance.* The cause of the disappearance of the Lion from Europe is very clear. The Leonine remains found in the ancient dwelling-places of Aurignac and La Madelaine testify to the warfare carried on by the Reindeer folk in France with the Post-glacial Lion, just as the story of the Nemean Lion, and the like, testify to the struggle carried on by the ancient Greek with the same animal in Peloponnese. Man cannot dwell at peace with the larger Carnivores. In exact proportion to his increase in numbers they decrease, being driven out of the field in the struggle for life. It would be almost possible to infer the want of civilisation and the small number of any people inhabiting a district fitted for the support of the large ruminants, by the amount of the carnivorous fauna. The fact, for example, that the Wolf lingered in Ireland as late as the

[1] 'The Fall of the Nibelungers,' by W. Lettsom, 1850, p. 164.
[2] 'Chips from a German Workshop,' vol. ii.

year 1710 is evidence of the sparse population and the uncivilised habits of the people in that island.

To this incessant warfare with man the retreat of the Lion from Europe may be attributed, and not to any want of food or to any climatal change. The winter cold of Mount Pindus and of the Balkans could not have been much less severe than that of the Pyrenees, the Vosges, or the Mendips; and the herds of Bison, Uri, and Elks that dwelt in the great Hercynian Forest that overshadowed the greater part of Germany in Prehistoric and Historic times were at least as well suited to become the prey of the Lions as any to be met with in the mountains of Thessaly or Macedonia.

§ 5. *Conclusion.* We have now briefly to sum up the results of our labours. Up to the present time *Felis spelæa* has been considered by various naturalists an extinct animal allied to the Lion, Tiger, or Jaguar. By a careful comparison of the remains of the animal, bone by bone, with those of the larger living Felidæ, we have arrived at the fact that it is specially identical with the Lion of Africa and Asia. Its range, both in space and time, has been determined so far as the materials at our command would allow; and lastly, the approximate date of its disappearance from Europe has been fixed by an appeal to the literature of Greece and Rome.

CHAPTER XIX.

Family—FELIDÆ.

Genus—Felis.

Species—Felis lynx, *Linnæus*.

Pl. XXIII.

§ 1. *Gisement.*
§ 2. *Description.*
§ 3. *Determination.*
§ 4. *Measurements.*
§ 5. *Conclusion.*

§ 1. *Gisement.* We are indebted to Dr. Ransom for the discovery of the remains of a Carnivore hitherto unknown in Britain, in a fissure that penetrates the Permian Limestone in Pleasley Vale, in Derbyshire, termed the Yew Tree Cave. The conditions under which the discovery was made are as follows :—"The cave is entered by a narrow opening, large enough for one person to creep through; the descent is a series of inclines and sudden falls, which require the help of a rope and a long pole. The total depth is 70 feet, and the length about 100 feet (of the part explored). It is everywhere narrow, and in some places so much so that only a person of moderate obesity can pass. I was obliged to move sideways. The mud which fills the insterstices between the angular blocks at the floor of the cave is red loam, interspersed with small fragments of the stalagmite. No rolled stones were found, and no transported ones. Here and there the mud was hardened with infiltration of carbonate of lime; this was particularly the case with that which lay upon the projecting ledges of the walls. The osseous remains found were imbedded in the red loam, and were best preserved when it was infiltrated with carbonate of lime. In some parts the bones were very friable, and fell to pieces on the slightest attempt to remove them. The number of fragments of bones in parts was so great as to form a large proportion of the mud. The bones were not found rolled or worn; they were much broken in some parts of the cave, not in others—on the whole, not more so than might easily be accounted for by the falling of stones, by which means, also, the stalagmite was much broken. Only one bone was found which appeared to show marks of teeth. . . . A number of jaws of Wolf, and one which I take to be that of a Fox, were found ; also numerous long bones and jaws of Roedeer, part of the skull and lower jaws of a Pig, several jaws of the Watervole, and a still larger number which I have not yet determined. . . . How the bones got there it is not easy to say, there were few or no indications of the cave having been a den of wild animals, although it is possible that the expanded portion near the mouth may have been so used at some time. In that case, the bones found in the deeper parts must have been those which had been washed or fallen down, or of animals which had run down in the ardour of the chase, as the steep part of the fissure could not, I feel sure, be ascended by any animal which had once gone down. This was illustrated by our finding the almost entire skeleton of a Dog in the deepest part of the cave, so recent that the pupa-cases of the flesh-fly were still found perfect; and similarly in the new cave, which is shaped so as to form a capital live trap, I found great numbers of rabbits' bones and hares' bones in each cave, clustered and lying together as the animals died. No confident opinion founded on the position of the bones in the floor of the cave could be formed as to their relative ages, as the dribbling of water through the loose stones of the floor carries away and displaces the mud and objects imbedded in it."[1]

It is clear, from this precise account given by Dr. Ransom, that the geological age of the remains in the cave cannot be determined with absolute certainty. So far as the internal evidence goes, they may be of Prehistoric, or even Historic, date with as great probability as Postglacial; but, nevertheless, there are two circumstances which render the latter hypothesis the most tenable. In the first place, in a cave in the neighbourhood, the tichorhine Rhinoceros, Mammoth, and Bison have been found; and in the second place, the Carnivore in question must have crossed over into Derbyshire while Britain formed part of the mainland of Europe, or, in other words, during the Postglacial epoch, or very possibly before; for it is impossible to suppose that it could have invaded our island from France or Germany during Prehistoric times, and that it should have been brought over by the care of man is most improbable. Its Postglacial age, therefore, may be assumed with a very high degree of probability, although not with absolute certainty.

§ 2. *Description.* The remains (Pl. XXIII) consist of a fragment of skull and a lower jaw that most probably belonged to the same individual. The former presents the occipital bone in a perfect state of preservation, together with the basisphenoid, tympanics, the zygomatic portion of the temporal, and fragments of the parietals. The latter is a right ramus perfect with the exception of a small portion of the coronoid process and the tip of the angle, and with all the teeth *in sitû*, except the incisors. The unworn condition of the teeth implies that the animal was an adult just coming into its full prime.

[1] Brit. Assoc., Nottingham, 1866, Paper read before Section C.

§ 3. *Determination.* These remains were submitted to Prof. Owen shortly after their discovery, and were pronounced by that high authority to belong to *Felis cervaria*, the Lynx of Northern Asia. A careful comparison, however, with the Lynx in the British and Oxford Museums, and that of the Royal College of Surgeons, proves that they may be referred with equal justice to the Lynx of Norway and Sweden, *Felis borealis* (Temminck). It is foreign to the plan of this work to analyse all the variations presented by the European and North-Asiatic Lynxes; but we cannot detect any osteological difference of specific value between the Norwegian Lynx and the North-Asiatic *Felis cervaria.* The variations also in size presented by the various European Lynxes seem to be of no more importance in classification than those of the African Panther (*Leopardus varius*).

Among the smaller Felines there are only the Lynxes which are capable of being compared with our fossil on account of their peculiarly formed teeth. It is differentiated from the Canadian Lynx by the presence of a small cusp *c* (Pl. XXIII, figs. 3, 4, 5) on the lower true molar, which is invariably absent from the corresponding tooth of the latter animal. It is allied most closely with the Norwegian Lynx and the *Felis cervaria.* We will compare the remains *seriatim.*

The basi-occipital in the fossil is remarkable for its intertympanic squareness, fig. 2, as in the Norwegian Lynx. In *Felis cervaria* the planes bounding it on either side next the tympanics are inclined at a much greater angle to each other. The occipital foramen, fig. 1, is slightly more roof-shaped above than in either of these two Lynxes. The sur-occipital encroaches somewhat further upon the superior surface of the head than in *Felis cervaria*, as is shown by the measurements; there are no other differences observable between the fossil skull and those of these two animals. The relatively small mastoid differentiates the fossil from the Panther of Africa, the large size of the paramastoids from the Caracal, in which animal they are reduced to a small lamina embracing the tympanic bulla. The same point also differentiates it from *Leopardus pardina*, and from the Peshoo or Canadian Lynx.

The lower jaw (figs. 3, 4, 5, 6) differs in no respect from that of *Felis borealis* and *F. cervaria*, excepting in the strength of the muscular impressions. The alveolar border is nearly parallel to the inferior, without any tapering; the anterior portion is very much thickened; the ramal process *a* (fig. 3) is developed, and causes the convexity of the lower contour. The exterior of the crown of the canine bears two sillons (figs. 3 and 7), of which the inner is the smaller. In *Felis cervaria* the latter is very faint; but it is very strongly marked in *Felis borealis.* The inner side of the crown also is traversed by one sillon, that bounds the flattened slightly convex internal area.

The crown of premolar 3 consists of three cusps, of which the anterior, or the smaller, *b* (figs. 3, 4, 5), is not mapped off from the primary, *a*, by a cleft, but springs from a cingulum that is well defined on the inner side; *a* is very large and triangular, and separated from the secondary, *c*, by a deep cleft; *c* is defined from the cingulum. In *F. borealis* the cusp, *b*, is more clearly defined.

Premolar 4 repeats all the characters of the preceding tooth, but the secondary cusps, *b* and *c*, are increased in size, and the former defined from the primary, *a*, by a cleft; and from the cingulum by a notch; *a* also is more trenchant and broader in the antero-posterior direction.

The sectorial molar presents absolutely no points of difference when compared with that of *F. borealis* and *F. cervaria*, but, as before mentioned, it is differentiated from that of the Canadian Lynx by the presence of the small accessory cusp, *c*, which is adherent to the posterior base of the posterior blade, *a*. In the latter animal, moreover, the anterior blade, *b*, is shorter as compared with the posterior, *a*.

§ 4. *Measurements.* In the following tables we have arranged the measurements, in inches and tenths, of the skulls and lower jaws most closely allied to our fossil. The differences in size and proportions can be seen at a glance. In the last column of the measurements of the lower jaw we have inserted those of the teeth, from a jaw marked and found by Senhor Delgado[1] in the Casa da Moura, a cave in the Jurassic Limestone of Cesareda, in Portugal, that had been inhabited by a tribe of cannibals, probably of the Bronze Age. They agree exactly with those of our fossil, and therefore, although the jaw to which they belong is smaller in every dimension than the fossil from Derbyshire, both probably belong to the same species. The difference of size is not greater than that existing between two skulls of Norwegian Lynxes in the British Museum.

Measurements of Skull.	*F. lynx*, Pl.XXIII.	*F. lynx* (*borealis*), Brit. Mus., 1230 A.	*F. lynx* (*cervaria*), Brit. Mus., 1156 A.	*F. lynx* (*cervaria*), Coll. Surg., 4587.	*F. Lynx* (*Canada*), Oxford Museum.
Maximum height of occiput	1·81	1·6	1·62	1·45	1·35
,, ,, occipital foramen	·86	·65	·68	·6	·55
,, ,, exoccipitals	1·05	...	...	·85	·8
Transverse extent of occiput	2·02	2·0	2·0	2·17	2·2
Transverse measurement of occipital foramen	·79	·7	·66	·65	·6
Antero-posterior extent of condyles	·57	·55	·57	·5	·55
,, ,, basi-occipital	1·05	1·08	1·02	1·02	·85
,, ,, zygomatic articulation	·42	·4	·42	·35	·28
Transverse ,, ,, ,,	·98	1·0	·78	·78	·9
Meatus auditorius to meatus auditorius	2·0	1·99	2·0	1·89	1·6
Glenoid articulation to glenoid articulation	1·88	1·82	1·86	1·62	1·6
Intertympanic space	·85	·7	·64	·46	·52
Antero-posterior extent of tympanic bulla	·92	·95	·96	1·05	·95
Encroachment of sur-occipital on parietal surface	·35	·3	·26	·2	...

[1] Commissão Geologica de Portugal. Estudos Geologicos. Da Existencia do Homem no nosso solo em Tempos mui remotos provado pelo estudos das cavernas. Primeiro opusculo. Noticia ácerca das Grutas da Çesarada. Par J. F. W. Delgado. Com a versao em Francez, par M. Dalhunty. This jaw is alluded to in the text as belonging to species *a*, and is figured in pl. ii, fig. 1. See also Bone Caves in Portugal, 'Quart. Geol. Journ.,' No. 94, Translations and Notices, p. 9.

Measurements of Lower Jaw.	*F. lynx*, Pl. XXIII.	*F. lynx* (*borealis*), Brit. Mus., 1230 A.	*F. lynx* (*cervaria*), Brit. Mus., 1156 A.	*F. lynx* (*cervaria*), Coll. Surg., 4587.	*F. lynx* (*Canada*), Oxford Museum.	*F. lynx*, Casa da Moura.
Maximum length	4·2	4·0	4·0	3·5	3·4	...
Maximum height	1·68	1·8	1·8	1·6	1·66	...
Circumference behind $\overline{M1}$	2·2	2·0	2·0	1·7	1·6	...
„ before PM3	2·4	2·0	2·0	1·5	1·4	...
Diastema	·3	·3	·25	...	...	·35
Length of inferior border	3·3+	3·5	3·2	2·9	2·8	...
Height of articulation above angle	·85	·7	·75	·8	·78	...
Length of molar series	1·54	1·55	1·5	1·2	1·16	1·4
Antero-posterior extent of $\overline{M1}$	·65	·65	·63	·42	·46	·65
Antero-transverse „ „	·26	·26	·25	·2	·2	...
Postero-transverse „ „	·24	·26	·23	·2	·18	...
Height of crown	·35	·39	·35	·28	·32	...
Antero-posterior extent of PM4	·49	·50	·46	·45	·42	·5
Antero-transverse „ „	·19	·2	·19	·17	·16	...
Postero-transverse „ „	·27	·25	·23	·2	·18	...
Height of crown	·35	·32	·35	·39	·31	...
Antero-posterior extent of PM3	·4	·4	·4	·34	·31	·35
Antero-transverse „ „	·15	·16	·13	·13	·11	...
Postero-transverse „ „	·23	·2	·22	·16	·16	...
Height of crown	·29	·28	...	·21	·24	...
Length of canine	1·85	...	...	1·4	...	...
Length of crown of canine	·75	·8	·8	·5	·55	...
Symphysial length	1·25	1·1	1·2	·9	·7	...
Symphysial breadth	·5	·55	·5	·4	·48	...
Condylar length	·9	...	...	·8	·7	...
Condylar breadth	·5	...	...	·4	·2	...

§ 5. *Conclusion.* In fine, there is sufficient evidence afforded by these two fragments to prove that the animal to which they belonged was specifically identical with the *Felis* (*lynx*) *borealis* of Norway, or with the variety *F.* (*lynx*) *cervaria* of Siberia. It was one of the larger Lynxes which in ancient times spread over the whole of the mainland of Europe, and still maintain their ground, in the wilder and more desolate parts, in Scandinavia, Russia, France, Germany, Spain, Italy, and the south. Its addition to the Fauna anciently dwelling in Great Britain is the more remarkable because it was predicted in the First Part of our Monograph written in 1865.

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BRITISH

PLEISTOCENE MAMMALIA.

BY

W. BOYD DAWKINS, M.A., F.R.S., G.S.,

AND

W. AYSHFORD SANFORD, F.G.S.

PART IV.

BRITISH PLEISTOCENE FELIDÆ.

FELIS PARDUS, Lin.; *FELIS CAFFER*, Desm.; *FELIS CATUS*, Lin.; *MACHÆRODUS LATIDENS*, Owen.

(Pages 177—194; Plates XXIV, XXV.)

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CHAPTER XX.

Family—FELIDÆ.

Genus—Felis.

Species—Felis (leopardus) pardus, *Linnæus*.

Pl. XXIV.

§ 1. *Introduction.*
§ 2. *Comparison of fossil remains with most closely allied living forms.*
§ 3. *Associated animals in Great Britain.*
§ 4. *Range of F. pardus.*

§ 1. *Introduction.* The former existence of one of the larger felines closely allied to the Panther or Leopard on the mainland of Europe was first established by the discovery of remains in the Caves of Cette in the South of France, and of Gailenreuth in Bavaria, which were described by Baron Cuvier under the name of *Felis antiqua*,[1] and the specific identity of this animal with the living Panther was the opinion of our great palæontologist Dr. Falconer.[2] Subsequently the animal has been identified by M. Lartet[3] among the remains from the cavern of Mars in the Maritime Alps, and by Professor Gervais from the cave of Mialet (Gard.).[4] Since then it had a place in the Pleistocene Fauna of Europe; it was reasonable to suppose that it also inhabited Britain during the time that our island formed part of the continent, and supported the Hippopotamus, the Lion, and the Hyæna, which at the present day are to be found side by side with the Panther, south of the Sahara desert. The first evidence of the animal having lived in Britain was offered by a canine (Pl. XXIV, fig. 4) from the bone cave at Banwell, in the Collection of the Earl of Enniskillen, F.R.S.; and subsequently we were able to assign to it the following remains from the caves of the Mendip Hills: two canines (Pl. XXIV, figs. 1, 2) obtained by the Rev. J. Williams from either Bleadon or Hutton Caves; and an ulna, femur (fig. 5), two metatarsals, and an upper milk canine from Bleadon Cave in the Collection of Mr. Beard. All the remains with the ex-

[1] 'Oss. Foss.,' 1825, vol. iv, p. 193, pl, xv, fig. 7; and p. 452, pl. xxxvi, figs. 4, 5.

[2] "Dr. Falconer stated this to me in one of the many conversations on fossil bones which will ever remain in my memory."—*W. Boyd Dawkins.*

[3] 'An. des Sc. Naturelles,' 5e série, tom. viii; 'Deux Têtes de Carnassiers Fossiles.'

[4] 'Animaux Vertébrés Vivaux et Fossiles,' 4to, 1867-9, p. 68, pl. xv.

ception of the canine belonging to Lord Enniskillen are preserved in the Taunton Museum.

§ 2. *Comparison of fossil remains with most closely allied living forms.*—Under the name *Felis* (*Leopardus*) *pardus* we intend to embrace the Panther properly so called, and the Leopard, the former consisting of the larger and stouter, and the latter of the more slender and smaller individuals; since an examination of a large number of skulls, skeletons, skins, and living animals, has convinced us that the differences are only varietal, and not of specific value. At the same time there exists in Northern China, and, we have reason to believe, also in other parts of Eastern Asia, a species which is undoubtedly distinct, and which differs from the Panther, in the comparative length of the nasals and frontal processes of the maxillaries, exactly as the Tiger differs from the Lion. This species has been named by Dr. Gray ('Proc. Zool. Soc.,' 1867, p. 264) *Leopardus Chinensis;* Dr. Gray describes a third species, under the name of *Leopardus Japonensis* ('Proc. Zool. Soc.,' 1862, p. 262); and the fourth is the Jaguar of America, *Leopardus onca,* Linn. These are the only living species with which it is necessary to compare the fossils in question.[1]

On comparing the fossil teeth with those of the living Leopard and the Jaguar, we find that they agree with the former in their slender, delicate, and compressed form. In the Jaguar (*Felis onca*) the teeth are much stouter and the cusps of the molar series more obtusely conical. The canines (Pl. XXIV, figs. 1, 3, 4) present a character which at once differentiates them from those of the latter animal in the two longitudinal grooves or *sillons* which traverse the outer and the inner sides of the crown. In the Jaguar the second *sillon* on the outer side is a mere rudiment, or in some cases is altogether absent. In all these points in which the teeth correspond with those of the Leopard, *Felis pardus,* they also agree with those of the allied species *Leopardus Chinensis* of Dr. Gray. They may, however, be referred with considerable certainty to the former animal, since it has been found in several caves in France, while the latter has not been known to live out of China.

A glance at the following table will give the relative size of the fossil lower true molar as compared with that of the Leopard and Jaguar (Pl. XXIV, fig. 2).

		Leopardus. Africa. Cat. 115. Brit. Museum.	*Leopardus.* Africa. Brit. Museum.	*Felis* (*Leopardus*) *onca.* Brazils. 117 C. Brit. Museum.
Antero-posterior length	0·81	0·7	0·7	0·74
Antero-transverse diameter	0·3	0·3	0·3	0·42
Postero-transverse diameter	0·28	0·28	0·28	0·38
Height of crown	0·44	0·38	0·39	0·39

[1] A fifth species of *Leopardus,* of large size, has been recently described by M. Milne-Edwards, from Northern China. 'Ann. Sci. Nat.,' ser. 5, tom. viii, pp. 374-76.

This variation in the size of the fossil, as compared with the recent Leopard, is not greater than that presented by living individuals of the same species.

The Femur.—The left femur figured (Pl. XXIV, fig. 5) corresponds with that of a large Panther from West Africa, in the Museum of the College of Surgeons. Its proportions may be gathered from the figure, and there is no necessity for a detailed description. The rest of the bones are too fragmentary to be figured or described.

The remains from the Pleiocene beds of Mont Perrier in Auvergne ascribed by MM. Croizet and Jobert to the *Felis antiqua* are far too large[1] to have belonged to the largest Leopard. Nor can any of the other fossil felines be identified with it with any certainty. M. de Blainville,[2] however, believes that the *Felis pardinensis,* and the *F. Arvernensis* of MM. Croizet and Jobert, are identical with the Panther. The *Felis pardoides*[3] of Professor Owen, from the Red Crag, differs from the Panther in the lowness of the crown of the last true molar.

§ 3. *Associated Animals.*—The species with which the remains of the Panther have been found in Britain, France, Germany, and Gibraltar, are represented in the following table; Marcel de Serres, Dr. Falconer, Mr. Busk, and Dr. Goldfuss, being the authorities for those of Lunel-viel, Gibraltar, and Gailenreuth. The *Ursus ferox* from the last cave is based on the examination of a series of teeth obtained by Sir Philip Egerton and Lord Enniskillen.

List of Species.	Caves.					
	Banwell.	Bleadon.	Sandford Hill.	Lunel-Viel.	Gibraltar.	Gailenreuth.
Ursus arctos, L.	...	×	×	...	...	×
U. spelæus, Gold.	×	×	×	×	...	×
U. ferox, L.	...	...	...	...	×	×
Gulo luscus, Latr.	×	×	...	...	...	×
Meles taxus, L.	...	...	...	×	...	...
Mustela putorius, L.	...	...	...	×	...	...
M. martes, L.	...	×	...	...	...	...
Lutra vulgaris, Erxl.	...	×	...	...	...	...
Canis vulpes, L.	...	×	×	×	×	×
C. lupus, L.	...	×	×	×	...	×
Hyæna (*spelæa,* Gold.) *crocuta,* Zim.	...	×	×	×	×	×
Felis catus, L.	...	×	...	×	...	×
F. (*antiqua*) *pardus,* L.	×	×	?	×	×	×
F. leo (var. *spelæa*), L.	...	×	×	×	...	×
F. pardina, L.	...	...	...	...	×	...
F. serval, Schreb.	...	...	...	....	×	...

