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Quod si cui mortalium cordi et curæ sit non tantum inventis hærere, atque iis uti, sed ad ulteriora penetrare; atque non disputando adversarium, sed opere naturam vincere; denique non belle et probabiliter opinari, sed certo et ostensive scire; tales, tanquam veri scientiarum filii, nobis (si videbitur) se adjungant
—*Novum Organum, Præfatio.*

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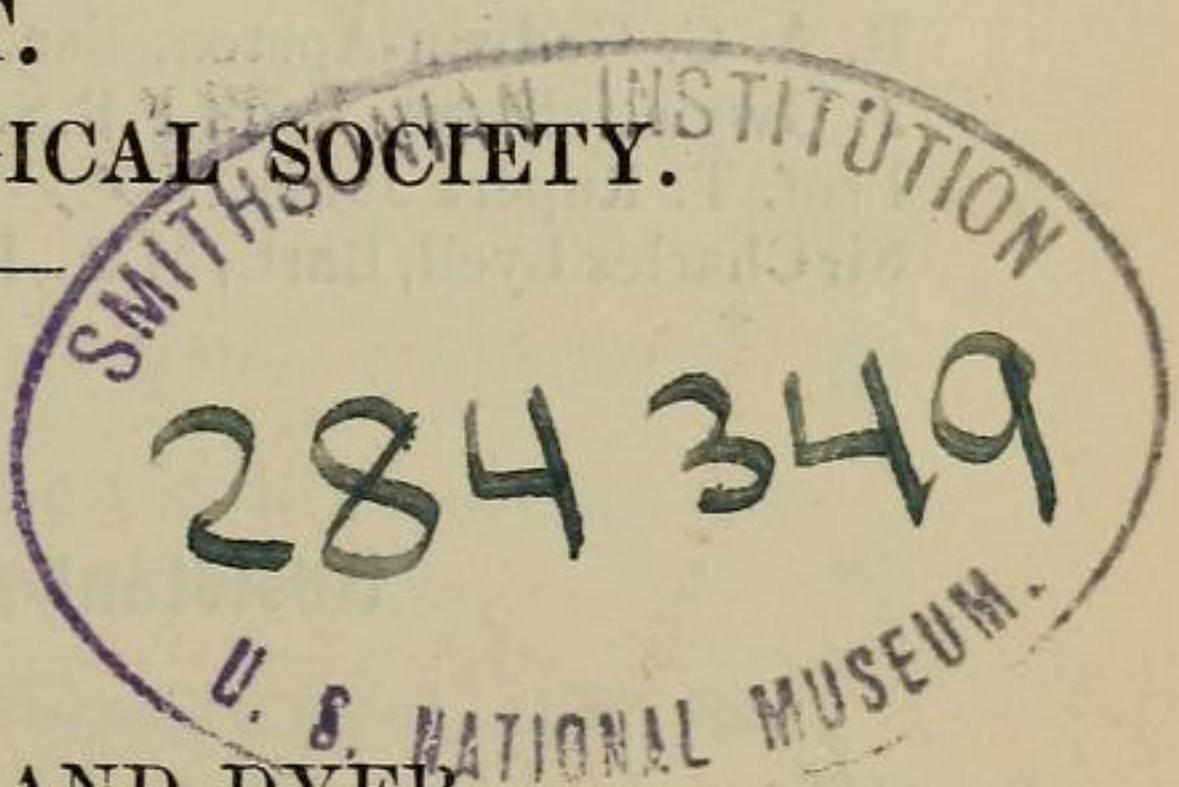
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MDCCCLXVII.



Age uncertain :—

{	White siliceous grit with cast of a <i>Pecten</i> .
	Fine yellow sandstone with casts of fossils.
	Hard yellow crystalline limestone with shells.
	Soft sandstone with <i>Leptæna</i> &c.

2. *On the DENTITION of RHINOCEROS LEPTORHINUS, Owen.*

By W. BOYD DAWKINS, Esq., M.A. Oxon., F.R.S., F.G.S.

[PLATE X.]

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I. INTRODUCTION.

1. *Rhinoceros tichorhinus*.—The remains of the British Pleistocene species of *Rhinoceros* merit a most careful examination, from their numbers and wide distribution, and the fact that they afford evidence of four species of the genus having roamed through the forests and perished in the floods of that portion of the ancient continent which now forms the British Isles. Of these, the most commonly known and the most widely spread is the *Rhinoceros tichorhinus* of Cuvier, or “*Rhinocéros à narines cloisonnées*”; it is characterized by the possession of an osseous septum, which completely insulates the one nostril from the other, and stands in direct relation to the development of a very large anterior horn, by the stoutness of its bones, and by certain dental and other peculiarities which it is unnecessary to mention in this place. The discovery of the carcass of this animal in 1771, preserved in the frozen sand of the Wilouji, a tributary of the Lena, proves that, unlike all the existing species of the genus, its hide was without folds, and that it was fitted to endure a climate of considerable severity by its clothing of hair. The remains swept down by the Pleistocene floods, and stored away in the dens of the Pleistocene carnivora, prove that the animals of this species ranged in considerable numbers throughout the Europeo-Asiatic continent (Scandinavia being excepted), north of a line passing through the Pyrenees, the Alps, the Caspian Sea, and the Altai Mountains. From the drawing of a lower jaw found near Bologna, and described by Professor Monti in 1719 as the head of a Morse, Baron Cuvier also would extend its range into Italy; but the spatulate expansion of the symphyses anterior to the molar series, upon which his determination is based, has since been proved to belong also to a species that occurs in vast abundance in Italy—the *Rhinoceros megarhinus* of M. de Christol*. With this equivocal exception, there is no

* A comparison of the megarhine jaw discovered in Hérault and figured by M. Gervais in the *Paléontologie Française*, pl. ii. fig. 8, with the figure of the jaw in question, *Oss. Foss. tom. ii. pl. ix. fig. 10*, shows the megarhine character of the latter. Since the above was written, M. Louis Caselli, the President of the Natural Science Section of the Society of the Immaculate Conception, at Rome,

instance on record of the occurrence of the tichorhine species in Southern Europe ; and it seems to have been the hardiest member of the genus, fitted to inhabit the country of the Reindeer, Bison, and Musk Sheep rather than the warmer climates of Southern Europe and Asia.

The labours of Pallas*, Cuvier†, and Professors Brandt‡ and Owen§, have made the *tichorhine* the most familiar of the fossil Rhinoceroses ; while the vast accumulation of organic remains in Wokey Hole Hyæna-den enabled me in 1863 || to define its dentition as compared with that of the three other species.

2. *R. megarhinus*.—Out of the confusion in which the non-tichorhine remains were involved throughout the Continent, M. de Christol in 1835 ¶ rescued the *Rhinoceros megarhinus*, or great slender-limbed Rhinoceros with largely developed nasals, which Baron Cuvier had considered identical with the *R. leptorhinus* of the Val d'Arno. The perfect skull found in a marine sand of Pliocene age near Montpellier, and figured by the founder of the species, proves that it was not furnished with any trace of a "cloison" or bony partition between the nostrils. The numerous bones and teeth in the British Museum from the river-deposits of Gray's Thurrock in Essex enabled me in 1865 ** to determine the occurrence of the species in the lower part of the Thames valley ; while a fine upper premolar in the collection of the Rev. J. Gunn, F.G.S., obtained at Cromer, proves that it inhabited the Eastern Counties while the Preglacial forest-bed was being formed. On the Continent its remains have been found :—in the Italian peninsula in vast abundance in the Val d'Arno ; in France, in the departments of Montpellier, Hérault, and Gard ††; and in Germany, near Würtemberg, where Professor Jäger‡‡ describes it under the name of *R. Kirchbergensis*. Thus the animal ranged through Germany and the east of England into France, and at least as far south as the Val d'Arno, its furthest northern range being the parallel of Norfolk. In the fact that it lived in the climate of Italy, while the Alps formed the southern limit of the tichorhine species, coupled with the range of the latter into the high northern latitudes, we may infer that it was specially adapted to the temperate zones of Europe. The megarhine species, indeed, probably bore the same geographical relation to the tichorhine as the Red deer does to the Reindeer. Of the two, the former was the older, and coexisted in Italy with the Pliocene *Mastodon Arvernensis*, in France with *Mastodon brevirostris* and