[1] 'Oss. Foss. de Puy de Dome,' p. 214, 4to, 1828. 'Ostéographie,' article "Felis," p. 143, pl. xvi.

[2] 'Ostéographie,' article "Felis."

[3] 'Brit. Fossil Mammals,' p. 169.

List of Species.	Caves.					
	Banwell.	Bleadon.	Sandford Hill.	Lunel-Viel.	Gibraltar.	Gailenreuth.
Cervus megaceros, Hart	...	×	...	...	...	...
C. tarandus, L.	×	×	...	...	...	×
C. capreolus, L.	...	×	...	...	...	...
C. elaphus, L.	...	×	...	×	×	×
C. *dama*, L.	...	...	...	...	×	...
Bos primigenius, Boj.	...	×	×	×	?	...
Bison priscus, Ow.	×	×	×	...	?	×
Capra ibex, L.	...	...	...	...	×	...
Hippopotamus major, Desm.	...	...	...	...	×	...
Sus scrofa, L.	...	×	...	×	×	×
Equus caballus, L.	...	×	×	×	×	×
Rhinoceros hemitœchus, Falc.	...	...	...	×	×	...
R. tichorhinus, Cuv.	...	...	×	...	...	×
Elephas antiquus, Falc.	...	×	...	...	...	...
E. primigenius, Blum.	...	×	×	...	...	×
Lemmus, sp.	...	×	...	...	...	...
Lepus cuniculus, Pall.	...	...	...	...	×	...
L. diluvianus, Serr.	...	×	...	×	...	...
Lagomys spelæus, Ow.	...	×	...	...	...	...
Spermophilus erythrogenoides, Falc.	...	?	?	...	...	...
S. —— ?	...	×	...	...	...	...
Arvicola pratensis, Bell	...	×	...	...	...	...
A. agrestis, Flem.	...	×	...	...	...	...
A. amphibius, Desm.	...	×	...	...	...	...
Castor fiber, L.	...	...	...	×	...	...
Mus musculus, L.	...	×	...	...	...	...

§ 4. *Range of F. pardus.*—The present home of the Panther or Leopard is to be found in the warm regions of Africa and Asia, and not in Europe, or the colder districts of Asia. The occurrence of the animal in the caves of Gibraltar proves that in the Pleistocene period it passed northwards into Spain, while the discovery of its remains in France indicates that it ranged over that region, and those in Gailenreuth Cave that it lived in Central Germany. The remains in the Mendip Caves show that it passed northwards over what is now the Channel, to prey upon the Reindeer, Bisons, and Horses of Somersetshire. Throughout this area it was very rare as compared with the contemporary Lions, Bears, and Hyænas.

The presence of this beautiful feline in Britain, now only living in a warm climate, may easily be explained by the hypothesis that it migrated northwards from time to time from the warmer regions around the Mediterranean; and it is very probable that the Arctic severity of the Pleistocene winter was the cause of its rarity in our latitude.

CHAPTER XXI.

The Smaller FELIDÆ.

PLATE XXIV.

§ 1. *Introduction.* | § 2. *Felis caffer.*
§ 3. *F. catus.*

§ 1. *Introduction.*—The remains of the smaller Felidæ have long been known to exist in the Pleistocene Caves and river deposits in Great Britain, France, Belgium, and Germany, and have for the most part been referred without any minute analysis of their characters to the common Wild Cat of Europe (*F. catus*, L.) M. Marcel de Serres[1] and his colleagues figure one lower jaw from the Cave of Lunel-Viel, and Dr. Schmerling[2] another from the Caves of Liége, which are larger than any well-authenticated lower jaw of Wild Cat which has passed through our hands. The former ascribe their specimen to the *Felis fera,* by which they probably mean the common Wild Cat, while the latter assigns his to the '*Felis catus magna,*' regretting at the same time his lack of recent specimens with which to compare it. The measurements of the depth of jaw given in the 'Ossemens fossiles de Lunel-Viel,' p. 120, show that the jaw figured in Pl. IX belongs to the same animal as that figured by Schmerling, while those given by the latter do not agree with his own Plate, the confusion being probably caused by the substitution of height for thickness.[3]

The smaller feline remains which we have examined from the Caves of Great Britain

[1] Marcel de Serres, 'Oss. Foss. de Lunel-Viel,' p. 120, pl. ix, figs. 12, 13, and 17.

[2] Schmerling, 'Oss. Foss. de Liége,' vol. ii, p. 88, pl. xviii, figs. 13, 14, 23, 24.

[3] In the text these measurements are—

		M.		INCH—ENG.
Hauteur de la machoire devant la première molaire .	(1)	0·007	=	0·027
la dernière . .	(2)	0·008	=	0·031
In the figures they are—	(1)	0·012	=	0· 55
	(2)	0·013	=	0· 51

The other measurements exactly agree with the figure.

seem to us to imply the existence of two species, one the *Felis caffer* of Africa, and the common Wild Cat, which is now rapidly being exterminated in our island. But on the very fragmentary evidence before us we do not attempt to define with absolute certainty the former existence of the *Felis caffer* in Britain. Nevertheless, the exact agreement in every particular of the lower jaw figured in Pl. XXIV, fig. 6, 6′, 6″, with that of the latter animal, and its disagreement in the same points with those of other animals, renders the specific identity almost certain; and with regard to the classificatory value of the points themselves in the recent lower jaws, we have found that they are present in all those of the former, and absent from all those of the latter which we have examined in the British Museum, the College of Surgeons, and elsewhere.

§ 2. *Felis caffer.*—The right lower jaw from Bleadon Cave in the Mendip Hills, figured Pl. XXIV, fig. 6, 6′, 6″, differs from the jaws of all the smaller Leopardine Cats of both the Old and New Continents, as well as from the Lynxes, by the smaller size of the molar series as compared with the depth of the jaw, while the jaws in these animals are thicker in proportion to their depth.

These smaller feline jaws being thus proved to be unlike that in question, there remain for comparison two groups of Cats, the larger, represented by the *Felis chaus* of India, which appears to have had a large share in the production of the Domestic Cat of that country; and the smaller, or that which is represented by the Wild Cat of Europe, and the *F. maniculata,* the latter probably having a share in the breed of the Domestic Cat of Europe. Intermediate between these groups are two species, the *F. caffer*, distributed at the present day throughout Africa, and the *F. torquata* of the Himalayas, which are closely related together, and are probably representative forms in their respective districts. In the series represented by *Felis chaus* the lower true molar, *m* 1 is larger in proportion to the premolars than in our fossil.

There remain, therefore, for comparison the Wild Cat of Europe, the *F. maniculata,* and the *F. caffer.* In all the well-authenticated specimens of Wild Cat which we have examined, as well as in those of the large domestic cats with brownish-grey fur, which have run wild, the posterior inner alveolar border is much thickened (Pl. XXIV, fig. 8, *c*), and rises higher than the outer border, so that the last true molar, and to a certain extent premolar 4, are thrown to the outside of the jaw. These characters are not to be found in our fossil, the molar series being set on the middle of the alveolar edge of the mandible. The ramus also in the fossil is deeper and transversely narrower than in the Wild Cat.

In the *Felis maniculata,* and the smaller specimens of Domestic Cat, the jaw is much less deep in proportion to its thickness than in the fossil. The jaw of *Felis caffer*, on the other hand, agrees with our fossil in the minutest detail, as well as with that figured by Dr. Schmerling, and measured by M. de Serres; and it is therefore impossible to resist the conclusion, that a species of Wild Cat most closely allied to the *F. caffer* lived in Britain, Belgium, and France, in the Pleistocene Period. There is indeed nothing unreasonable in the suggestion of a Cat now found only in Africa having once ranged over Europe, since the Spotted Hyæna, the Hippopotamus, and the Panther were members of our Pleistocene Fauna, as well as being now associated with *F. caffer* in Africa.

In the following table we have represented the relation of the fossil lower jaws to those of the Wild Cat and *Felis caffer*. The measurements are taken in inches:

Measurements.	Fossil Bleadon.	Schmerling's fig.	*F. Caffer.* Coll. Surg., 4606.	*F. Caffer.* Brit. Mus., 857 A.	*F. Catus.* Scotland. Coll. Surg.,	*F. Catus.* Germany. Brit. Mus.
Length of molar series	0·91	0·92	0·91	0·92	0·82	0·74
$\overline{\text{M1}}$. Length	0·35	0·36	0·34	0·33	0·32	0·29
Postero-transverse diameter	0·16	...	0·16	0·14	0·13	0·11
Antero-transverse diameter	0·15	...	0·15	0·13	0·14	0·10
Height	0·11	0·13	0·11	0·10	0·09	0·08
$\overline{\text{PM4}}$. Length	0·34?	...	0·35	0·30	0·28	0·26
$\overline{\text{PM3}}$. Length	0·26	0·25	0·26	0·26	0·20	0·20
Transverse	0·14	...	0·15	0·13	0·10	0·10
Height	0·20	0·20	0·19	0·17	0·18	0·15
Depth of jaw at $\overline{\text{M1}}$	0·53	0·54	0·56	0·52	0·40	0·39
Thickness „ „	0·22	...	0·23	0·21	0·25	0·22
Depth at $\overline{\text{PM4}}$	0·45	0·45	...	...	...	...

The fragments of ulna (fig. 8) and of femur (fig. 7) of a large Cat from Bleadon Cave may most probably be referred to the *F. caffer*, since they were obtained from the same place as the jaw which we have just described. They may, however, belong to the Wild Cat.

§ 3. *F. catus.*—The lower jaws and bones of the Wild Cat of Europe, which is now so rapidly becoming extinct in Great Britain, have been discovered in the Cave of Kirkdale by Dr. Buckland, and in that of Kent's Hole by the Rev. J. MacEnery, and differ in no respect from those of the living representative. If that figured Pl. XXIV, fig. 8, be examined, it will be seen that in its slender form it contrasts with that figured 6, 6′, 6″. The lower jaw (Pl. XXIV, 9, 9′) is from the Brickearth of Grays Thurroch, and is in the Collection of Mr. Wickham Flower: its external aspect has been figured in the 'British Fossil Mammals,' p. 172. There are no points presented by these fragments which are worthy of a detailed notice.

The remains of the Wild Cat have been obtained from several of the localities in Great Britain, and it lived in our country from the age represented by the Brickearths of the Thames Valley to the present day.

CHAPTER XXII.

FAMILY—FELIDÆ.

Genus—MACHÆRODUS, *Kaup*.

Species—MACHÆRODUS LATIDENS, *Owen*.

PLATE XXV.

§ 1. *Nomenclature.*—The history of the discovery of the great sabre-toothed Feline *Machærodus* shows at once the difficulty with which naturalists have to contend in assigning fragmentary remains to their rightful possessor, and of the gradual steps by which that difficulty was removed. The tooth of the animal now known as *Machærodus cultridens,* from having been associated with the remains of the Bear in the deposits of the Val d'Arno, was assigned to an abnormal species of that genus by Cuvier in 1824, or the *Ursus cultridens,*[1] and by Nesti in 1826 to the *U. drepanodon;*[2] and similar teeth found in Auvergne have been described by MM. Croizet and Jobert[3] as *U. cultridens Issidorensis.* M. Bravard,[4] however, having discovered a feline skull in the same district, which was possessed of sockets such as would fit the large compressed canines somewhat resembling those in question, and of a mandible in which there was a deep outer depression for the reception of the upper canine when the jaws were shut, inferred that the animal was a

[1] 'Oss. Foss.,' 4to, 3rd edit., 1824, vol. v, pt. ii, p. 517.
[2] 'Lettera Terza dei alcune Ossa fossili, al S. Paolo Savi,' 8vo, Pisa, 1826.
[3] 'Oss. Foss. de Puy de Dome,' p. 200.
[4] 'Monographie de deux Felis d'Auvergne,' p. 143.

Felis, and described it as *F. megantereon*. And that this conclusion of M. Bravard was true is proved, as Professor Owen remarks,[1] by the fragment of skull of an allied form in the British Museum, from the Sevalik Hills. Dr. Kaup,[2] on the other hand, who had met with the remains of the animal at Eppelsheim pointed out that the compressed and serrated canines, in which the two longitudinal grooves so characteristic of the larger Felines were absent, separated the animal to which they belonged frem the genus Felis, and he therefore proposed for them the name *Machærodus,* or the Sabre-toothed Carnivore.

On the whole, the evidence which we possess as to the affinities of the animal prove that it belongs to the great family of the Felidæ, although those points which Dr. Kaup has brought forward forbid its classification with the genus Felis, from which it differs in the enormous development of the serrated upper canines, as well as the presence of a third lobe on the sectorial edge of the upper Premolar 4. And that it is an aberrant member of the great family of Cats is the opinion of M. de Blainville, Professor Owen, and M. Albert Gaudry. Its dental formula is that of the true Felines.

§ 2. *Range of Genus.*—The genus Machærodus is of very wide range both in space and time. It has been found alike in the Meiocene deposits of India by Falconer, the plains of Marathon by Gaudry, and the river-deposit of Eppelsheim by Kaup.[3] It has been known to occur in the Pleiocene strata of the Val d'Arno since 1812, and of Auvergne since the year 1828. It has also been found in the Pleiocene Caves of Brazil by M. Lund, along with the great Sloth, the Megatherium, and the peculiar Horses at that time living in South America. The best known and most widely spread European species is that which ranged over France, Germany, Italy, and Greece, during the late Meiocene and the early Pleiocene periods, under the name of *Machærodus cultridens* of Kaup, and which has been fortunate in being described by M. Gaudry in his classical work on the 'Animaux Fossiles de l'Attique.' And the proof of the presence of a closely allied form in England we owe to the labours of the Rev. J. McEnery in Kent's Hole Cave, near Torquay.

§ 3. *History of British Remains.*—The seven teeth which afford the proof of the ancient sojourn of the Machærodus in Great Britain were discovered so long ago as 1826, and their history has been very remarkable. The Rev. J. MacEnery unfortunately did not publish the results of his explorations in Kent's Hole, which he carried on from time to time after 1825 up to his death in 1840, and the manuscripts were lost, until they fortunately fell into the hands of Mr. J. Vivian, of Torquay, who published an abstract in the year 1859. Ten years later they were published in full by Mr. Pengelly, F.R.S., and afford an authentic and circumstantial account of the discoveries, which had been lost to

[1] 'Brit. Foss. Mam.' (1846), p. 176.

[2] 'Oss. Foss. de Museum de Darmstadt,' 2nd part, 1833.

science for nearly thirty years. The lithographs also which had been originally made to illustrate a work on 'Cavern Researches,' which was never carried out, were published in part in 1859 by the permission of Mr. F. Buckland, into whose hands the stones of seventeen out of the thirty plates to which Mr. MacEnery refers in his prospectus had passed at his father's death, and now even these cannot be traced. Two more plates were fortunately added to these in the year 1869; and a third plate, which had not been known to be extant, was added subsequently, through which additional evidence as to the sojourn of the Machærodus in the Cave was obtained.

Nor were the remains of the animals which Mr. MacEnery discovered, more fortunate. At his death they were sold by auction and divided up among private collectors, and for the most part irretrievably lost. Out of the seven teeth of Machærodus we are able only to trace five. The canine in the Oxford Museum was purchased by Dr. Lovel Phillips at the sale, and given to Dr. Buckland; that in the College of Surgeons, and figured by Professor Owen, was presented by Lord Enniskillen to Professor Owen; a third, the original of pl. F′, figs. 4, 5, found its way into the Museum of the Geological Society; the fourth, figured pl. F′, figs. 1, 2, 3, is in the British Museum; and the fifth (pl. F′, fig. 7) is in the Collection of Sir Walter Trevelyan, Bart., to whom it was given shortly after its discovery by Mrs. Cazalet.[1] We are unable to trace the two incisors, one of which is figured in the fossil mammals (fig. 70).[2]

§ 4. *Relation to Machærodus cultridens.*—All the canines which had the above eventful history belong to the upper jaw, and are remarkable for their width as compared with the length of the crowns. That in the College of Surgeons, which Professor Owen takes as the type-specimen of *M. latidens* measures 6·5 inches along the outer curve, and 1·2 inches across the base of the crown, while in the Italian *Machærodus cultridens* the corresponding measurements are 8·5 inches and 1·5 inches. If the proportions of the Italian specimen be constant, it is obvious that the British specimen in question must belong to another species, since the basal measurement of the crown is so much greater. Professor Owen attaches a specific value to this greater width, while Dr. Falconer, after carefully weighing the evidence, believes that the difference has merely a varietal importance. The size of the canines is, to a certain extent, a sexual character, and therefore liable to variation in different individuals of the same species. And to what an extent this variation may take place within the limit of a species may be gathered from the comparative measurements of canines of the Cave-Lion in our Monograph on the animal. But although the character in question be not of specific value, the strongly marked serration in the incisors (woodcuts 1, 2, 3) differentiates, as M. Gervais remarks, the British from the French species of

[1] Letters to W. Boyd Dawkins, dated 11th and 26th May, 1869.

[2] Mr. Pengelly has given a full account of the teeth in question, and of their singular history, in his series of 'Essays on the Literature of Kent's Hole,' published by the Devonshire Association.

Machærodus, since it is not presented by the teeth in the cranium found in the Pleiocene strata of Auvergne by M. Bravard, and admitted by Blainville, Owen, Kaup, and Gaudry, to belong to *Machærodus cultridens*, Kaup. For this reason, therefore, we consider the British *Machærodus latidens*, Owen, to be distinct from the *M. cultridens* of the Continent. The recent discovery of a lower true molar, in the cave of Baume, in the Jura, renders it probable that all the teeth were serrated.

§ 5. *Description.*—The upper canines of Machærodus are characterised by their compression parallel to the median line, and the strongly marked serration of the ridges which traverse the teeth in front and behind, and give it a sharp cutting edge, which Professor Owen describes as uniting the power of a saw with that of a knife.[1] The regular curvature of the crown and fang causes the tooth to present an outline strongly resembling, according to Nesti, the crescent-shaped new moon when first appearing above the horizon. The crown is thicker in front than behind (Pl. XXV, figs. 3, 6), and thus possesses great strength without the penetrating power of the posterior edge being impaired. Altogether the tooth is the most perfect instrument for piercing and dividing flesh which is presented by any of the Carnivora, and doubtless belonged to an animal which lived solely on flesh.

The general shape of the upper canines from Kent's Hole may be gathered from Pl. XXV, which is a copy of the plate drawn by Mrs. Buckland, and lithographed by Mr. Scharf, for the work of the Rev. J. MacEnery, and kindly lent to us for the purpose by Mr. Pengelly, F.R.S. In figs. 1, 2, 3, the perfect crown is represented, which is now preserved in the British Museum, while figs. 4 and 5 represent the perfect fang. The lower canines are proved by the lower jaw of *Machærodus cultridens* discovered by M. Bravard, along with the perfect cranium in the Pleiocene strata of Mont Perrier in Auvergne, to be very much smaller in every dimension.[2]

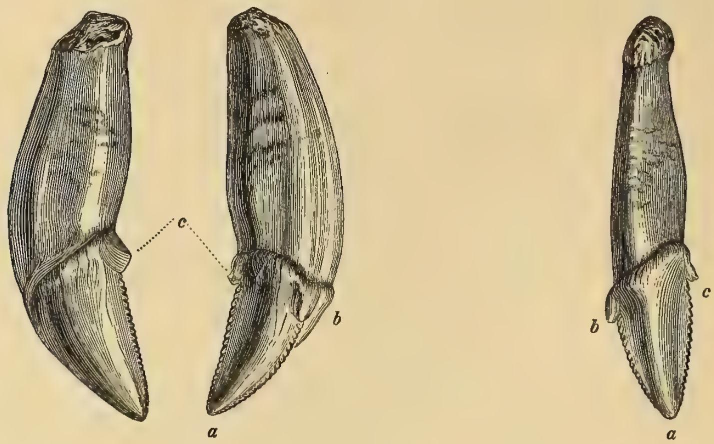
The incisors of *Machærodus latidens* are now only known to have been found in Kent's Hole by three figures of the natural size in a lithograph which is deposited in the Museum of the Natural History Society of Torquay. The accompanying woodcuts have been drawn on wood from a photograph of the original, which has been placed at our disposal through the kindness of the Society, and fig. 1 representing the inner aspect of the left upper incisor, 3 is that which has been copied by Professor Owen. The anterior and posterior ridges traversing the crown *a* are serrated, as in the canines, and at the base of each there is a well-defined cusp, *b* and *c*, both of which points are unknown in the incisors of any of the living Carnivores. The incisors of the left lower mandible reproduced the peculiar characters of the corresponding upper tooth, the serration being well

[1] 'Foss. Mam.,' p. 180.

[2] M. Bravard's 'Monographie,' pl. iii. Blainville, 'Ostéographie,' Article Felis, pl. 17.

marked, and the cusps *b* and *c* clearly defined. The crown of both these teeth are considerably larger than those of any living or fossil species of the Felidæ, and are of an eminently sectorial character.[1]

Fig. 1. Fig. 2. Fig. 3.



There is not the slightest evidence that the Machærodus was more closely allied to the Tiger than to any of the other larger Felines, and therefore the very tempting name of "Sabre-toothed Tiger" must be given up, as implying a relationship which does not exist.

The size of the teeth may be gathered from the following measurements in inches:

	Length of crown.	Basal width of crown.	Length of fang.
Pl. XXV, fig. 1. Brit. Mus.	2·4	1·2	...
„ „ 4. Geol. Soc.	...	1·18	3·2
„ „ 7. Sir W. Trevelyan	...	1·3	3·5
Coll. Surgeons	2·7?	1·2	3·3
Oxford Mus.	...	...	...

§ 6. *Evidence that Machærodus latidens was derived from Kent's Hole.*—There can be no reasonable doubt as to these remarkable remains having been derived from Kent's Hole, and not from the Continent, since the animal to which they belong differs specifically from the Continental Pleiocene species. The MSS. also of the Rev. J. MacEnery point out the precise circumstances under which they were found:[2]

[1] Gervais, 'Zool. et Paléont. Française,' 1859, p. 231.

[2] See Mr. Pengelly's admirable series of "Essays on the Literature of Kent's Cavern." McEnery's MSS., 'Trans. Devonshire Ass.,' 1869, pp. 55-6.

"We now returned," he writes, "to the excavation (in the 'Wolf's Passage'), which produced the Wolf's head. The stalagmite was about a foot and a half thick, and of excessive hardness, in which were imbedded rocky fragments rolled down the slope; but as we advanced inwards, the stalagmite became altogether free from foreign admixture and moulded itself upon the mass of bones. Of the quantity and condition of the remains here it is scarcely possible to give a just idea without appearing to exaggerate. They were so thickly packed together that to avoid injuring them we were obliged to lay aside the picks and to grub them out with our fingers. They had suffered considerably from pressure after having first undergone violence from the force which impelled and congregated them in this narrow neck. They were found driven into the interstices of the opposite wall, or piled in the greatest confusion against its side, with but a scanty covering of soil, and that of the finest and softest sand intermixed with greasy earth. To enumerate the amount of fossils collected from this spot would be to give the inventory of half my collection, comprising all the genera and their species including the *cultridens*, there were hoards; but I must specify the jaws and tusks of the Elephant, with the teeth in the sockets, and the bone of which was so bruised, that it fell to powder in our endeavour to extract it, a rare instance of the teeth occurring in their jaws or gums. The same may be observed of the jaws of the Rhinoceros, one portion alone of which was saved, but the teeth of both were numerous and entire. The teeth of the Elk, Horse, Hyæna, were taken out whole; the teeth of the two last were gathered in thousands, and in the midst of all were myriads of Rodentia. The earth, as may be expected, was saturated with animal matter; it was, to use the expressive words of my fellow-labourer Walsh, fat with the marrow and sinews of more wild beasts than would have peopled all the menageries in the world."

§ 7. *Continental Range of Species.*—Such as this is the evidence of the sojourn of the formidable *Machærodus latidens* in the Cave of Kent's Hole. The proof that the species lived also on the Continent of Europe is due to the discovery of an upper incisor in every respect identical with figs. 1, 2, in a deposit near Puy, in Auvergne, by M. Aymard, which is doubtfully considered "diluvium" by M. Gervais,[1] and most probably belongs to the Upper Pleiocene, or the passage beds between the Pleiocene and Pleistocene formations. M. Gervais[2] has also recently determined the existence of the same species in the Cavern of Baume, which M. Lartet considers to be of preglacial age,[4] in the Jura, associated with horse, ox, wild boar, elephant, and a non-tichorhine species of rhinoceros, the cave bear, and the cave hyæna.[3] The two teeth of Machærodus are a lower canine (? upper incisor), and a portion of the lower sectorial, both of which have serrated edges. The serration in

[1] 'Zool. et Paléont. Françaises,' 1859, p. 231.

[2] Gervais, 'Animaux vertébrés vivants et fossiles,' 4to, 1867-9, p. 78, pl. xviii, 3, *3a*, *3b*.

[3] 'Congrès Internationale d'Anthropologie et d'Archeologie Prehistoriques,' Paris volume, p. 269.

[4] M. Lartet considers the rhinoceros to be non-tichorhine.

the latter, as well as in the canine (incisor ?), renders it probable that all the teeth of this species were serrated.

§ 8. *Antiquity in Kent's Hole.*—We have now to consider the very difficult question as to the relative antiquity of the *Machærodus latidens* in Great Britain. Is it Pleiocene or is it Pleistocene? Was it a contemporary of the woolly Mammoth and Reindeer, or had it disappeared before the lowering of the temperature in the Glacial period? Unfortunately the peculiar physical conditions under which Kent's Hole has been filled with its present contents forbids an answer which is absolutely decisive. In the present cave-earth, and underneath the stalagmite which now constitutes the floor, are large masses of breccia and of stalagmite, which evidently had formed a floor that had been broken up before the introduction of the cave-earth. They are remarkable for their hard crystalline structure, and in one or two cases they have yielded fragments of very dense mineralized bones. In a portion of the cave, called the gallery, there is evidence of the undisturbed portion of the crust in a "ceiling" or uppermost floor, that extended from wall to wall, "without further support than that afforded by its own cohesion. Above it there is, in the limestone rock, a considerable alcove. This branch of the cavern, therefore, is divided into three stories or flats; that below the floor occupied with cave-earth, that between the floor and ceiling entirely unoccupied, and that above the ceiling also without a deposit of any kind." For a ceiling of this kind to have been formed it is absolutely necessary for the cave to have been filled up to its level with materials of some kind. It would, indeed, be as impossible for a solid calcareous sheet to be formed in mid-air as it would be for a sheet of ice to be formed without resting on water. From some cause or other this ancient stalagmite has been in part broken up, and the materials by which it has been supported have disappeared; and that it was deposited on cave-earth, like that now occupying the lowest story, is shown by its red colour. Prior, however, to its formation, animals dwelt in the cave, since bones are imbedded in the large fallen masses of stalagmitic breccia. Moreover, there is reason to believe that certain fragments of bone and splinters of teeth, remarkable for their mineralization, that have been found in the earth now occupying the cavern, were derived from this more ancient deposit, for they differ essentially from the remains with which they are now associated, being heavier and of a more crystalline structure. Some splinters have assumed the fracture of greensand-chert. So hard, indeed, was one of the canines of Bear that it has been splintered by the hand of man into the form of a flint-flake, and has evidently been used for a cutting purpose. Its fracture proves that it was mineralized before it was splintered; and as it was found in the present cave-earth, it must have been fashioned while the cave was being inhabited by palæolithic man, prior to the accumulation of the earth. For these reasons, the evidence in favour of these denser remains having belonged to the deposit which once supported the ancient floor seems to us incontrovertible.

To which, then, of these two periods of accumulation of cave-earth in Kent's Hole can the Machærodus be referred? Was it living at the time of the older deposit, and did it become extinct before the newer had been formed? It is impossible to give a distinct answer to these questions; but a careful examination of all the circumstances tends to the belief that the older period was that to which the Machærodus belongs. Since it is a species which differs but slightly from the *M. cultridens*, and belonging to a genus which inhabited Europe in the Meiocene and Pleiocene ages, its affinities are undoubtedly Pleiocene, and it belongs to a group of animals that inhabited Europe before the lowering of the temperature brought about the invasion of the Arctic Mammalia from the north and the east. On the other hand, in the teeth-marks on the incisors figured, as well as on the canines, we recognise the unmistakable traces that the animal to which they belonged fell a prey to the Hyena;[1] and since the Pleistocene *Hyæna crocuta* (var. *spelæa*) is abundant in the cave, to its teeth the marks in question may probably be referred. It seems, therefore, to us, to be almost certain that the animal inhabited Devonshire during an early stage of the Pleistocene, and most probably before the Arctic invaders had taken full possession of the valley of the English Channel, and of the low grounds which now lie within the hundred-fathom line along the Atlantic shore of western France. Along a great, fertile, low-lying region, which then was offered by what is now the bed of the sea, there must necessarily have been a swinging to and fro of animal life; and before the temperature of France had been sufficiently lowered to exterminate or drive out the southern forms, it is most natural to suppose that in warm seasons some of the southern Mammalia would find their way northwards, and especially a formidable Carnivore such as the Machærodus. The extreme rarity of its remains forbids the hypothesis that it was a regular inhabitant of Britain during the Pleistocene age. It seems, therefore, to us that it belongs to the earliest stage in the complicated history of the deposits in Kent's Hole, and that it probably became extinct before the great majority of Pleistocene caves in Great Britain had been filled with their present contents.

This view of the extreme antiquity of Machærodus in Kent's Hole is materially strengthened by an animal which has been determined by Professor Busk among the Mammalia from the fissures of Oreston, near Plymouth. The Rhinoceros from that cave, considered by Professor Owen to belong to the tichorhine species, so common in the Pleistocene period, turns out to belong to the megarhine, which is a well-known Pleiocene species. In that case, also, it is evident that the Southern forms of life still lingered on the British side of the valley of the English Channel, while the Pleistocene Mammalia were the normal dwellers in the British caves.

Both these animals, therefore, may be taken to indicate an early stage in the Pleisto-

[1] The Rev. J. MacEnery made the same remarks on the gnawed condition of the canines. MSS., op. cit.

cene period, and both, most probably, may be referred back to a time before the maximum point of cold was reached, in the Glacial period.

§ 9. *Machærodus from Norfolk.*—A small fragment of a right upper canine, in the collection of Mr. Jervis, probably from the Forest bed of Cromer, has been identified, by Mr. E. R. Lankester[1] with the Machærodus. It consists of a portion of the crown, with the serrated edges very well marked. It is too small a fragment to enable any conclusion to be drawn as to the species. It shows, however, that the genus was living in the Eastern Counties at a still earlier period than that indicated by the remains in Kent's Hole.

[1] 'Geol, Mag.,' 1869, vol. vi, p. 440.

CHAPTER XXIII.

CONCLUSION.

We have now described all the members of the family of the Felidæ which have been proved to have lived in Britain. Out of the six species we have been able to add two to the catalogue of British animals—the Panther or Leopard, and the *Felis Caffer*—and the latter of these has been hitherto unknown in Europe.

Our investigations into the osteology of the living Lion and the *Felis spelæa* have resulted in the identification of the fossil with the living animal, and the probable extension of its range into North America. We have also brought forward the very curious historical evidence as to its retreat from Europe some two hundred years before the Christian era.

The Lynx, and the Leopard or Panther, and the *Felis catus* and *Felis Caffer*, living during the Pleistocene age, have also been shown to be specifically identical with the living forms.

The *Machærodus latidens*, an aberrant member of the Felidæ, is the only Pleistocene member that has become extinct. And since it is specifically distinct from the Pleistocene and Meiocene *M. cultridens* by the serration of its incisors, it is very probably a form that characterises an early phase of the Pleistocene period, a modification of the Pleiocene type that lived on into the succeeding geological age.

In the following table we have given the range and distribution of the British Fossil Felidæ:

List of Species.	Britain.				European Continent.				North America.
	Pleiocene.	Pleistocene.	Prehistoric.	Historic.	Pleiocene.	Pleistocene.	Prehistoric.	Historic.	
Felis leo (*spelæa*), L.	...	×	...	...	...	×	×	×	×
F. lynx, L.	...	×	...	...	...	×	×	×	...
F. pardus, L.	?	×	...	...	...	×	...	...	...
F. Caffer, Desm.	...	×	...	...	×	×	...	...	...
F. catus, L.	...	×	×	×	..	×	×	×	...
Machærodus latidens, Ow.	...	×	...	...	...	×	...	...	...

The presence of the Lion in Europe in Prehistoric times is rendered necessary from the fact that it is both Pleistocene and Historic, although it has not been discovered in any Prehistoric deposit.

It may be that in the long interval which elapsed between the Pleistocene and the succeeding age, it had retreated from Northern and Central Europe, partly from the competition with man, and partly from the operation of the same obscure causes which banished the Spotted Hyæna and the Hippopotamus to Africa.

It will be seen from the above table that the Wild Cat is the only British feline which still lives, and the time is not far distant when it will become extinct in our island.

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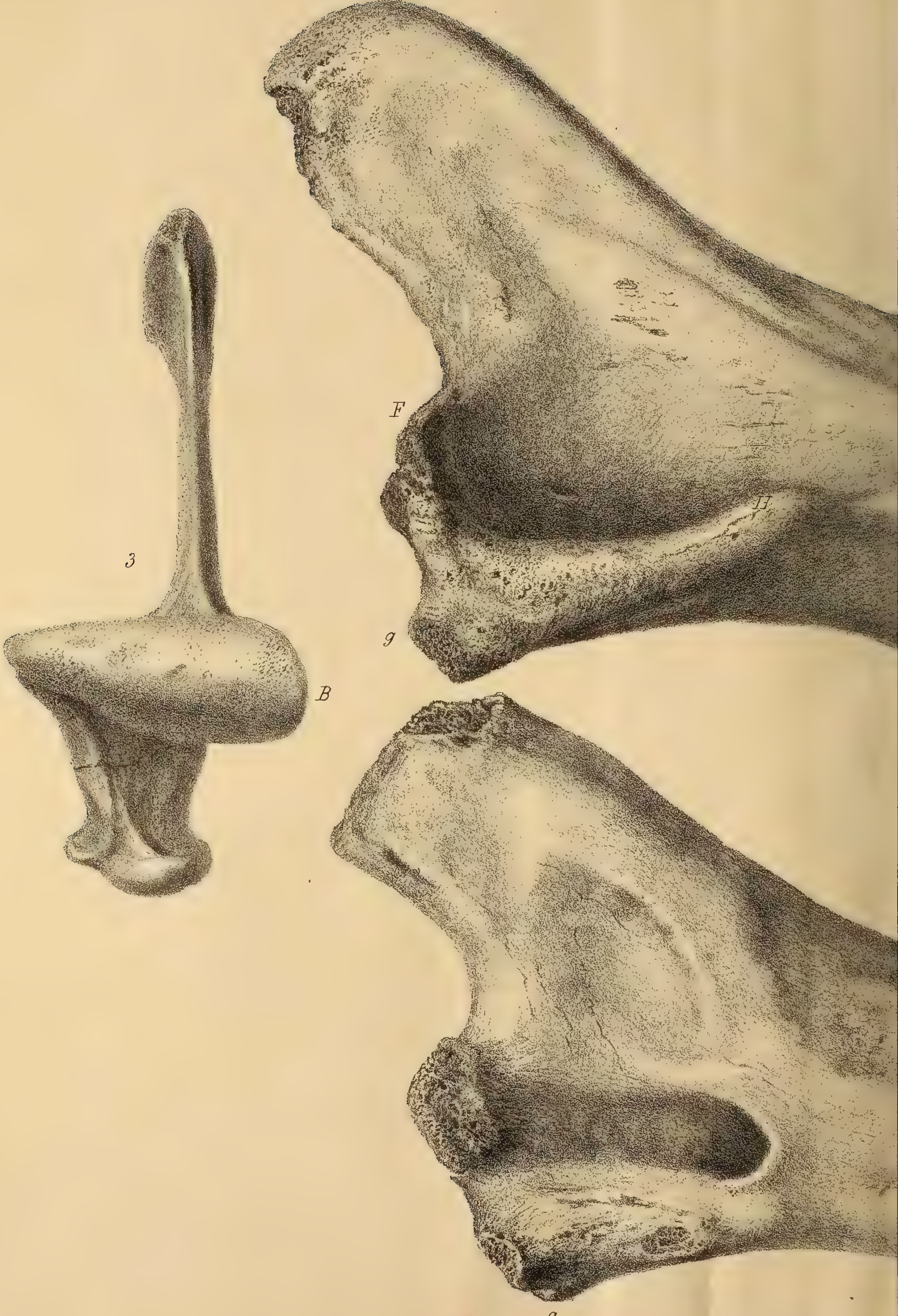
PLATE I.

Felis spelæa, Goldfuss.

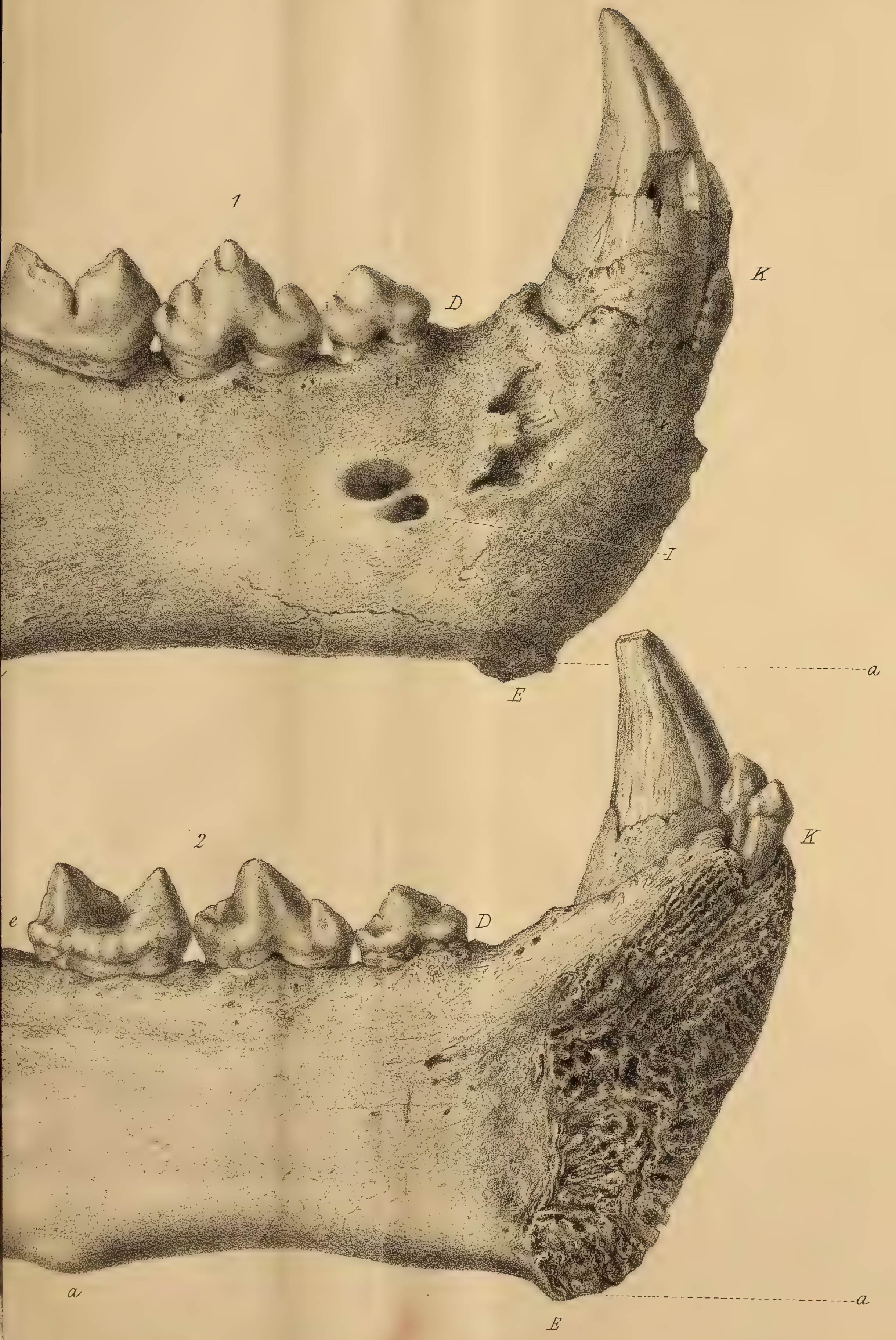
(Natural size.)

Fig.

1. Lower jaw, external aspect. } These are from Bleadon Cavern, and form part of the
2. Lower jaw, internal aspect. } Collection of Mr. Beard in the Taunton Museum.
3. Lower jaw, posterior aspect, showing condyle, coronoid process, and angle. From the Brickearth of Crayford. In the possession of Dr. Spurrell.



W.A.S. del. J. Dinkel lith.



W.West imp.

W.A.S del. J Dinkel lith

W.West imp.

Lower Jaw.

PLATE II.

Felis spelæa.

FOREARM.

(Half natural size.)

Fig.

1. Radius. Sandford Hill Cavern. Mr. Beard's Collection in Taunton Museum. FS. S. H. B. 1.
2. Radius, proximal articulation of fig. 1.
3. Radius, distal articulation of fig. 1.
4. Radius, small form. Bleadon Cavern. Mr. Beard's Collection at Taunton. Bl. B. FS(L). 1.
5. Ulna, largest specimen known to authors (proximal half). Bleadon Cavern. Mr. Beard's Collection at Taunton. Bl. B. U. FS. 1.
6. Ulna, external view of fig. 5.
7. Ulna, internal view of fig. 5.
8. Ulna, proximal end. Sandford Hill. Belongs to same individual as the radius, fig. 1. FS. U. 1. S.H.B. Taunton. Mr. Beard's Collection.
9. Ulna, small form, external view. From Wokey Hyæna-Den. Mr. Boyd Dawkins's Collection.

½ nat. size.

W. Bidgood del. J. Dinkel lith.

W. West imp.

PLATE III.

Felis spelæa.

OS INNOMINATUM.

(Two thirds of natural size.)

Fig.

1. Os innominatum of *Felis spelæa.* Brick-earth, Slades Green, Crayford. British Museum.

2. Os innominatum of *Felis tigris.* India. In British Museum.

3/4 nat. size.

J. Dinkel del et lith

W. West imp.

PLATE IV.

Felis spelæa.

LEFT TARSUS.

(Natural size.)

Fig.

1. Astragalus.
2. Calcaneum.
3. Naviculare, reversed from right paw.
4. Cuboid.

4′. Cuboid, internal aspect.

4″. Cuboid, distal or metatarsal aspect.

5. Ecto-cuneiform, reversed from right paw.

5′. Ecto-cuneiform, internal aspect, right paw.

5″. Ecto-cuneiform, internal aspect. Lion.

5‴. Ecto-cuneiform, internal aspect. Tiger.

6. Meso-cuneiform.
7. Endo-cuneiform.

Figs. 1, 2, 3, 4, 5, 6, 7, show the front or superior aspect of these bones; all those of *Felis spelæa* are from Bleadon Cavern, and formed part of the Collection of Mr. Beard, now in the Taunton Museum.

W.A.S. del. J.Dinkel lith.

W West imp.

PLATE V.

Felis spelæa.

RIGHT HIND PAW.

(Natural size.)

FIG.

1. Metatarsal 1. Bleadon Cavern.
2. Metatarsal 2.
3. Metatarsal 3.
4. Metatarsal 4.
5. Metatarsal 5.

} From Sandford Hill Cavern. These have the appearance of having all belonged to the same individual. Metatarsal 3 is reversed from a left paw.

6.
7.
8.
9.

} First phalanges. From Bleadon Cavern.