has found *R. tichorhinus* in the high-level fluviatile beds at Rome, associated with flint implements of the ordinary palæolithic types, and remains of *Megaceros*, *Cervus elaphus*, *Hyæna spelæa*, and *Ursus spelæus*, and many other species. (Correspondance de Rome, No. 455, 4 Mai, 1867.)

* Nov. Comment. Petrop. tom. xiii. † Oss. Foss. tom. ii. pt. 1. 1825.

‡ Mém. Acad. St. Péters. 6^e sér. tom. vii.

§ British Fossil Mammals, 1846.

|| Nat. Hist. Rev. 1863, xii. p. 525.

¶ Ann. de Sc. Nat. 1835.

** Nat. Hist. Rev. 1865, xix. p. 339.

†† Gervais, Paléont. Franç. second edit. p. 91.

‡‡ Ueber die fossilen Säugethiere welche in Würtemberg aufgefunden worden sind. Stuttgard, 1835. Folio, p. 179.

Halitherium Serresii, and in the Eastern Counties with *Elephas meridionalis* and *E. priscus*.

3. *R. Etruscus*.—The third British species of Rhinoceros is represented by comparatively numerous remains derived from the Forest-bed of Norfolk and Suffolk, for some of which the late Dr. Falconer proposed the name *Rhinoceros Etruscus*. The name of this unfigured and undescribed species rests upon MS. notes attached to specimens in the British and Norwich Museums, and in the collections of the Rev. S. W. King, F.G.S., and the Rev. J. Gunn, F.G.S., and is retained, out of respect for the memory of so much knowledge buried in Dr. Falconer's grave, for the assemblage of remains of Rhinoceros which belong to one and the same unpublished species.

An examination of the plaster cast of the skull of Rhinoceros found in the Val d'Arno, and exhibited in the Exhibition of 1861, proves that the Etruscan Rhinoceros, unlike the tichorhine and megarhine, had its nasals supported by a demi-cloison or osseous partition, which sundered in part the one nostril from the other, and strengthened the basement of the anterior horn. The head was smaller and more slender than that of the other species. The upper molars are characterized by the lowness of their crowns, which strongly resemble those of the milk-teeth of *R. megarhinus*; and the last true molar strongly resembles in general form that of the Miocene *Acetherium incisivum* of Dr. Kaup, in the possession of Sir Philip Egerton, Bart., F.R.S. I have met with the remains of this species in the collections of Messrs. Gunn and King, and in the British and Norwich Museums. The teeth in the collection of Mr. Fitch, of Norwich, ascribed by Professor Owen to *R. leptorhinus*, belong to this animal. In Britain its remains have occurred only in the Forest-bed on the east coast. On the Continent they have been determined by Dr. Falconer from Malaga; and in the collection made by M. Bravard, from Perolles, and preserved in the British Museum, are two upper molars, labelled in the MS. Catalogue as tichorhine, which, beyond all doubt, belong to the Etruscan species, and correspond exactly in size, form, and sculpturing with specimens from the Cromer shore in the possession of the Rev. S. W. King, of Saxlingham. *Rhinoceros Etruscus*, therefore, in Preglacial times ranged from the Eastern Counties, southwards through France, on the one hand across the Pyrenees as far as the Straits of Gibraltar, on the other across the Alps, at least as far down in the Italian peninsula as the Vale of Florence. Its range over South-western Europe may perhaps prove that it was fitted for a warmer climate than the tichorhine species, which it preceded in point of time. In common with the other fossil members of the Genus Rhinoceros found in Britain, it was bicorn, and possessed a dental formula of three premolars and three true molars in both jaws. The description of the species, so far as my materials allow, I hope to complete in a few months.