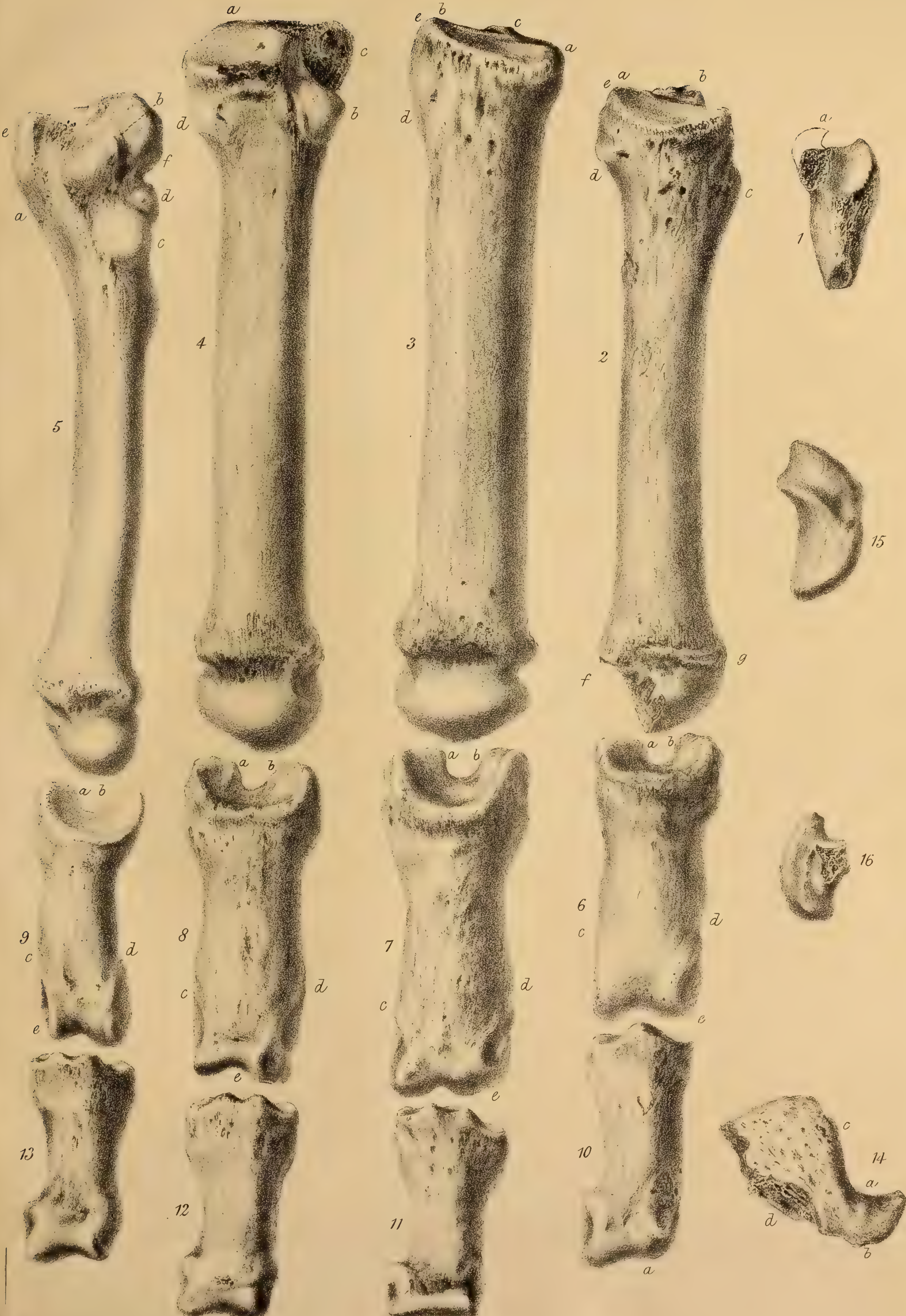
10.
11.
12.
13.

} Second phalanges. From Bleadon Cavern.

14. Third phalange, probably of the fifth toe. From Bleadon Cavern.

15.
16.

} Sesamoids. From Bleadon Cavern.



S del. J. Dinkel lith. W West imp.

PLATE VI.

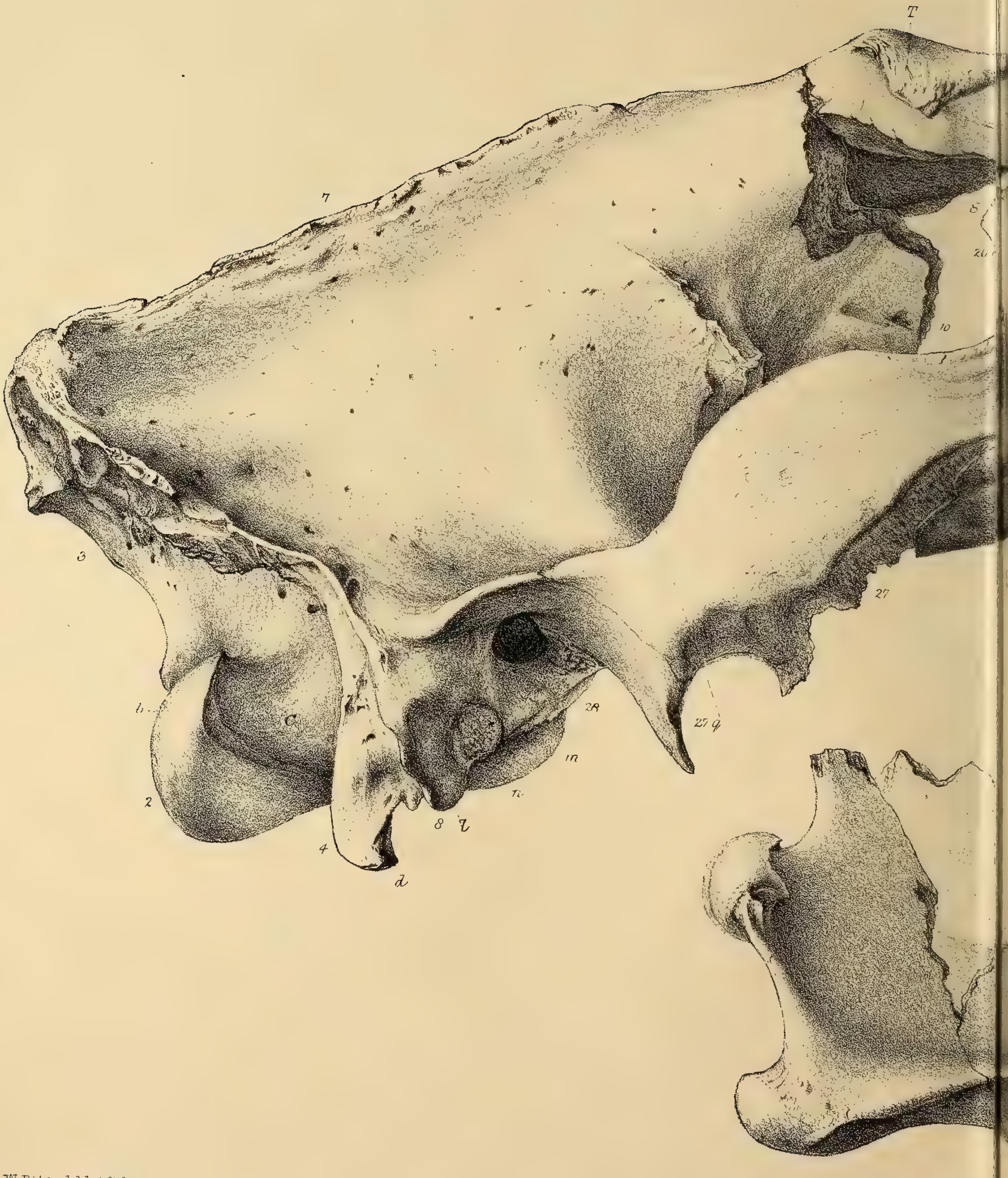
Felis spelæa, Goldfuss.

(Skull: small form: lateral aspect.)

The skull belonged to Mr. Williams; the jaws to Mr. Beard.

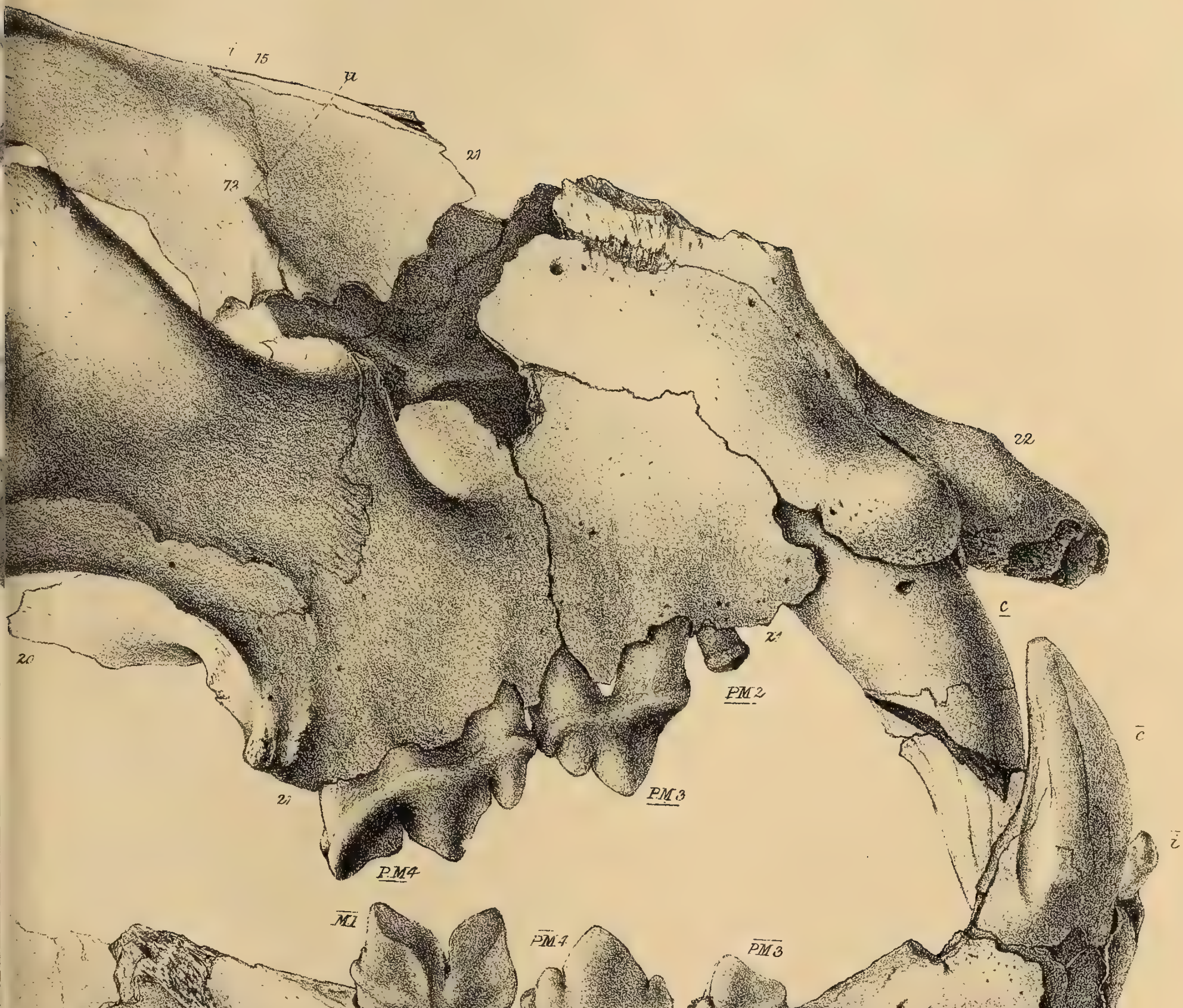
From either Sandford Hill or Hutton Caves in the Mendip. Now in the Taunton Museum.

FELIS



W. Bidgood del. et. lith.

S K

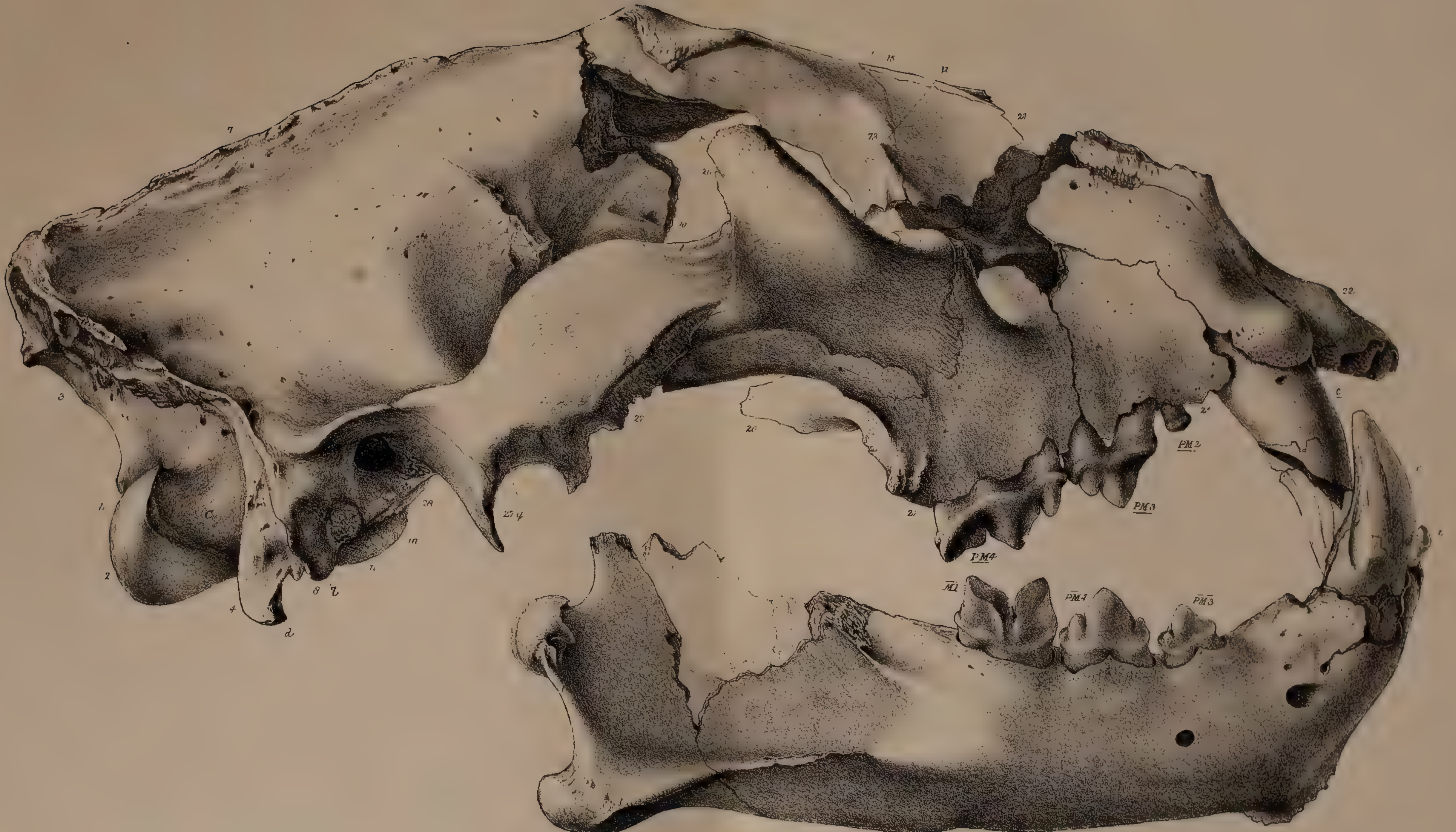


L

W. West imp.

FELIS SPELÆA

PLATE VI.



W Bidgood del. et lith

W West imp

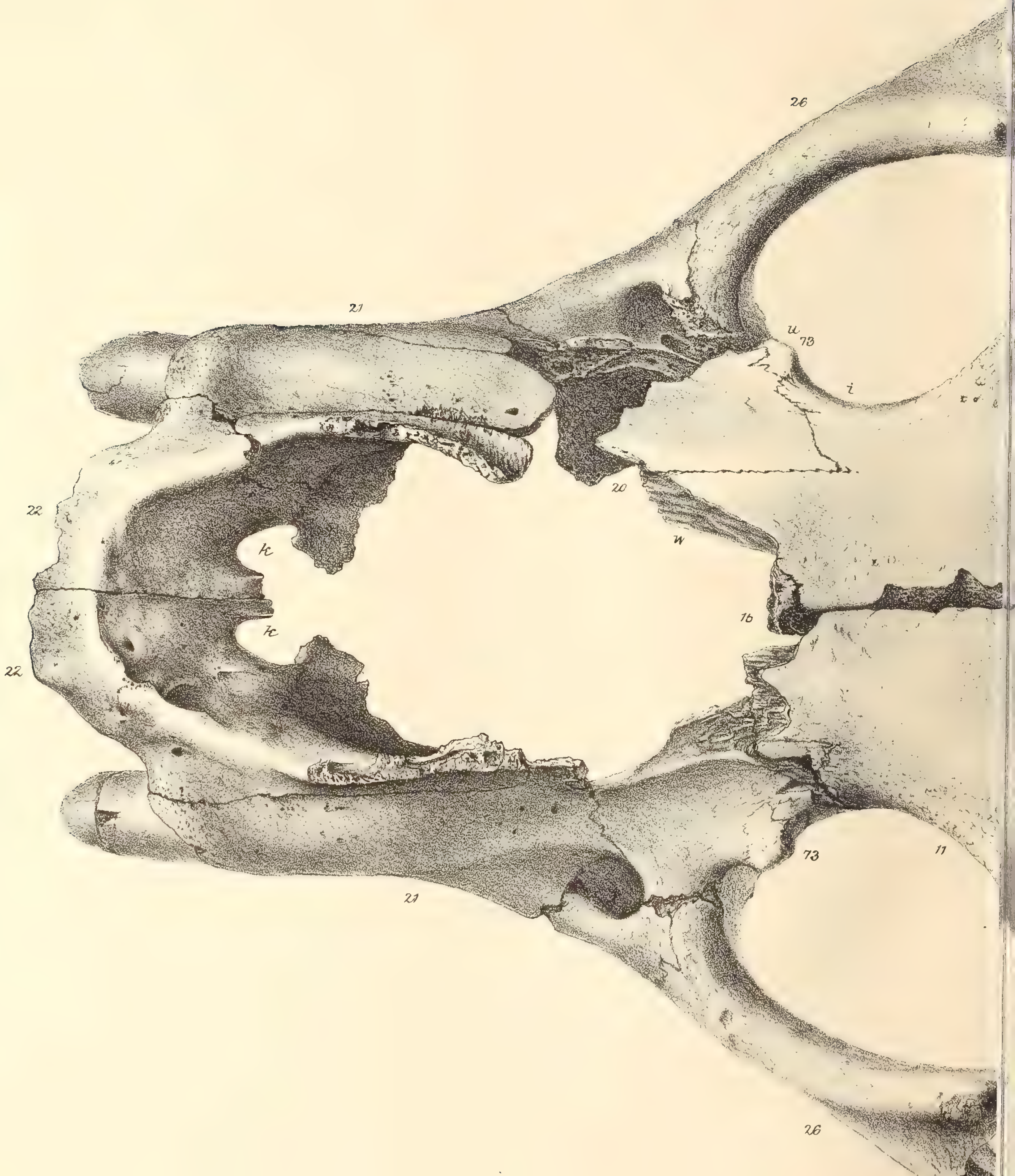
SKULL

PLATE VII.

Felis spelæa, Goldfuss.

Skull: small form: natural size.)

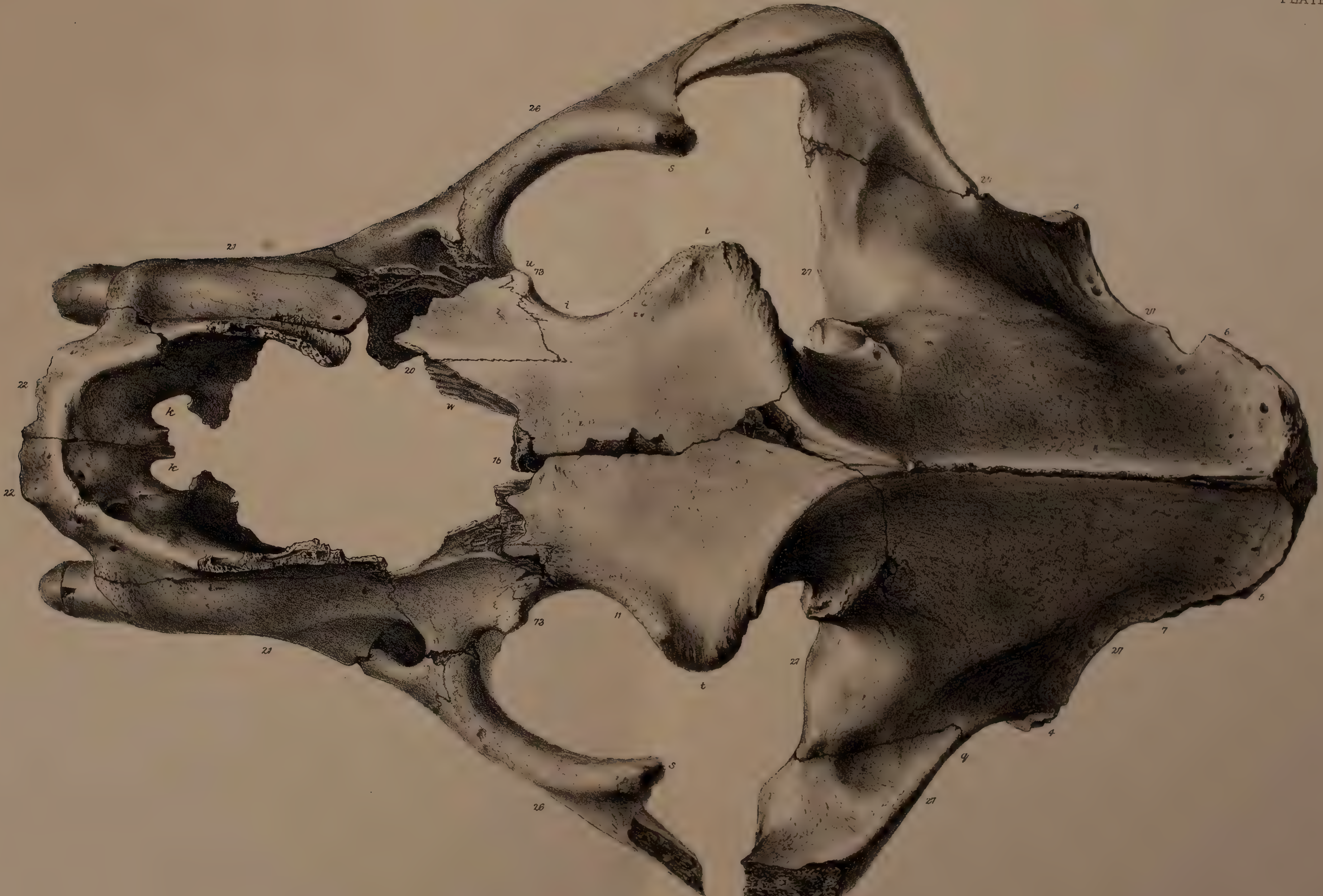
Skull: the same as in Plate VI; inferior or palatal aspect, showing the dentition.



W. Bidgood, del. et lith

W. West imp

KULL



W Bidgood, del. et lith

W West imp

SKULL.

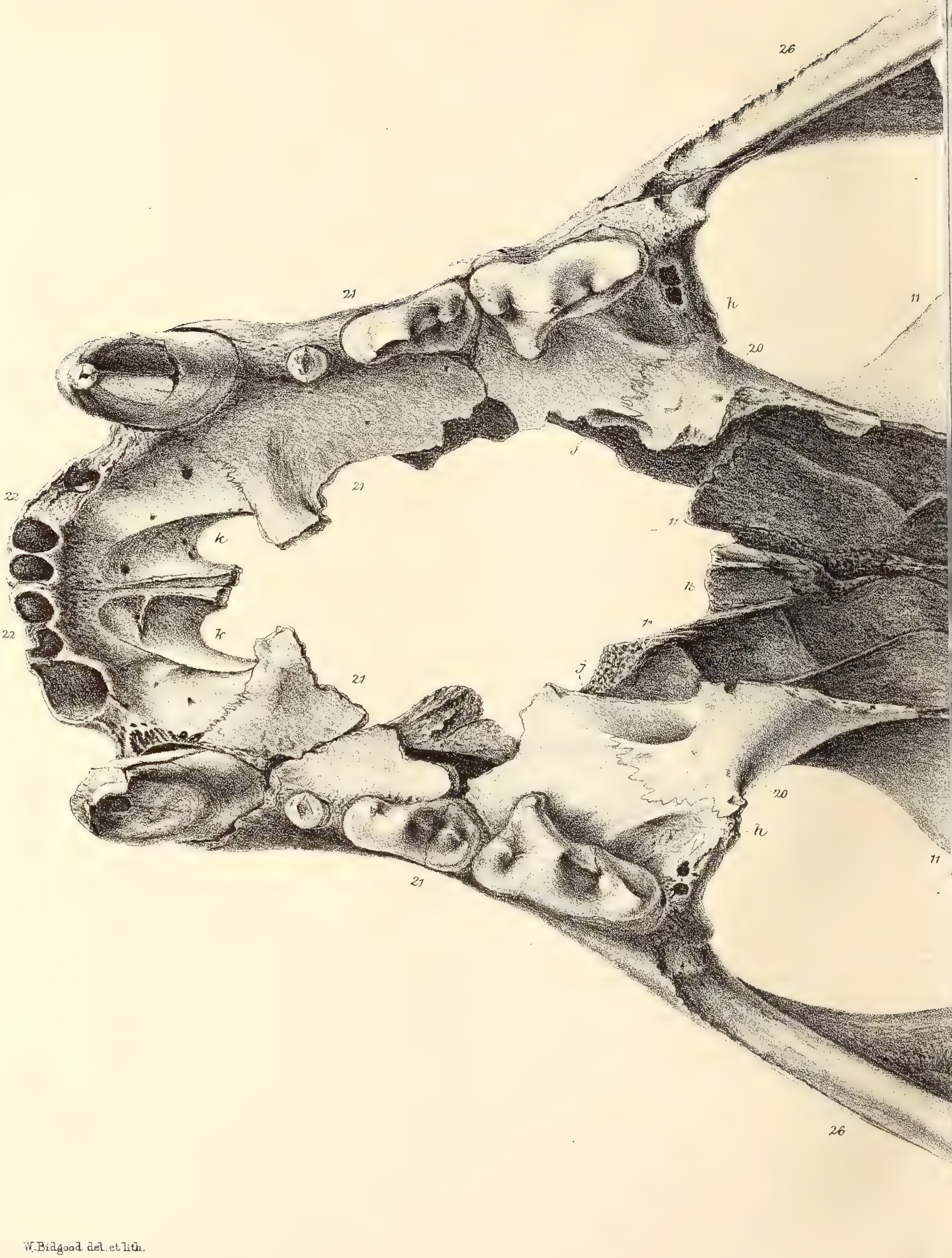
PLATE VIII.

Felis spelæa, Goldfuss.

(Skull: small form: natural size.)

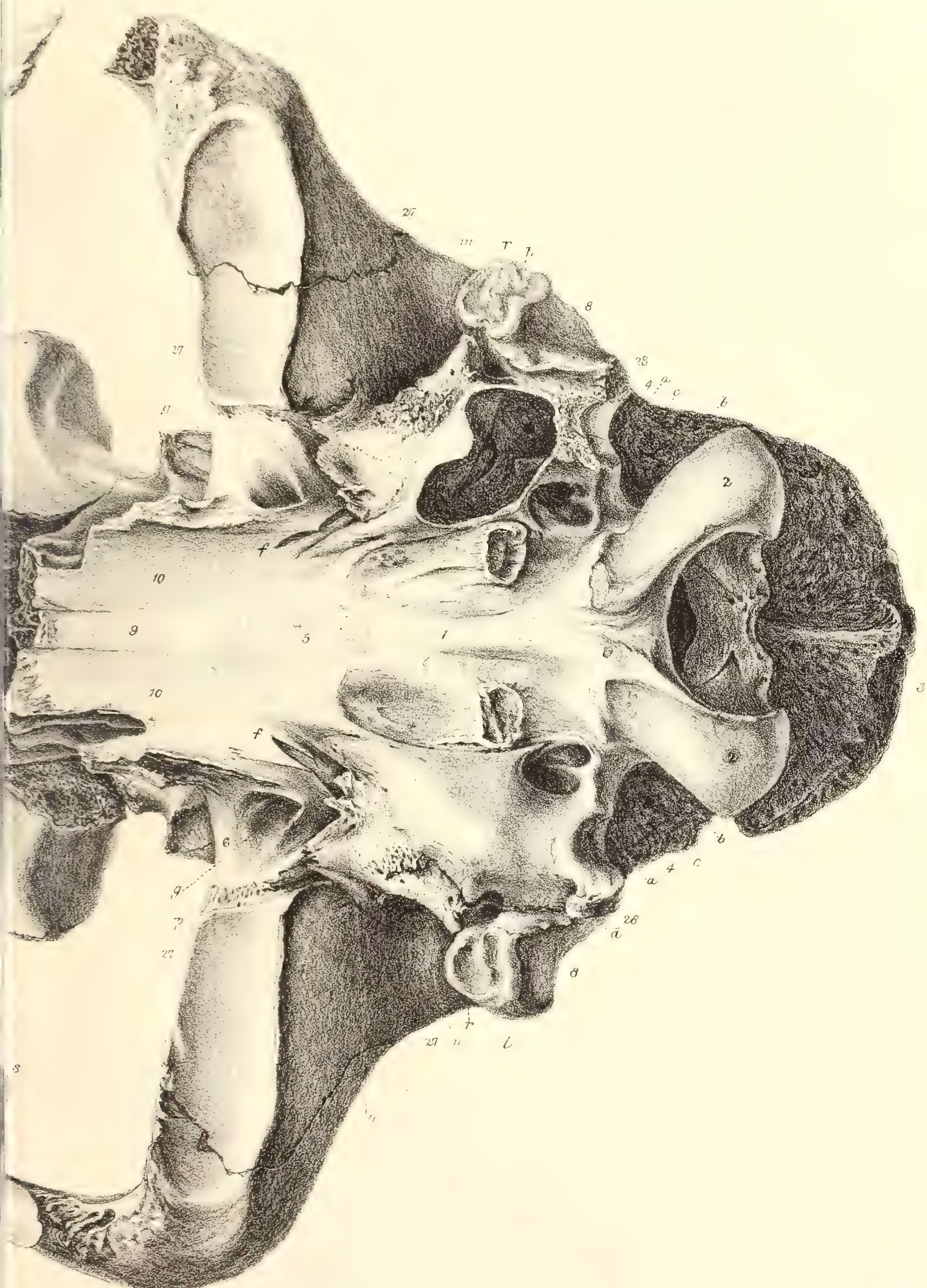
Skull: the same as in Plate VI; upper or frontal aspect.

N.B.—The reference to Plate VIII, with regard to Dr. Spurrel's metatarsals, in page 22, must be transferred to Plate XXIII.



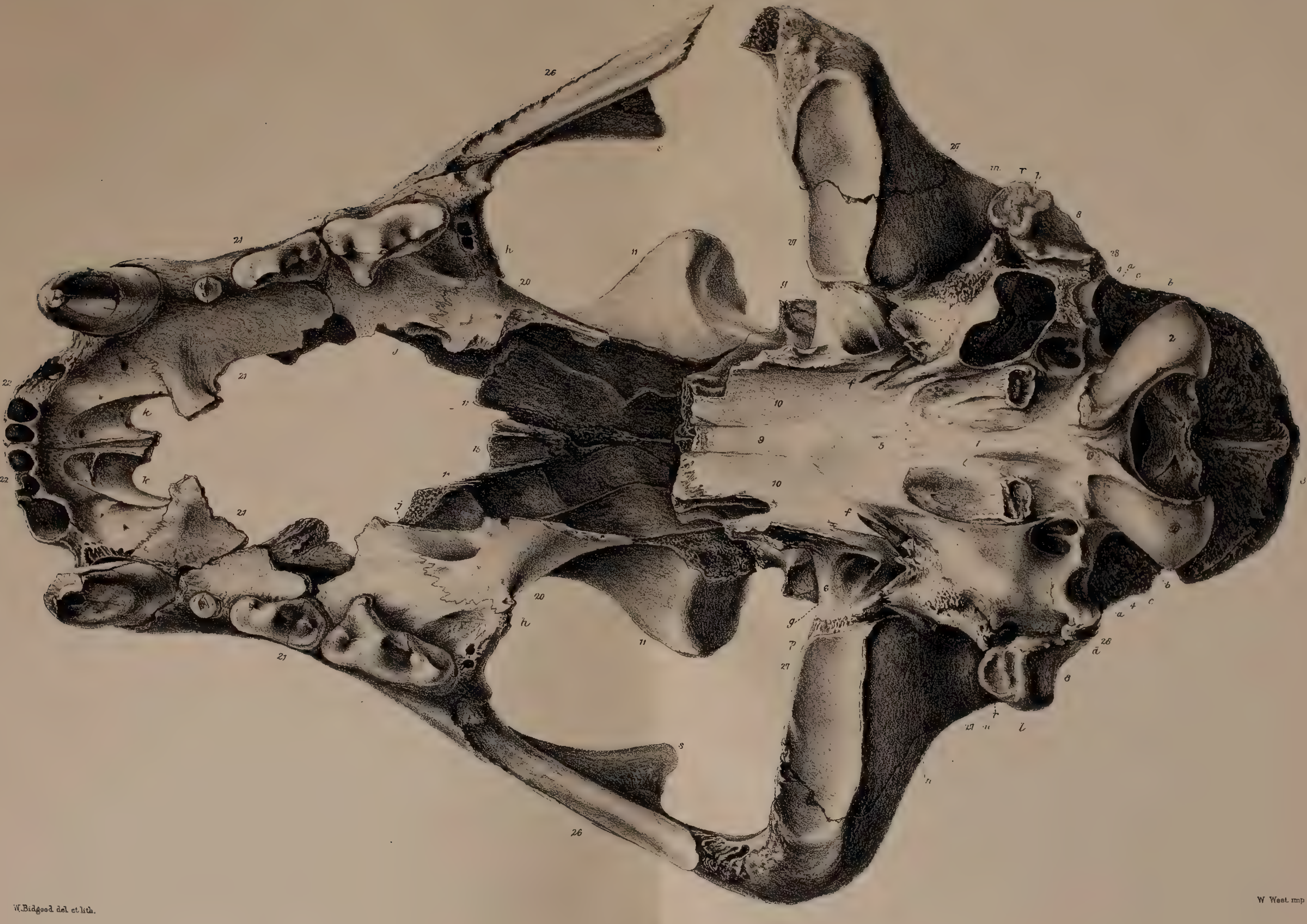
W. Bidgood del. et lith.

S



W West imp

U L L.



W. Bidgood del. et lith.

W. West imp.

SKULL.

PLATE IX.

Felis spelæa, Goldfuss.

(Skull : small form : natural size.)

Fig.

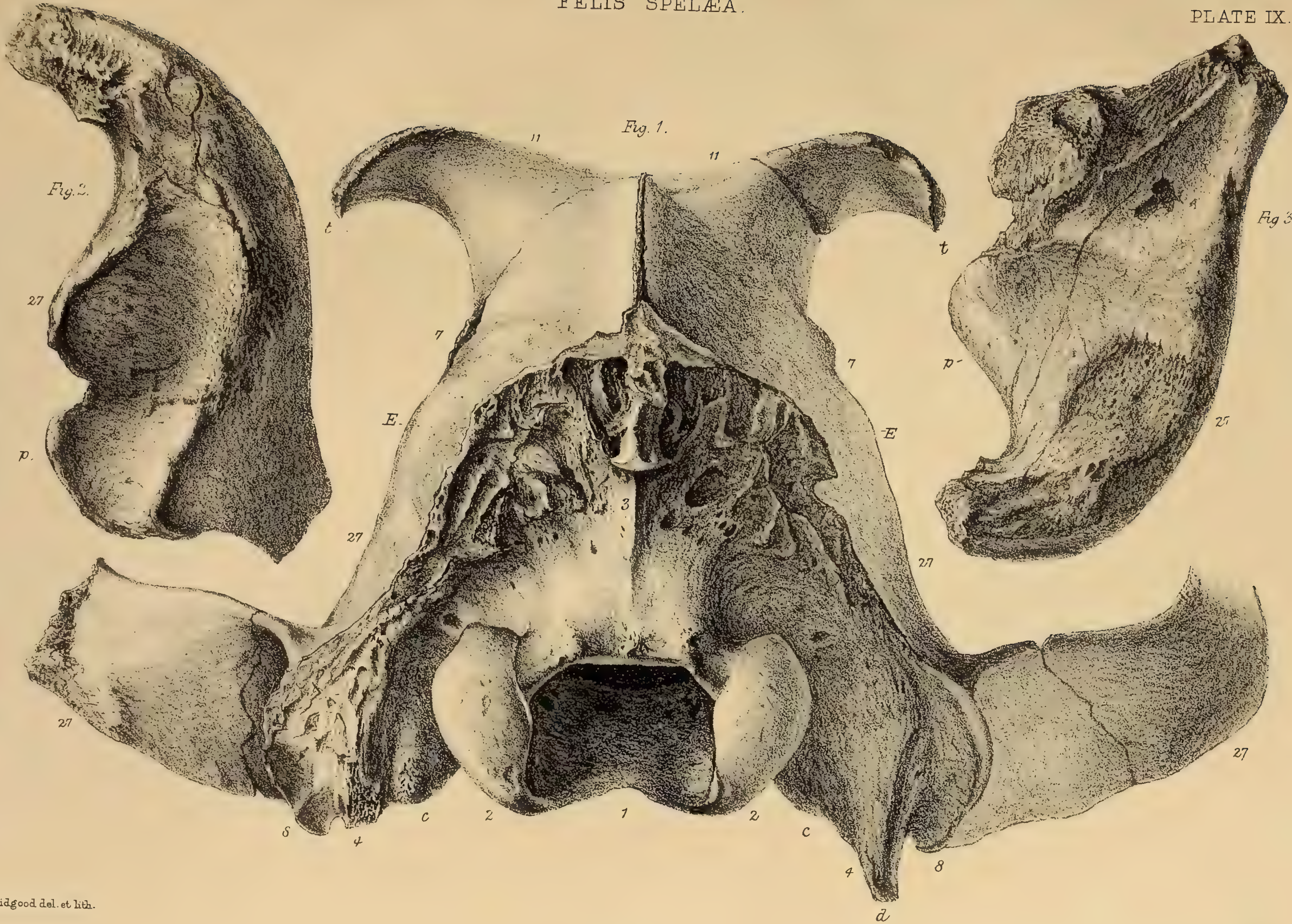
1. Skull : the same as in Plate VI ; occipital or basal aspect.

2. Articular portion of the squamosal of a very large skull ; inferior or glenoid aspect. From Bleadon Cave. Mr. Beard's Collection, Taunton Museum.

3. Upper aspect of the same specimen.

FELIS SPELÆA.

PLATE IX.



W. Bidgood del. et lith.

SKULL.

W. West imp.

PLATE X.

Felis spelæa, Goldfuss.

SKULL : LARGE FORM.

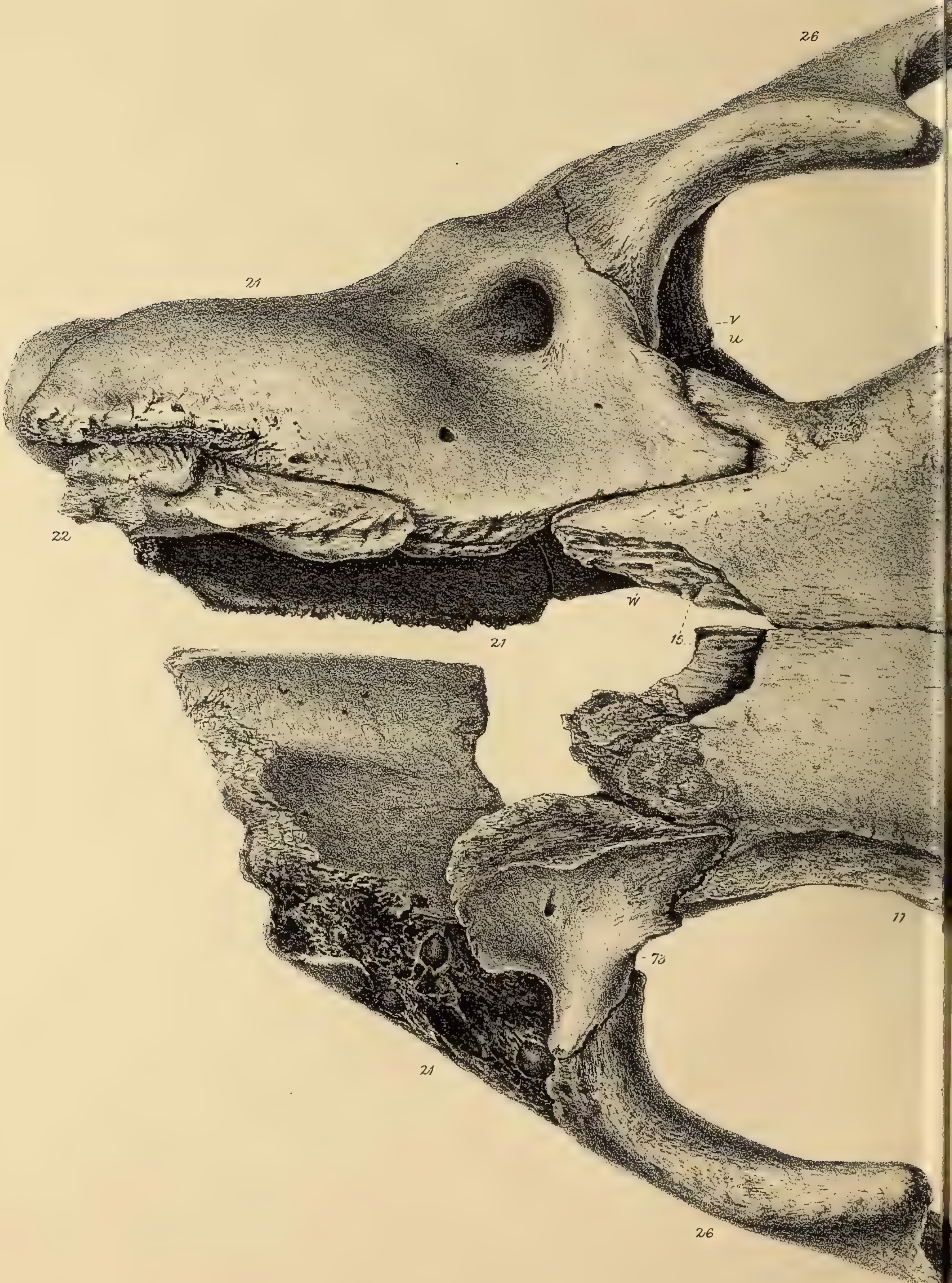
(Natural size.)

FIG.

1. Skull; upper or frontal aspect: large form. To this skull belong the lower jaws figured in Pl. I, unfortunately described by us in the first chapter as having been found in the Bleadon Cave. The whole were found together in Sandford Hill Cave by Mr. Beard, and are in the Taunton Museum.

2. Upper aspect of malleus from the above skull.

3. Lower aspect of malleus from the above skull.



W. A. Sanford. del. W Bidgood lith.

PLATE X.

Fig. 2 Fig. 3

L L

W. West imp.

FELIS SPELÆA

PLATE X.

W. A. Sanford del. W. Bidgood lith

W. West imp

SKULL.

PLATE XI.

Felis spelæa, Goldfuss.

UPPER PERMANENT DENTITION.

(Natural size.)

FIG.

1. Maxillaries and intermaxillaries of very large animal, showing the whole of the dentition, except the first right incisor, the second premolars, and both true molars. The tips of the canines are slightly restored. From Sandford Hill Cave. Mr. Beard's Collection, Taunton Museum.

2, 2′. First right incisor, outer lateral and posterior or palatal aspects.

3, 3′. Second right incisor, inner lateral and posterior or palatal aspects. These two teeth are from Raven's Cliff Cave, Gower. Col. Wood's Collection.

4, 4′, 4″. Third right incisor, outer lateral, coronal, and inner lateral aspects. Bleadon Cave, Mr. Beard's Collection, Taunton Museum.

5. Right canine, outer lateral aspect, very perfect specimen of average size of large form. Raven's Cliff Cave, Gower. Col. Wood's Collection.