II. RHINOCEROS LEPTORHINUS, Owen*.

1. *History of the name*.—The fourth British species of Rhinoceros

* *Op. cit.* p. 356.

is remarkable for the confusion in which it is involved from the fact of its being entirely distinct from the *R. leptorhinus* of Baron Cuvier *. The latter is founded upon a drawing of the head found near the Monte Pulgnasco in the upper Val d'Arno by M. Cortesi in 1805, and preserved in the Museum at Milan. The original, Baron Cuvier never saw; but from the drawing made by M. Adolphe Brongniart he inferred that it exhibited no trace of the osseous partition between the nares, so characteristic in the tichorhine species; and he therefore made it the type of the "Rhinocéros à narines non-cloisonnées," or *R. leptorhinus*. This determination was considered valid by the scientific men of Europe until, in 1835, M. de Christol, after having obtained very careful drawings of the same skull by MM. Gené and De la Marmora, came to the conclusion that the sketch published by Cuvier was incorrect, and accounted for the absence of the cloison by the hypothesis that it had been broken away. A comparison of his figure (Annales des Sciences, 2^{me} série, t. iv. pl. ii. fig. 4) with that in the 'Ossemens Fossiles' (3rd edit. t. ii. part i. pl. ix. fig. 7) proves the truth of these inferences, which, moreover, were indorsed in the year 1846 by the authority of Prof. Owen. On the other hand, Dr. Falconer incidentally mentions, in his masterly treatise on the Mastodon and Elephant †, that the skull in question is exactly as Baron Cuvier described it—without the cloison. This conflicting evidence may perhaps be explained by the presence of more than one skull of Rhinoceros in the same Museum from the same deposit. As, however, M. de Christol's criticisms upon Baron Cuvier's species have remained unchallenged up to the present time, and, considering also that the remains of the species without the cloison are very abundant in the upper Val d'Arno, the probability seems to me that M. de Christol is right in disallowing the validity of Baron Cuvier's species, and that the skull which Dr. Falconer examined belongs to *Rhinoceros megarhinus*. To which of the fossil species the skull described by Cuvier may really belong, to the tichorhine, megarhine, Etruscan, or leptorhine of Professor Owen, is entirely a matter of conjecture. M. de Christol has succeeded only in demonstrating that it is not what it was supposed to be when it was constituted the type of the *R. leptorhinus* or "R. à narines non cloisonnées." For it Desmarest proposed the name of *R. Cuvieri* ‡; and Dr. Fischer § defined it specifically as "capite bicorni, dentibus primoribus nullis, septo narium nullo; naribus multo gracilioribus, ossibusque nasalibus tenuioribus quam in *R. Africano*."

In this confusion the non-tichorhine species of Pliocene age were left up to the year 1846. In that year Professor Owen, in his great work the 'British Fossil Mammals' proposed the name of *R. leptorhinus* for portions of a skull, a lower jaw, and bones of *Rhinoceros* found in the freshwater deposits of Clacton, in Essex. A comparison of the lower jaw with those from the Val d'Arno described by

* *Op. cit.* p. 71.

† *Quart. Journ. Geol. Soc.* 1865, p. 285.

‡ *Mam.* pp. 402, 632.

§ *Synopsis Mammalium*, 8vo, Stuttgardiae (1829), p. 416.

Cuvier, led him to infer that the leptorhine of Essex was identical with that of Italy. The skull presenting a *partially ossified* cloison, or bony partition between the nostrils, enabled him to amend Cuvier's definition of "R. à narines non cloisonnées" into "R. à narines demi-cloisonnées," the name *leptorhinus* being retained because "the nasal bones, notwithstanding their partial osseous supporting wall, are actually more slender than those of *R. tichorhinus*"*. The specific identity of the lower jaws found in Italy with that found in Essex is, indeed, open to considerable doubt; but, since the species of *Rhinoceros* found at Clacton is one which I have traced widely in the bone-caverns and river-deposits, and since its definition by Professor Owen has been amply verified by recent discoveries, there is every reason for the *R. leptorhinus* of Professor Owen being retained as a specific name. Its identity with the *R. leptorhinus* of Cuvier, from the conflicting evidence as to the presence of the cloison in the skull which he constituted his type, is altogether a matter of conjecture.

2. *Synonyms*.—The *Rhinoceros leptorhinus* of Professor Owen is the equivalent of the species mentioned by Dr. Falconer in his account of the Caves of Gower as *R. hemitæchus* †, an undescribed and undefined species that owes its existence to the translation of Professor Owen's definition 'à narines demi-cloisonnées' into a Greek specific name. In central France it is probably identical with the *R. mesotropus* and *R. Velaunus* of M. Aymard ‡, the *R. Aymardi* of M. Pomel §, and the *R. leptorhinus* (Du Puy) described by M. Gervais in his 'Paléontologie Française' ||.

The species is characterized by the possession of two horns, by the partial ossification of the septum, by the slenderness of the bones, and by certain peculiarities in the dentition, which I propose to describe in the following pages. In regard to the *partially ossified* septum, it is intermediate between the tichorhine *Rhinoceros*, in which the ossification is complete, and the megarhine, in which, according to M. de Christol, there is no trace of a cloison. The development of this bony support for the nasals stands, as Cuvier remarked of it in the tichorhine *Rhinoceros* ¶, in direct relation to the horn-development; and therefore we may infer that also in respect of the size of its anterior horn it was intermediate between the two above-named species.

The dentition of two out of the four British species of Pleistocene *Rhinoceros*, the tichorhine and megarhine, has already been described in the 'Natural History Review' **; that of the leptorhine of Professor Owen merits a more careful examination than the rest, because of its close resemblance to that of the megarhine, and the wider range of the species in Britain than of the latter. The terms and letters rendered necessary for its accurate description are those

* *Op. cit.* p. 368.

† *Quart. Journ. Geol. Soc.* xvi. p. 489.

‡ *Pictêt, Pal. tom. i.* p. 298, sec. ed. (1853).

§ *Cat. Méth.* 78, 1859.

|| *Sec. edit.* (1859) p. 90.

¶ *Op. cit.* p. 68.

** *No. XII.* (1863). *No. XIX.* (1865).

used to denote homologous parts of the teeth of the tichorhine and megarhine species *.

3. *Milk Dentition*.—The Hyæna-den at Wokey Hole, which has afforded a vast quantity of the remains of the tichorhine *Rhinoceros*, has also yielded the best examples of the milk-teeth of the leptorhine species, in two fragments of an upper and lower molar. Those in the Museums of Oxford and the Geological Society of London, from Kirkdale, are so badly preserved as to be unworthy of a detailed notice. The fragment of the upper milk-molar, consisting of the *external lamina* (fig. 1) of the second of the series occupying the right upper jaw, is remarkable for the stoutness of the pyramidal *second costa* (*k* 2), which stands out boldly above the plane of the rest of the *lamina*, and is defined basally by two well-marked folds. The *third costa* (*k* 3), also pyramidal, but very faintly defined, occupies the *posterior area* (*n*) ; and between their apices is a small well-defined elevation on the exterior of the crown-summit, which is probably a mere individual variation, as it occurs also in some of the corresponding teeth of the tichorhine *Rhinoceros*. As compared with the homologous tooth of the latter species, the leptorhine is characterized by its smoothness, its small size, and the faint definition of its *third costa* ; as compared with that of the megarhine, by the presence of the *third costa*, the stoutness of the *second* (*k* 2), but especially by its small size. The average basal measurement of the *lamina* of the second upper milk-molar is in the tichorhine 1.2 inch, in the megarhine 1.35 to 1.53, in the leptorhine 0.9 inch.