6. Left canine, inner lateral aspect. Wookey Hyæna-den. Dr. Boyd: Taunton Museum.

7. Right canine, outer lateral aspect. This belongs to the same animal as fig. 11. Williams's Collection, Taunton.

8, 8′. Coronal and outer lateral aspects of left second premolar, large form. Bleadon Cave. Mr. Beard's Collection, Taunton Museum. The small form is shown in figures of skull in Pls. VI and VII.

9. Third premolar, outer lateral aspect, right side, largest known to authors. Wookey Hyæna-den. In possession of Mr. Boyd Dawkins.

10. Third left premolar, inner lateral aspect, average size of large form. Bleadon Cave. Mr. Beard's Collection, Taunton Museum.

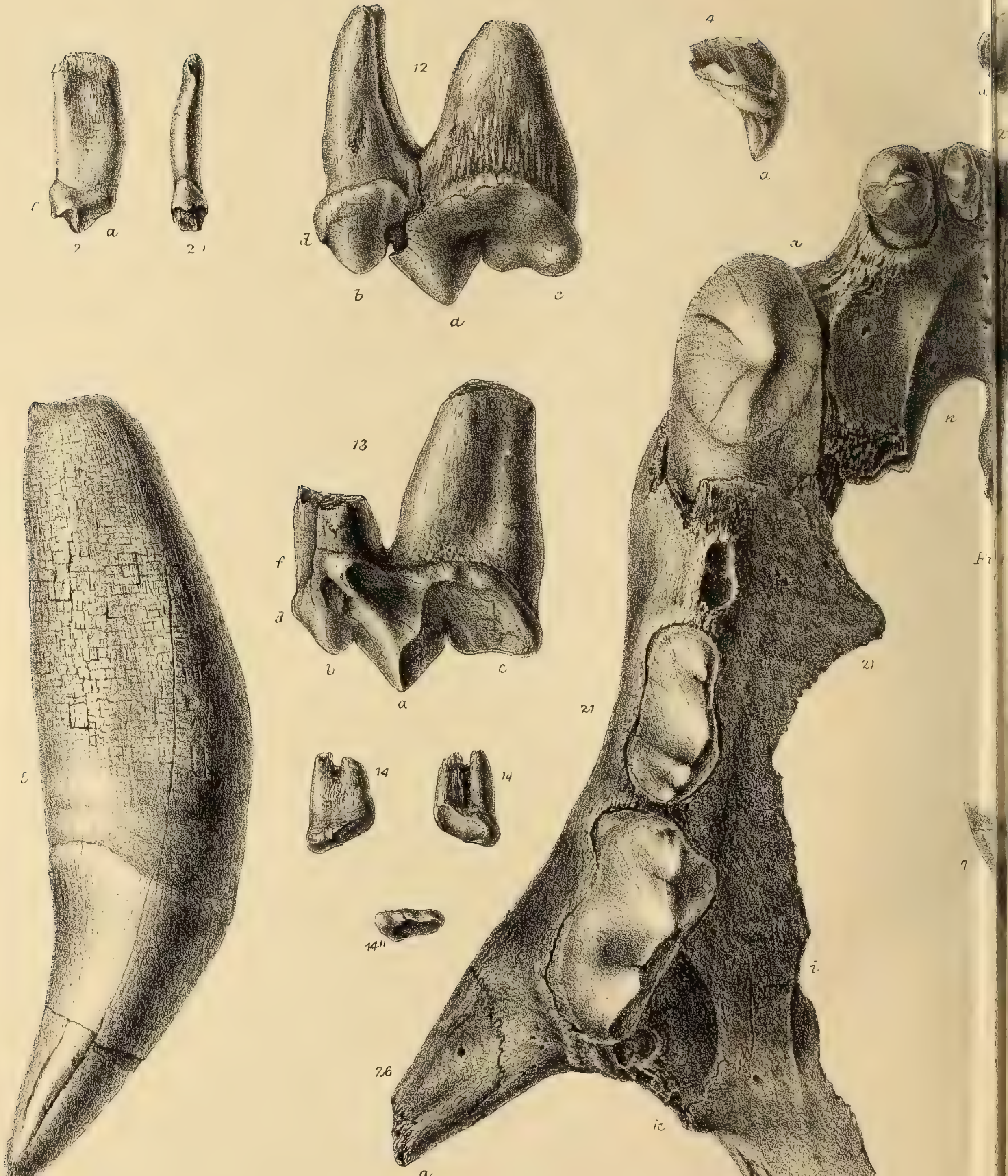
11. Third right premolar, inner lateral aspect, smallest known to authors. Probably from Bleadon. Mr. Williams's Collection, Taunton Museum.

12. Fourth right premolar, outer lateral aspect, largest known to authors. Probably from Bleadon. Mr. Williams's Collection, Taunton Museum.

13. Fourth left premolar, inner lateral aspect, average size of large form. Probably from Bleadon. Mr. Williams's Collection, Taunton Museum.

14, 14′, 14″. Posterior or outer anterior or inner and coronal aspects of the true molar. Bleadon Cave. Mr. Beard's Collection, Taunton Museum.

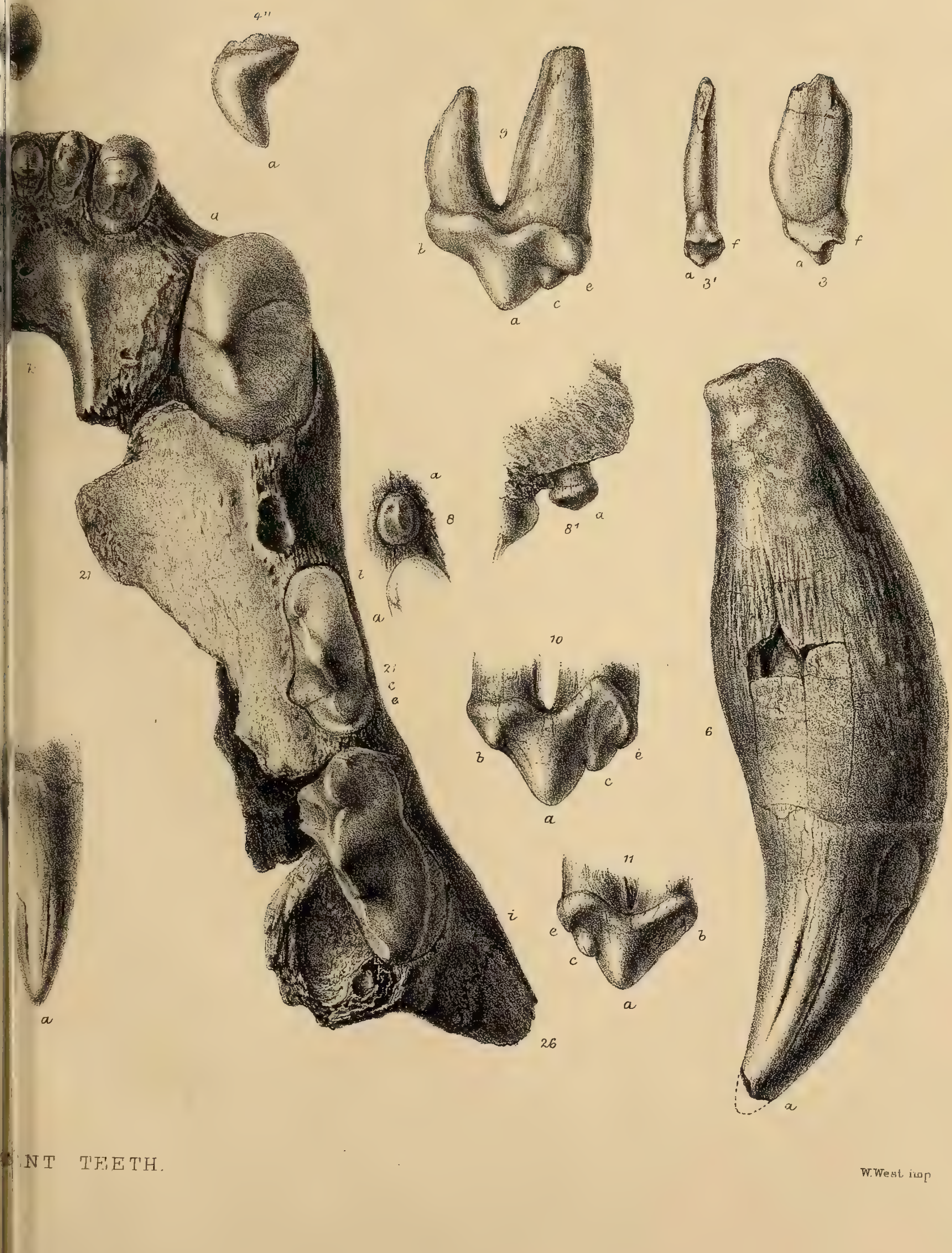
N.B. The small form of the fourth premolar is fully illustrated in the Pls. VI and VII of the smaller skull.



W A. Sanford del. Wm. Bidgood lith.

UPPER PERM

PLATE XI.



NT TEETH.

W.West imp

FELIS SPELÆA

PLATE XI

W.A. Sanford del. Wm Bidgood lith

UPPER PERMANENT TEETH.

W West imp

PLATE XII.

Felis spelæa, Goldfuss.

LOWER PERMANENT DENTITION.

(Natural size.)

Fig.

1, 1′. First left incisor, anterior or outer and posterior or inner aspects.

2, 2′, 2″. Second left incisor, anterior or outer, posterior or inner, and inner lateral aspects.

3, 3′, 3″. Third left incisor, anterior or outer, posterior or inner, and outer lateral aspects. These three teeth are from Sandford Hill. No. 2 and 3 belong to mandible figured in Pl. I.

4. Right canine, outer lateral aspect: the largest known to the authors. Probably from Bleadon Cave. Mr. Williams's Collection, Taunton Museum.

5. Right canine, inner lateral aspect; rather small size of large form. Sandford Hill Cave. Mr. Beard's Collection, Taunton Museum.

6. Left canine, outer lateral aspect, of very old animal. Probably from Bleadon Cavern. Williams's Collection, Taunton Museum.

7. Third right premolar; largest known to the authors; outer lateral aspect. Bleadon Cave. Mr. Beard's Collection, Taunton Museum.

8, 8′. Third left premolar, inner lateral and coronal aspects, of the average size of large form. Bleadon Cave. Mr. Beard's Collection, Taunton Museum.

9. Third left premolar, inner lateral aspect: the smallest known to the authors. Wookey Hyæna-den. In possession of Mr. Boyd Dawkins.

10. Fourth right premolar, outer lateral aspect: the largest known to the authors. Bleadon Cave. Mr. Beard's Collection, Taunton Museum.

11, 11′. Fourth left premolar, inner lateral and coronal aspects: of the average size of large form. Probably from Bleadon Cave. Mr. Williams's Collection, Taunton Museum.

12. Fourth left premolar, inner lateral aspect: smallest known to the authors. Probably from Bleadon. Mr. Williams's Collection, Taunton Museum.

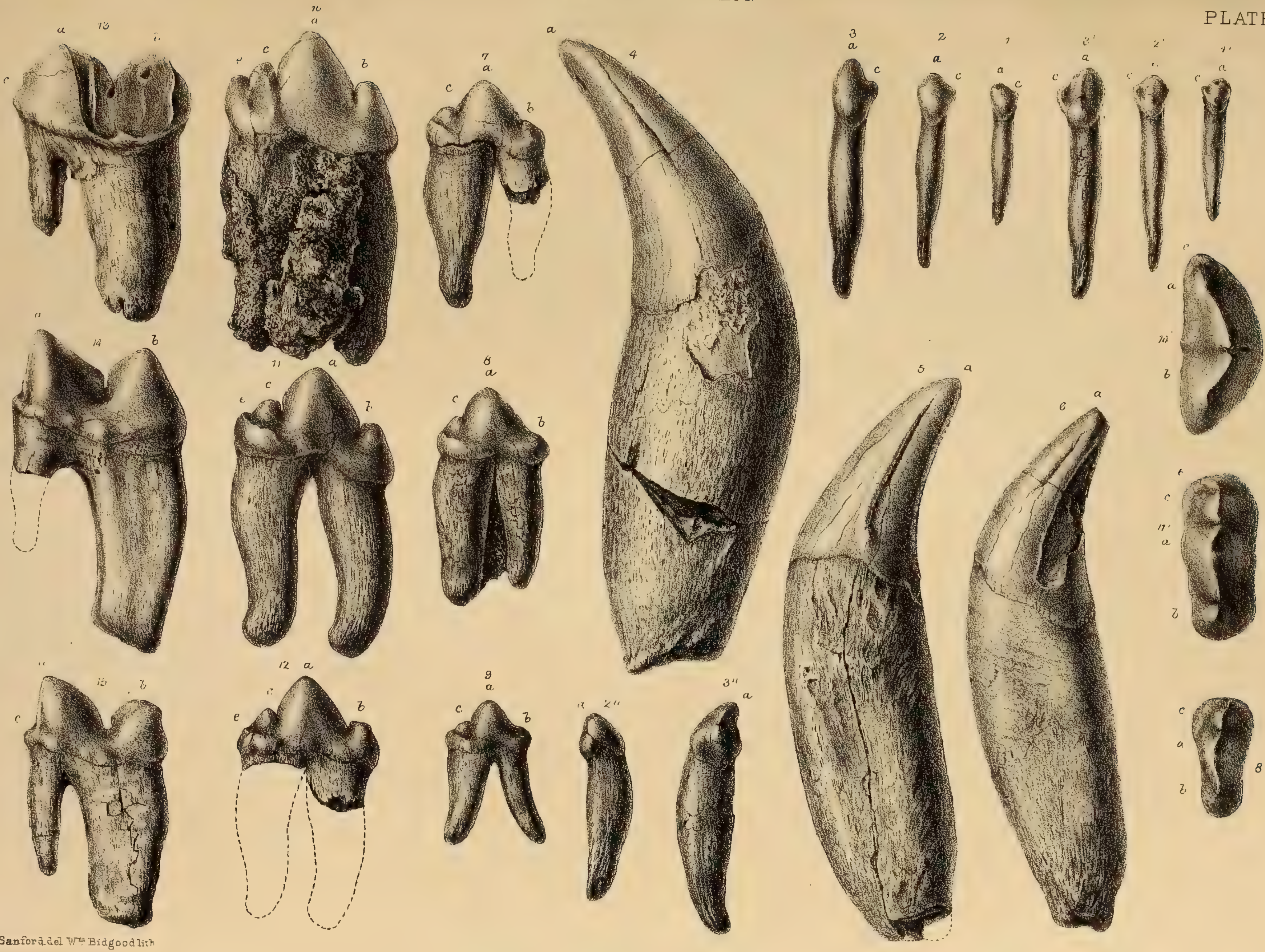
13. Right true molar much worn, outer lateral aspect: the largest known to the authors. Wookey Hyæna-den. In possession of Mr. Boyd Dawkins.

14, 14′. Left molar, of the average size of large form, inner lateral and coronal aspects. Probably from Bleadon. Mr. Williams's Collection, Taunton Museum.

15. Left molar, inner lateral aspect: smallest known to the authors. Wookey Hyæna-den. In possession of Mr. Sanford.

FELIS SPELÆA.

PLATE XII



W.A. Sanford del. Wm Bidgood lith

LOWER PERMANENT TEETH.

W West imp

PLATE XIII.

Felis spelæa, Goldfuss.

MILK DENTITION.

(Natural size.)

FIG.

1, 1′, 1″. Outer, inner, and inferior aspects of left maxillary. The small premolar 2 inserted in fig. 1″ is from that figured in fig. 2. Hutton Cave.

2, 2′. Outer and inner aspects of anterior portion of left maxillary. Bleadon Cave.

3, 3′. Outer and posterior aspects of right lower jaw, the crown of the canine and the incisor copied from other specimens, the lines of restoration being shown in the canine, and by the junction of the incisor with the jaw. Hutton Cave.

4. Inner aspect of part of right ramus of young individual. From Sandford Hill Cave.

5. Upper canine, inner aspect. Probably from Sandford Hill Cave.

6. Upper milk molar 3, inner aspect. Sandford Hill Cave.

7. Lower canine, inner aspect. Probably from Sandford Hill. This tooth furnished the restoration for that in fig. 3.

8. Lower milk molar 3, inner aspect, of large size. Bleadon Cave.

All the above are in the Taunton Museum, and were found by Messrs. Beard and Williams in the caverns of the Mendip Hills.

FELIS SPELÆA.

PLATE XIII.

W.A. Sanford del. W. Bidgood lith.

MILK DENTITION.

W West imp.

PLATE XIV.

Felis spelæa, Goldfuss.

VERTEBRÆ.

(Natural size.)

FIG.

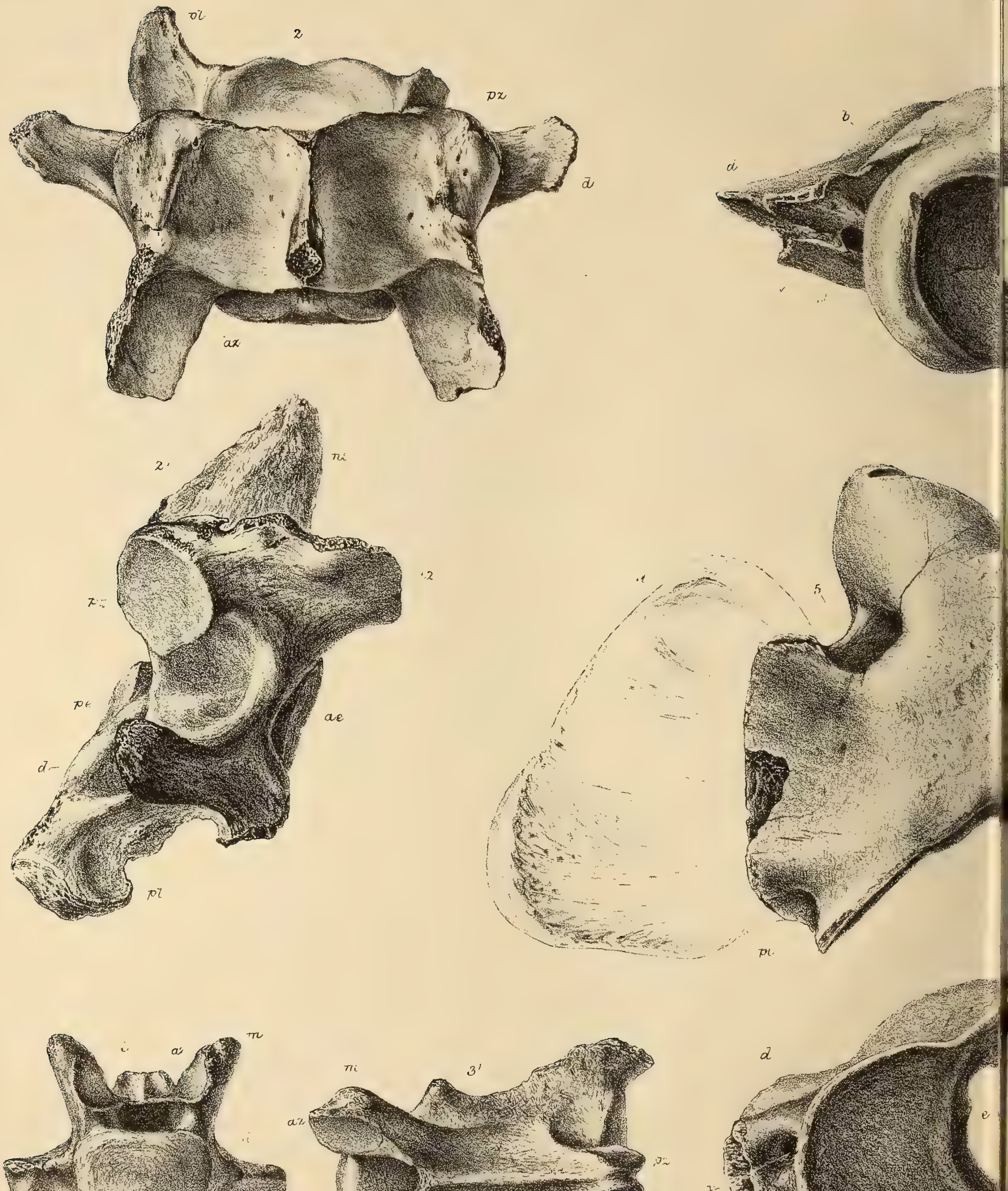
1, 1′, 1″. Proximal, dorsal, and distal aspects of atlas. Sandford Hill Cave. The restoration of the transverse process is slightly enlarged from the cast of a specimen from Gailenreuth, in the possession of Sir Philip Egerton. It is to be seen in the British Museum and the Museum of the College of the Surgeons.

2, 2′, 2″, 2‴. Dorsal, lateral, proximal, and distal aspects of sixth cervical vertebra. Sandford Hill Cave.