The second fragment (fig. 2), consisting of the unworn germ of the third lower milk-molar, probably (from its condition) belonged to the same individual as the preceding. Its *external lamina* (*l*) is divided by a deep oblique groove (*i*) into two areas, of which

* The following is the list of the terms and letters used to identify homologous parts in the most complex of the fossil *Rhinoceros* teeth (those of *R. tichorhinus*), and applicable to the teeth of all the species of the genus :—

a=Anterior valley="Vallis anterior," Brandt,="Vallon oblique" in upper molars, Cuvier.

b=Posterior valley="Vallis posterior," Brandt,="Ecorchure au bord postérieur," Cuvier,="Fossette postérieure," Blainville.

c=Accessory valley="Vallecula accessoria," Brandt.

d=Anterior collis="Collis anterior," Brandt,="Colline seconde," of upper molars, Cuvier.

e=Median collis="Collis medius," Brandt,="La troisième colline" of upper molars, Cuvier.

f=Posterior collis="Collis posterior," Brandt,="Le bord postérieur de la dent," Cuvier, Blainville.

g=Anterior combing-plate, a small process of enamel springing from the external lamina and peculiar to *R. tichorhinus* among the fossil species.

h=Posterior combing-plate, a small process of enamel thrown *forward* into the anterior valley. In the tichorhine species the union of *g* and *h* cuts off *c* from *b*.

i=Median groove on the external lamina.

k=Costæ="costæ," Brandt, on the external lamina.

l=External lamina="Collis externus," Brandt,="Colline première qui suit exactement le bord," Cuvier.

m=Anterior area.

n=Posterior area.

the anterior (*m*) bears two *costæ* (*k* 1 & *k* 2), faintly divided from each other by a broad shallow V-shaped depression, while the *posterior* (*n*), tumid basally, is sloped off abruptly from the base towards the crown-summit. The presence of the *costæ* defines the tooth from the megarhine homologue, the tumidity of the *posterior area* (*n*) from the tichorhine. On the crown-surface the *anterior valley* (*a*) is more shallow than the *posterior* (*b*) ; and of the three *colles*, as in all the homologous teeth of the genus, the *median* (*e*) is the largest. The summit of the latter is flattened antero-posteriorly at its inner side ; and the transverse bridge of enamel that joins it from the *external lamina* is traversed by a notch ending in a cleft. The result of this arrangement would be, that in the slightly worn tooth the summit of the *median collis* (*e*) would exhibit a trefoil pattern, somewhat after the fashion of the teeth of the Pig and Hippopotamus. The low crown, the smoothness of the enamel, and the small size differentiate the tooth from the corresponding one of the tichorhine species, while the latter characteristic affords an easy means of defining it from the closely allied megarhine form.

4. *Permanent Upper Dentition*.—The entire permanent series of the teeth of this species was obtained by the late Mr. John Brown, of Stanway, from the brickfields of Lexden, near Colchester, in association with remains of *Hippopotamus major* and *Elephas antiquus*, and are preserved in the British Museum. The upper-jaw teeth very closely resemble those of the megarhine Rhinoceros, but are distinguished from them by the possession of the following characteristics:—by the rugosity of the enamel surface, by the development of a *third costa* (*k* 3) on the posterior area of premolars 3 and 4, by the concavity of the base of the *external lamina* (*l*), and by the inner side of the *collis* not being sloped off so abruptly as in the former species. As compared with the tichorhine Rhinoceros, the absence of the *anterior combing-plate* (*g*), so persistent in the teeth of that animal, the height of the entrance of the *anterior valley* in Premolars 3 and 4, the comparative smoothness and thinness of the enamel, the faintness of the *costæ* on the *external lamina*, the gradual slope of the *collis* on the inner side, and the great development of the *guard*, or stout ascending ridge of enamel on the anterior surface, are the salient points upon which a specific determination can be made. Besides these, also, the most noteworthy in the jaw under consideration are the stoutness of the *guard* in premolars 3 and 4, and the passage of a ridge across the entrance of their *anterior valley* (*a*). The posterior wall, also, or *third collis* bears a cusp, as in the tichorhine species ; but it is faintly developed and is soon worn away.