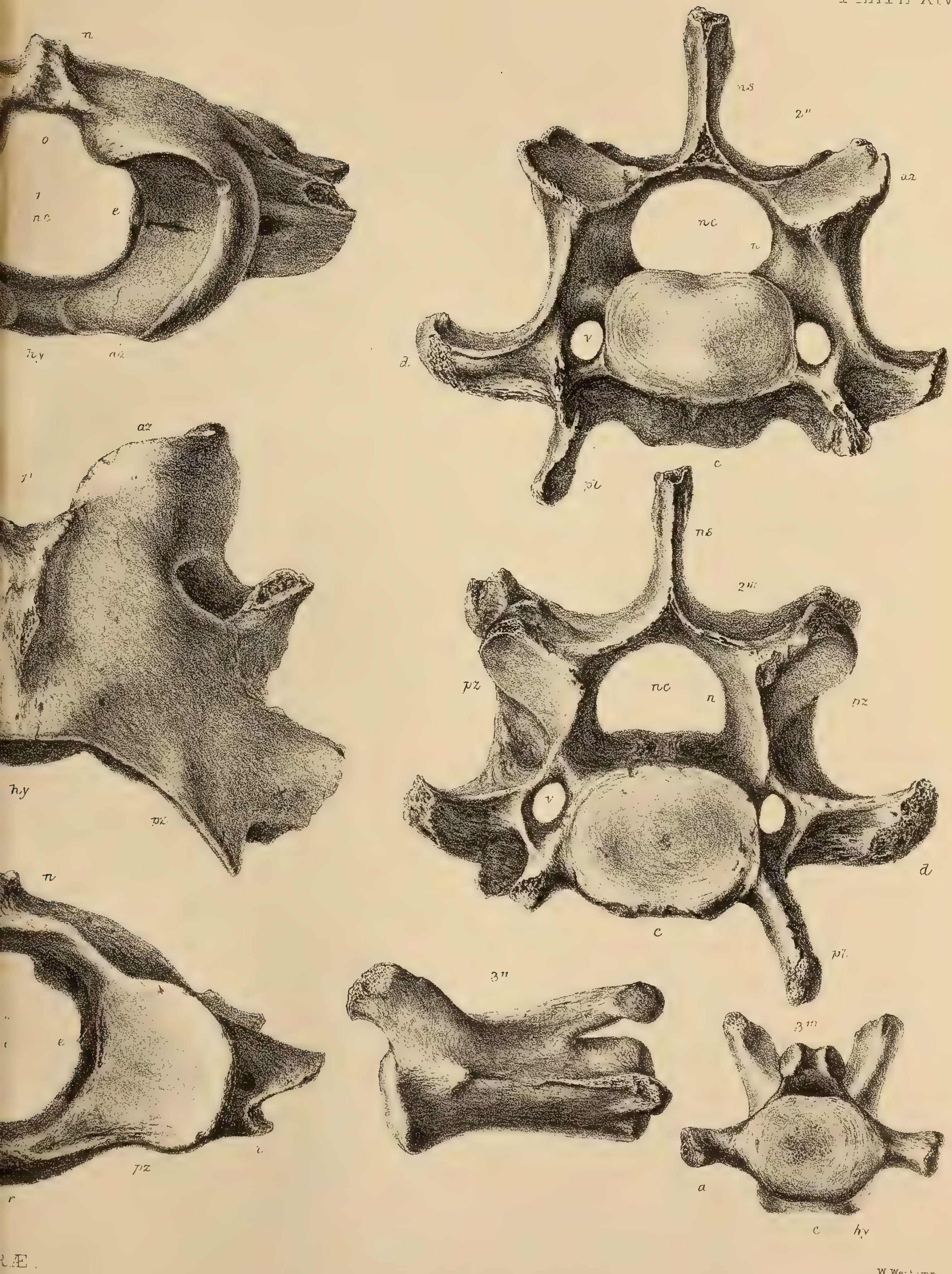
3, 3′, 3″, 3‴. Proximal, dorsal, lateral, and distal aspects of seventh caudal vertebra. Bleadon Cave. All these specimens were found by Mr. Beard, and are now in the Taunton Museum.

The following letters are used for the different parts of the vertebræ in Pls. XIV, XV, XVI:

c, centrum.
ae, anterior epiphysis.
pe, posterior epiphysis.
n, neurapophysis.
ns, neural spine.
pa, parapophysis.
pl, pleurapophysis.
hy, hypapophysis.
d, diapophysis.
a, anapophysis.
m, metapophysis.
az, pre-zygapophysis.
pz, post-zygapophysis.
nc, neural canal.
v, canal for vertebral artery.

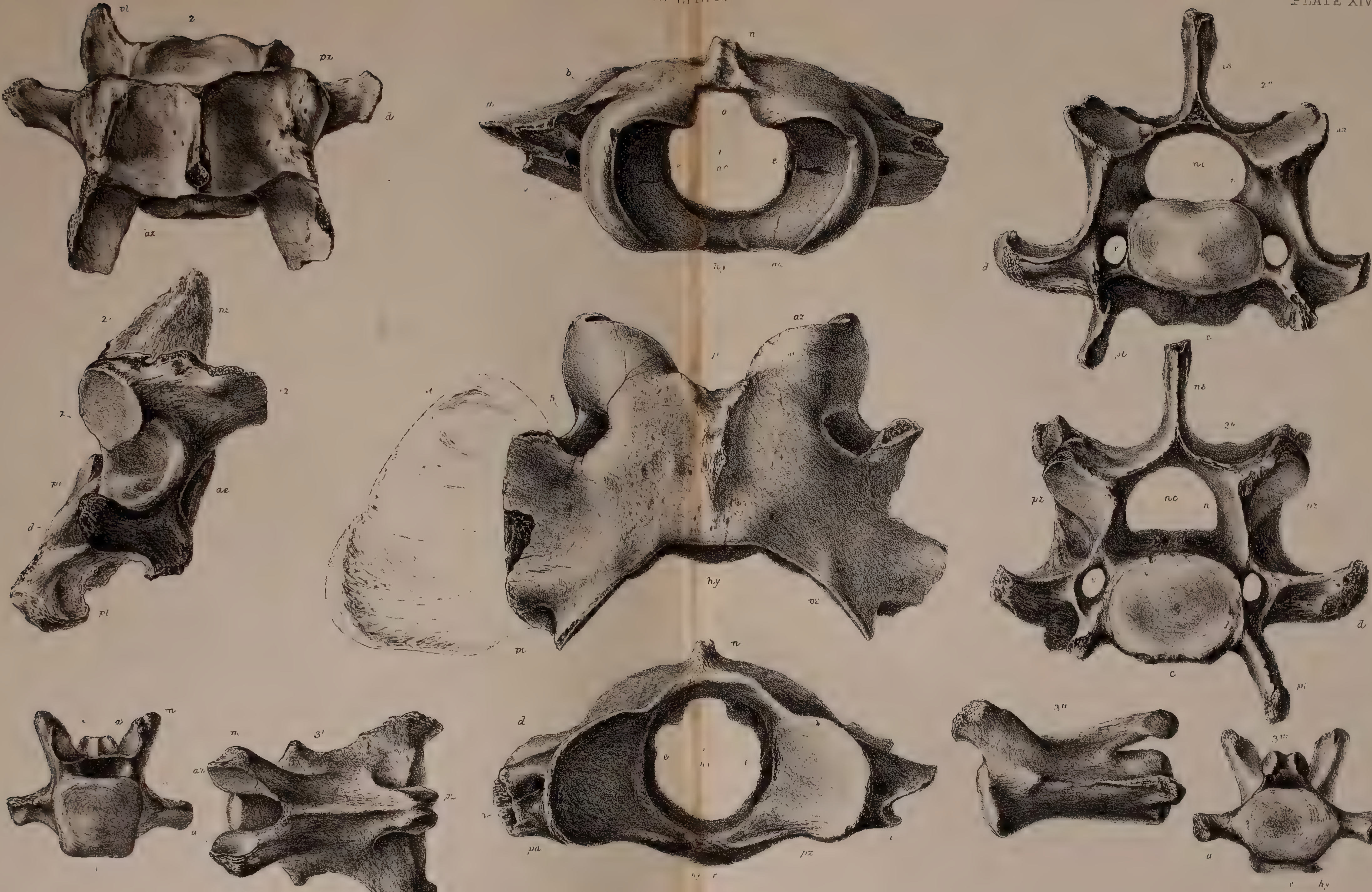


W. A. Sanford del. W. Bidgood lith.



RÆ.

W.West imp



VERTEBRÆ

W. A. Sanford del. W. Bidgood lith.

W. West imp.

PLATE XV.

Felis spelæa, Goldfuss.

VERTEBRÆ.

(Natural size.)

Fig.

1, 1′, 1″. Proximal, lateral, and distal aspects of a perfect second dorsal vertebra. Sandford Hill Cave. Mr. Beard's Collection, Taunton Museum.

FELIS SPELÆA.

PLATE XV.

W.A.Sanford del. J.Dinkel lith.

SECOND DORSAL VERTEBRA.

W.West imp.

PLATE XVI.

Felis spelæa, Goldfuss.

VERTEBRÆ ; STERNUM.

(Natural size.)

Fig.

1, 1′. Seventh dorsal vertebra, distal and lateral aspects.

2, 2′, 2″, 2‴. Eleventh dorsal ; lateral, distal, proximal, and dorsal aspects.

3, 3′, 3″, 3‴. Second lumbar vertebra, proximal, lateral, dorsal, and distal aspects.

4, 4′. Fourth caudal vertebra, ventral and distal aspects.

5. Ninth caudal vertebra, dorsal aspect.

6. Tenth caudal vertebra, ventral aspect.

7, 7′, 7″. Eleventh caudal vertebra, dorsal, proximal, and distal aspects; very large specimen.

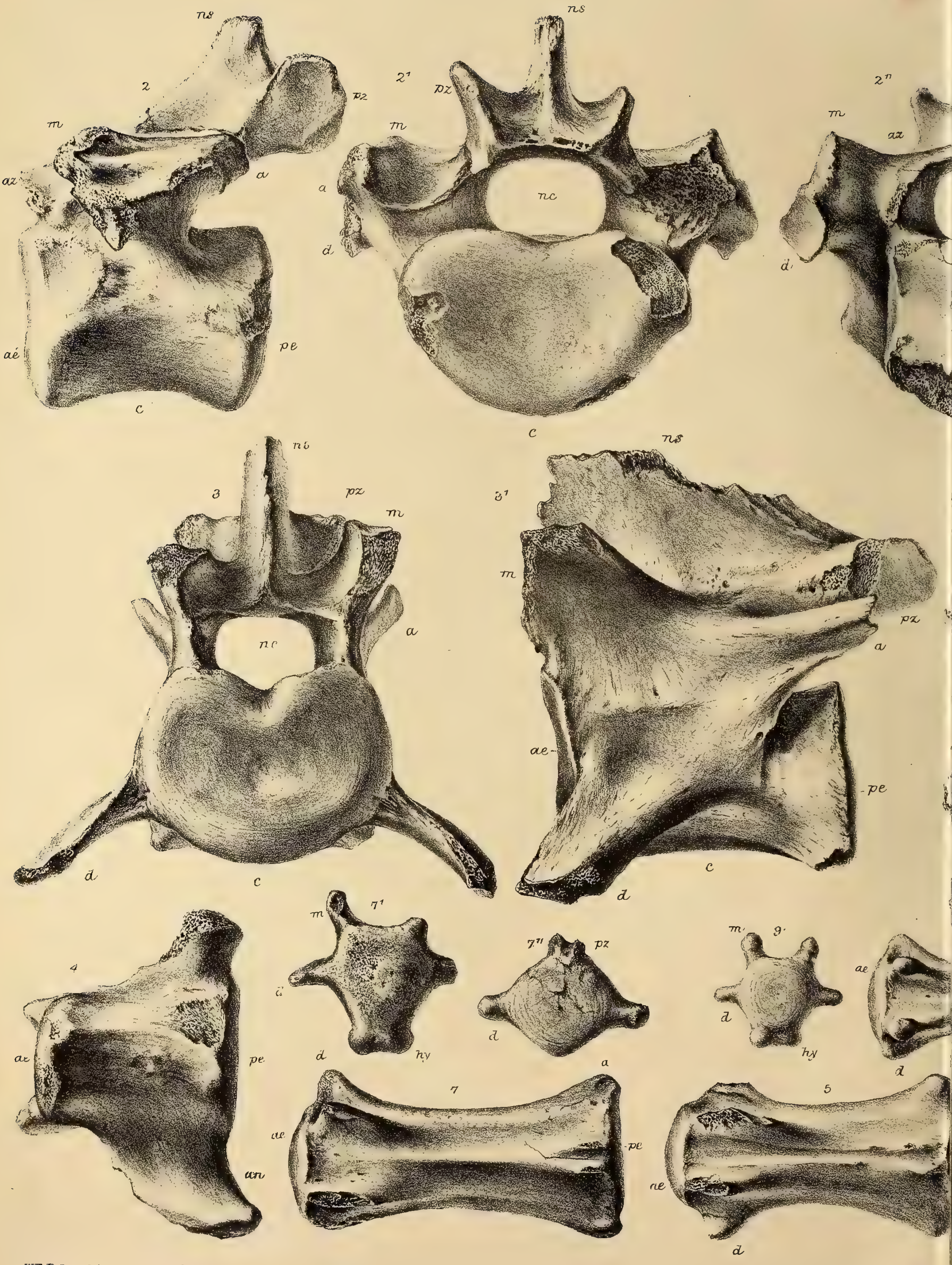
8. Twelfth caudal vertebra, lateral aspect.

9, 9′, 9″. Fourteenth caudal vertebra, dorsal, proximal, and distal aspects.

10, 10′. Third sterneber, lateral and ventral or superior aspect.

The above are in the Taunton Museum, and were in Mr. Beard's Collection. All were derived from Bleadon Cave, except No. 3, which was from Sandford Hill.

Nos. 5, 6, 8, 9, and perhaps 4, have the appearance of having belonged to one animal.



Wm Bidgood del. et lith. May 1867.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W West imp.

Wm Bidgood del et lith. May 1867.

W West imp

VERTEBRÆ, STERNALS.

PLATE XVII.

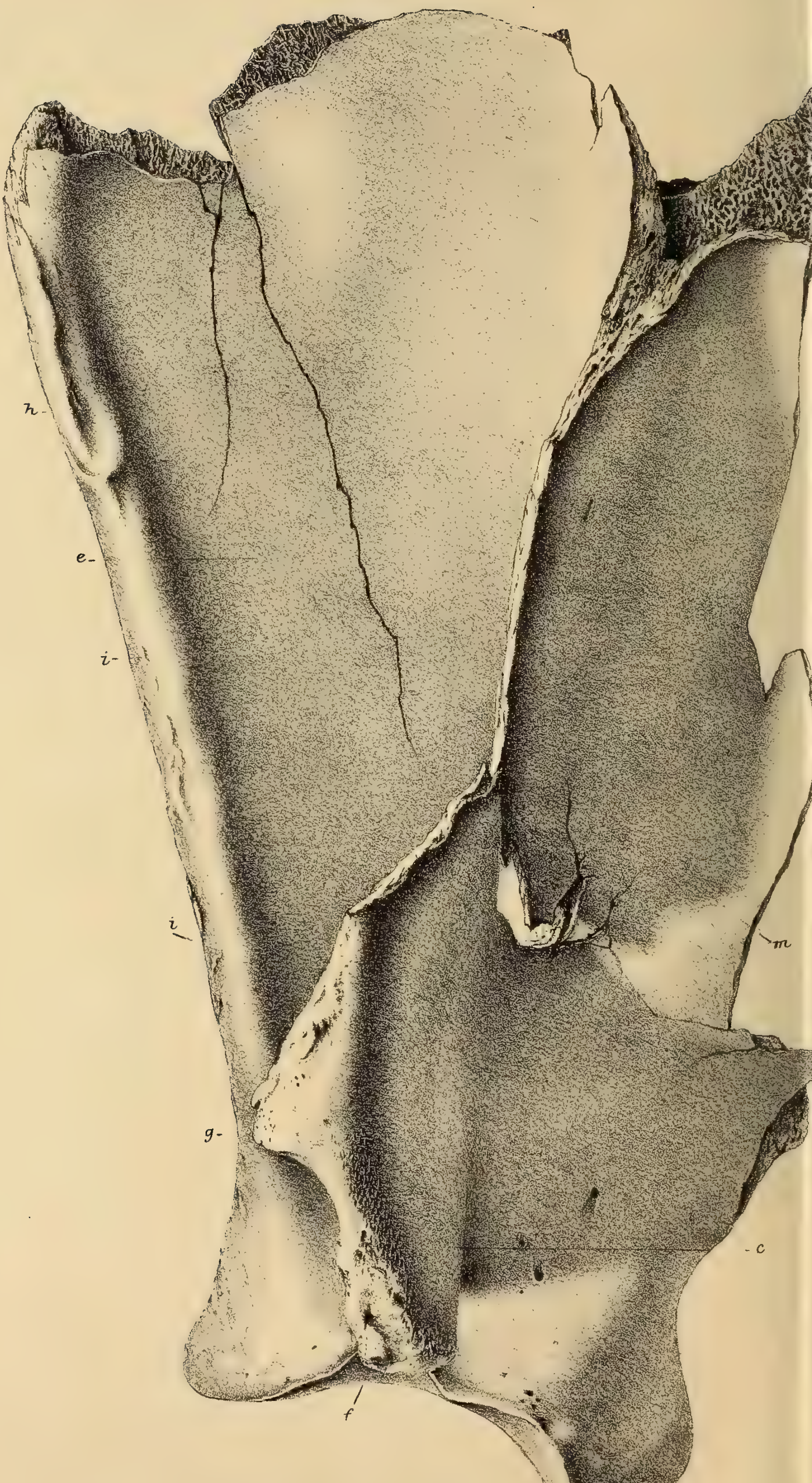
Felis spelæa, Goldfuss.

SCAPULA.

(Natural size.)

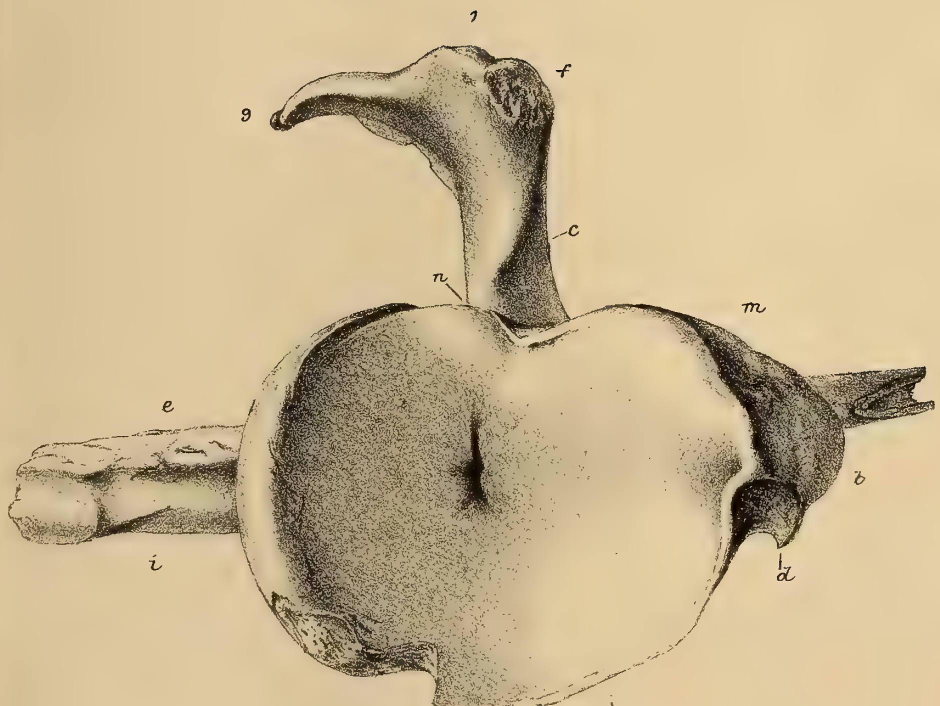
Fig.

1. Glenoid cavity and distal surfaces of the right scapula. From Sandford Hill Cave. Found by Mr. Beard; now in the Taunton Museum.
2. Outer or superior surface of the same bone.



Wm. Bidgood del. et lith

SCA



Scapula

JLA.

W. West imp.

Scapula

SCAPULA

W^m^ Bidgood del. et lith

W West imp

PLATE XVIII.

Felis spelæa, Goldfuss.

HUMERUS. FEMUR.

(Natural size.)

FIG.

1. Composite figure of the posterior or palmar aspect of the left humerus. The groundwork in pale tint is taken from Dr. Schmerling's great work on the caverns of Liège ('Oss. Foss. de Liège,' vol. ii, pl. xv, fig. 2). The distal end is from a humerus found in Bleadon. The small compressed shaft was found in Oreston, and is now preserved in the Bristol Museum. The imperfect proximal and distal articular portions are from Bleadon Cave. All the specimens from this latter cave are in the Taunton Museum.
2. Anterior aspect of distal end of left humerus, obtained by the Rev. H. H. Winwood, F.G.S., from the gravel of Larkhall, near Bath.
3. Distal articulation of very large humerus, left side. Sandford Hill Cave. Taunton Museum.
4. Composite figure of left femur. A cast of a specimen obtained by Sir Philip Egerton, from Gailenreuth Cave, supplied the groundwork in light tint. The proximal and distal ends and the fragment of shaft were obtained from Bleadon Cave by Mr. Beard, and are now preserved in the Taunton Museum.
5. Distal articulation of femur. Bleadon Cave. Taunton Museum.

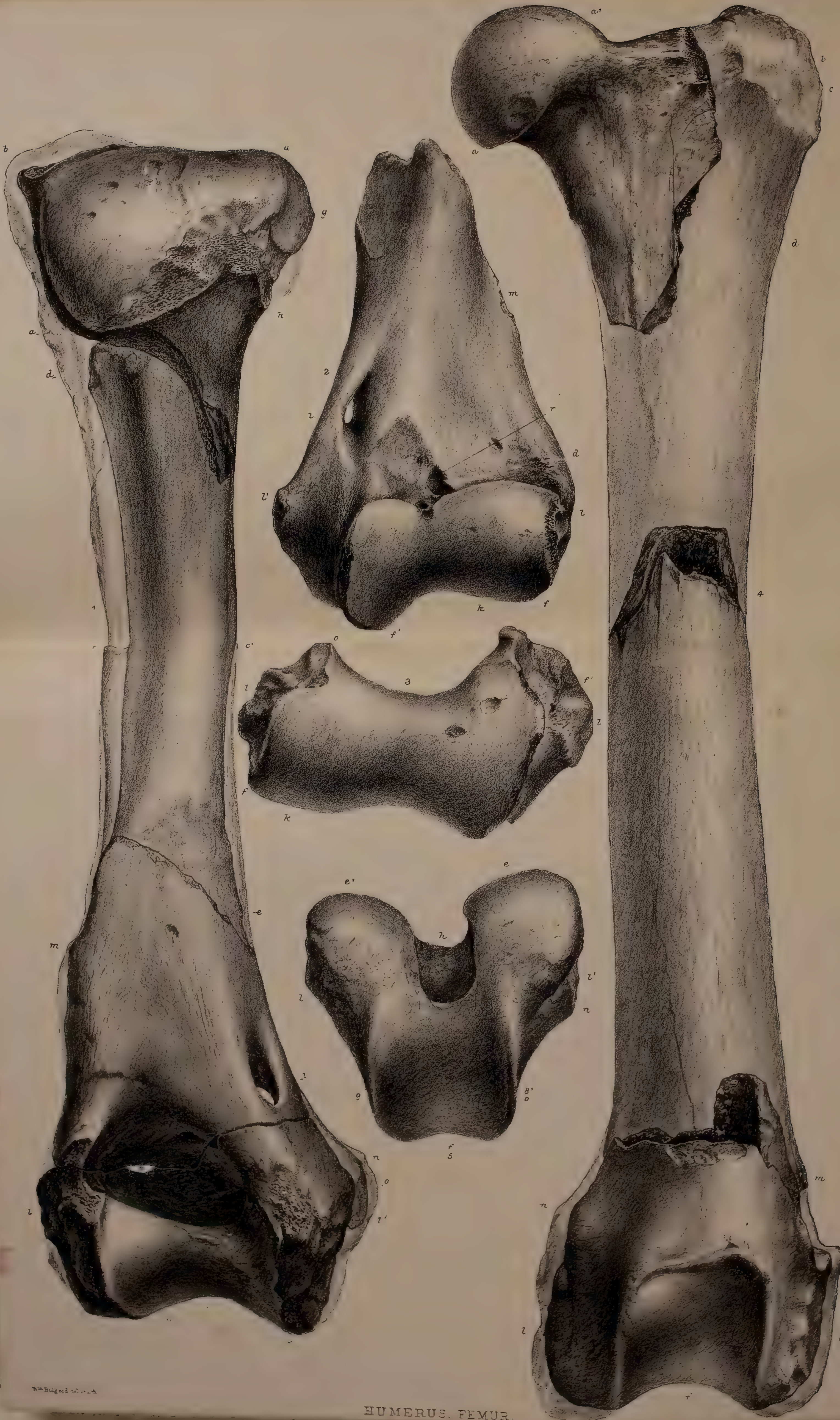
FELIS SPELÆA.

PLATE XVIII.

W^m Bidgood del et lith

HUMERUS. FEMUR.

FELIS SPELÆA



HUMERUS. FEMUR.

ATE XVIII

PLATE XIX.

Felis spelæa, Goldfuss.

TIBIA. FIBULA. PATELLA. METACARPAL. METATARSAL.

(Half natural size.)

Fig.

1. Left tibia of young adult, anterior aspect; perfect, with the exception of the proximal articulation. Sandford Hill Cave. Taunton Museum.

1′. Proximal end of shaft.

1″. Distal articulation.

2. Anterior aspect of proximal end of left tibia. Sandford Hill Cave. Taunton Museum.

2′. Proximal articulation of the same bone.

3. Posterior aspect of right fibula, which probably belonged to the same animal as fig. 2. Sandford Hill Cave. Taunton Museum.

4. External aspect of distal end of left fibula. Bleadon Cave. Taunton Museum.

5. Anterior aspect of patella. Sandford Hill Cave. Taunton Museum.

5′. Posterior aspect of ditto.

(Natural size.)

6. Second left metacarpal of gigantic size. Lower Brickearths, Crayford. Dr. Spurrell's Collection.

7. Second left metatarsal of gigantic size. Lower Brickearths, Crayford. Dr. Spurrell's Collection.

These are referred to in p. 22 as figured in Pl. VIII.

FELIS SPELÆA. PLATE XIX

J. Dinkel del.et lith.

W. West imp.

BONES OF LIMBS.

PLATE XX.

Felis spelæa, Goldfuss.

CARPUS. METACARPALS.

(Natural size.)

Fig.

1. Scaphoido-lunare, anterior or dorsal aspect. Sandford Hill Cave. Taunton Museum.

1′. Distal aspect of same.

2. Scaphoido-lunare of the small form, anterior or dorsal aspect. Bleadon Cave. Taunton Museum.

3. Distal aspect of pisiform. Bleadon Cave. Taunton Museum.

4. Proximal or ulnar aspect of pisiform. Sandford Hill Cave. Taunton Museum.

5. Anterior or dorsal aspect of unciform, right side. Sandford Hill Cave. Taunton Museum.

5′. Distal or metacarpal aspect of same bone.

6. Proximal end of fourth metacarpal of the ordinary form and size. Bleadon Cave. Taunton Museum.

7. Fifth metacarpal internal aspect. Wookey Hyæna-den. Mr. Boyd Dawkins' Collection.

W. A. Sanford del. Wm. Bidgood lith.

CARPUS.

W West imp

PLATE XXI.

Felis spelæa, Goldfuss.

RIGHT FORE PAW.

(Natural size.)

FIG.

1. First metacarpal. Bleadon Cave.

2.–5. Remaining metacarpals from the same individual. Sandford Hill Cave.

6.–10. The first phalanges, apparently belonging to the individual as the last.

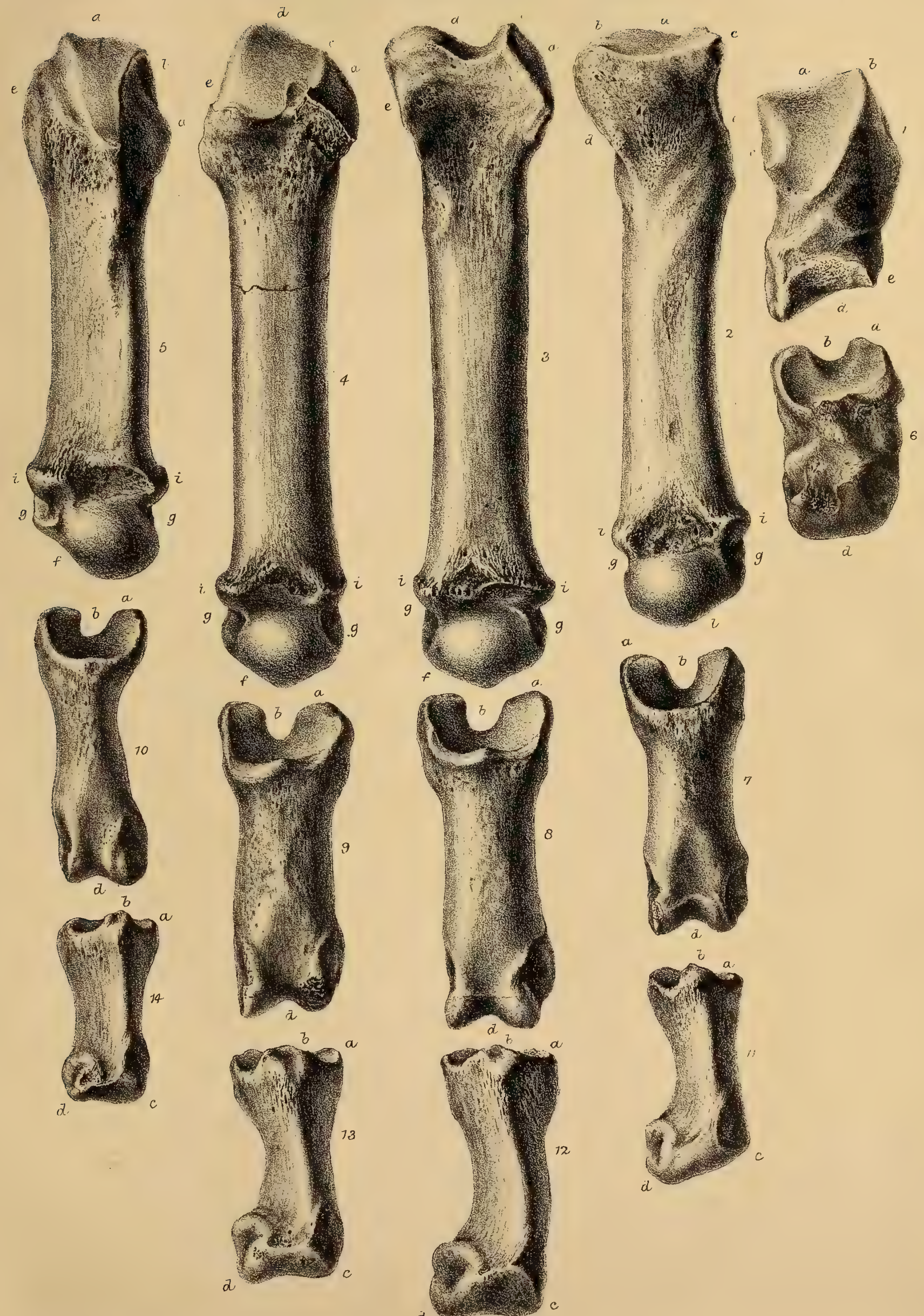
11. Second phalange of second digit. Bleadon Cave.

12. Second phalange of third digit. Bleadon Cave.

13. Second phalange of fourth digit, apparently belonging to the same individual as the set of metacarpals and first phalanges.

14. Second phalange of fifth digit (reversed), from left paw. Bleadon Cave.

All these were found by Mr. Beard, and are now preserved in the Taunton Museum.



W. A. Sanford del. Wm Bidgood lith. W. West imp.

FORE—PAW

PLATE XXII.

Felis spelæa, Goldfuss.

BONES OF WHELP.

(Natural size.)

1. Left humerus, posterior aspect.
2. Right ulna, external aspect.
3. The same, internal aspect.
4. Left fifth metacarpal, dorsal aspect.
5. First phalange of one (second or fifth) of the outer digits of the hind paw.
6. Second phalange, dorsal aspect.
7. Right femur, posterior aspect.
8. Left femur, front aspect.
9. Shaft of left fibula, tibial aspect.
10. Left calcaneum, external aspect.

These bones, with the exception of 6 and 9, were found in Hutton Cave by Messrs. Beard and Williams, and probably belonged to one animal. The two exceptions were found in Bleadon Cave. All are now in the collection of cave-mammals in the Taunton Museum.

FELIS SPELÆA. PLATE XXII.

W.A.S. del. J. Dinkel lith. W. West imp.

BONES OF WHELP.

PLATE XXII A.

Felis spelæa. Goldfuss.

ULNA. RADIUS. TIBIA. FIBULA. PATELLA.

(Natural size.)

FIG.

1. Internal or ulnar aspect of right radius, represented in Pl. II, figs. 1, 2, 3, described at pp. 8, 9. Sandford Hill Cave.
2. Internal aspect of proximal half of right ulna represented in Pl. II, fig. 8, described at pp. 6, 7. Sandford Hill Cave.
3. Composite figure of external aspect of right tibia. The proximal portion is represented in Pl. XIX, figs. 2, 2′, the shaft and distal end in Pl. XIX, fig. 1 *a*. Both are described at pp. 122—4. Sandford Hill Cave.
4. External or tibial aspect of shaft of right fibula, represented in Pl. XIX, fig. 3, described at pp. 125—6. Sandford Hill Cave.
5. Internal aspect of distal end of right fibula, represented in Pl. XIX, fig. 4, described at pp. 125—6. Bleadon Cave.
6. Lateral aspect of patella, described at p. 127. Bleadon Cave.

We have added this and the following supplementary Plate XXII B in consequence of the desire, which has been expressed, that all the plates should be of life size. In no case has the same aspect of the same bone been repeated.

Wm. Bidgood del. et lith.

W. West imp.

BONES OF THE LIMBS, nat. size

BONES OF THE LIMBS, nat. size

Wm Bidgood del. et lith. W. West imp.

PLATE XXII B.

Felis spelæa, Goldfuss.

OS INNOMINATUM. VERTEBRA.

(Natural size.)

FIG.

1. External aspect of right os innominatum. Sandford Hill Cave.
2. Internal aspect of left os innominatum. This pair probably belonged to a Lioness, on account of the slenderness and curvature of the os pubis. The texture of the bone closely resembles that of the sacral vertebra, fig. 4, and several other young bones from the same locality. The animal, therefore, to which it belonged, though of full size, was probably young at the time of its death. Sandford Hill Cave.
3. Os pubis of very large animal, much stouter and less curved than that of fig. 2. Sandford Hill Cave.
4. Third sacral vertebra, with portion of the second (see p. 96). Sandford Hill Cave.

Wm Bidgood del. et lith.

W.West imp.

Wm Bidgood del et lith

PELVIC BONES, nat. size

W. West imp.

PLATE XXIII.

Felis Lynx, Linnæus.

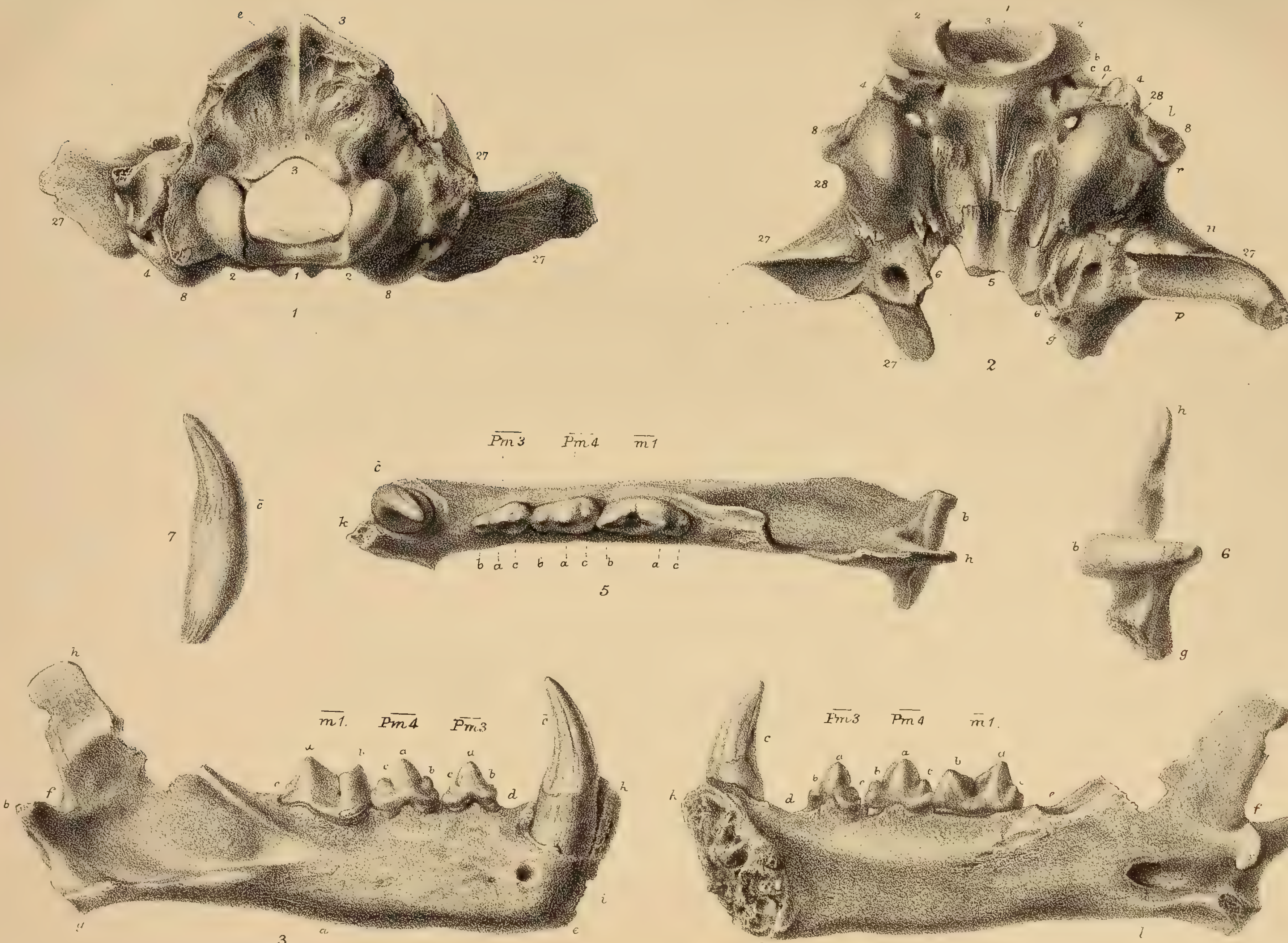
SKULL AND LOWER JAW.

(Natural size.)

FIG.

1. Occipital aspect of skull. Yew Tree Cave. Dr. Ransom's Collection.
2. Basal aspect of fig. 1.
3. External aspect of right lower jaw. Yew Tree Cave. Dr. Ransom's Collection.
4. Internal aspect of fig. 3.
5. Superior ditto.
6. Posterior ditto.
7. Exterior aspect of right lower canine, taken from the lower jaw.

FELIS LYNX.



J. Dinkel, del et lith

SKULL AND LOWER JAW.

W West imp

PLATE XXIV.

Felis pardus, Linnæus.

(Natural size.)

Fig.

1. Internal aspect of upper canine. Bleadon Cave. Taunton Museum.
2. Lower true molar. ,, ,,
3. Internal aspect of lower canine. ,, ,,
4. External aspect of lower canine. Banwell Cave. In the Collection of the Earl of Enniskillen.
5. Posterior aspect of left femur. Taunton Museum.

Felis Caffer, Desmarest.

6. Left mandible. Bleadon Cave. Taunton Museum.
7. Posterior aspect of upper portion of femur, which probably belongs to this species. Bleadon Cave. Taunton Musenm.
8. Radial aspect of ulna, which may belong to *Felis catus*. Bleadon Cave. Taunton Museum.

Felis catus, Linnæus.

9. Left mandible, from the Lower Brickearths of Grays Thurrock, Essex. In the possession of J. Wickham Flower, Esq., F.G.S.

The letters attached to the figures of this plate indicate the same parts as those which have been used in the plates of *Felis leo*, var. *spelæa*. In this work we propose to use one system of letters for the teeth and another for the bones of the Carnivora, since in that way the homologies can be shown with the greatest precision.

w. Bidgood del. et lith. W. West, imp.

FELIS PARDUS = ANTIQUA Figs. 1. 2. 3. 4. 5.

F. . . . CAFFER (?) 6. 7.

F. . . . CATUS 8. 9.

PLATE XXV.

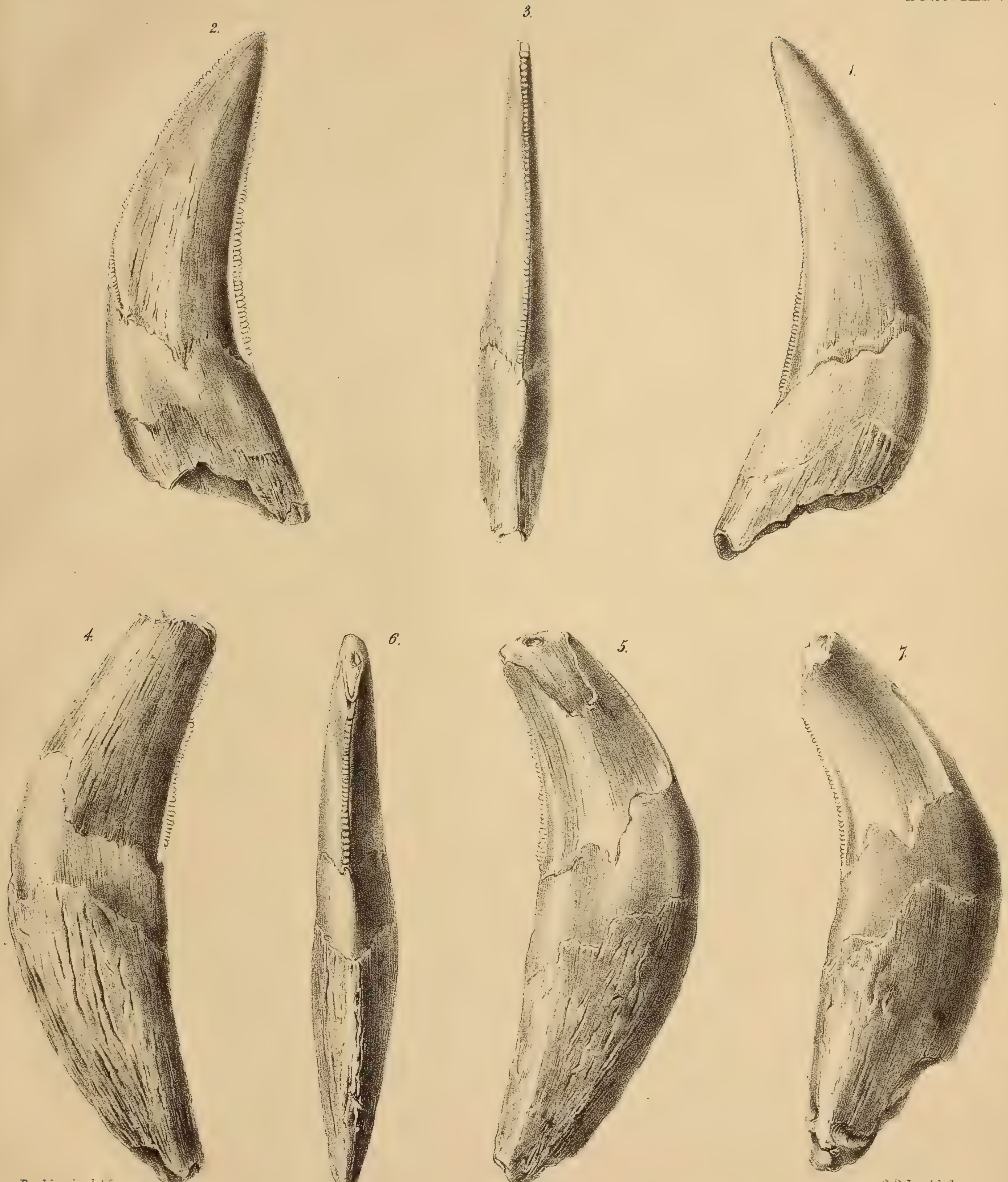
Machærodus latidens, Owen.

(Natural size.)

This plate is copied from that which was intended to have formed a portion of the 'Cavern Researches' of the Rev. J. MacEnery.

Fig.

1. Left upper canine of young adult, inner aspect. British Museum.
2. ,, ,, outer aspect.
3. ,, ,, posterior aspect.
4. Right upper canine of adult, outer aspect. Museum of the Geological Society of London.
5. ,, ,, inner aspect.
6. Right upper canine of adult, inner aspect. In possession of Sir Walter Trevellyan, Bart.
7. ,, ,, posterior aspect.



Mary Buckland delt. G. Scharf lithog.

Nat. size.

Teeth of Ursus Cultridens

Found in the Cave of Kents Hole, near Torquay, Devon, by Revd. Mr. McEnery. Janry. 1826. in diluvial Mud mix'd with Teeth and gnaw'd Bones of Rhinoceros, Elephant, Horse, Ox, Elk & Deer, with Teeth & Bones of Hyænas, Bears, Wolves, Foxes &c.

MACHÆRODUS LATIDENS. (OWEN).

[illegible]