Figures 3 and 4 (Pl. X.), which I owe to the kindness of my friend Professor Phillips, F.R.S., of a right upper premolar 4, from the Crawley Rocks, near Swansea, show all the salient points of the Upper premolar dentition of the species ; while fig. 5, of a second upper true molar from Peckham, is typical of the leptorhine upper true molars. We are indebted to Professor Owen for a figure of the leptorhine first upper true molar from Clacton, in 'British Fossil

Mammals,' p. 141, which does away with the necessity of figuring that tooth.

The characters of the Lexden upper molars are found also in all those of the *Rhinoceros* of Kirkdale. In fig. 125 of the 'British Fossil Mammals' there is a tooth from this locality figured as the deciduous upper molar of the tichorhine species. Examined, however, by the light of other specimens discovered since that great work was written, the tooth in question, preserved in the British Museum, presents characters found only in the leptorhine species. The stoutness of the guard, the bevelling off of the inner surface of the anterior and middle collis, the absence of the *anterior combing-plate*, and, consequently, of the *accessory valley*, the large size of the *posterior valley* (A of Figure) differentiate it from the tichorhine, and prove it to belong to the leptorhine *Rhinoceros*. A comparison of the tooth with the figures given by Professor Brandt of the permanent teeth of *R. tichorhinus*, and with those of the deciduous dentition that I have published in the 'Natural History Review,' proves conclusively that it is non-tichorhine in character. It corresponds in every respect with a right upper premolar (4) in the Oxford Museum from the same cavern. The second right upper true molar, figured by Dr. Buckland in the 'Reliquiae Diluvianæ' (pl. 7. fig. 3), also presents characters essentially leptorhine—namely, the excavation of the base of the *external lamina*, the stoutness of the ascending *guard*, and the suppression of the *anterior combing-plate*. The tooth is very much worn; and the guard obliterated to such a degree that in the figure the section of it visible on the crown-surface presents merely a deep fold at the inner and anterior angle. The germ of a first premolar (Pm. 2), also from Kirkdale, and in the Oxford Museum, presents the peculiarity of the entrance of the *anterior valley* being completely blocked up, of the *median collis* being represented by a thin bridge of enamel crossing the crown-surface obliquely backwards from the inner to the outer side and insulating the *anterior* from the *posterior valley*. The latter, also, is larger than the former. All the remains of *Rhinoceros* from the Kirkdale Hyæna-den that have passed through my hands belong, without exception, to the leptorhine species of Professor Owen.

A right upper premolar (4), from the Crawley Rock Cave near Swansea, in the Oxford Museum, presents the peculiarity of having the *posterior combing-plate* (h, fig. 4) divided into two, as in the corresponding tooth of the megarhine species from Hérault, figured by M. Gervais (Paléont. Fr. pl. 2. fig. 4). It is figured as illustrating all the salient points in the upper dentition of the species, and not merely as a fine specimen of the last premolars. Upper leptorhine molars have also been found in two other bone-caverns in this country—in Gower, quoted by Dr. Falconer as belonging to *R. hemitæchus*, and in the cave on Durdham Down near Bristol, whence they were obtained by Mr. Stutchbury and deposited in the Bristol Museum. To the courtesy of Mr. William Sanders, F.R.S., I am indebted for their examination. They consist of the upper teeth of

the left side, with the exception of premolar 2. With the following exceptions they present all the characteristics of the series obtained from Lexden, above described. Premolar 3 presents a faint cusp at the entrance of the *anterior valley* (*a*) close to the cingulum. Premolar 4 has the *posterior combing-plate* (*h*) divided into three secondary folds, as in a corresponding tooth of the megarhine species, from the Forest-bed of Cromer, preserved in the collection of the Rev. J. Gunn, F.G.S. The first upper true molar also has a small cusp at the entrance of the *anterior valley*, and has the *third collis* divided from the *second* by a shallow notch, which, being worn away at an early period in the life of the adult, is not very often seen in the upper molars.

In the river-deposits of the Thames valley a leptorhine premolar 4 and molar 2 (fig. 5) were discovered in 1862, during the main-drainage works near Peckham, on the Surrey side of the Thames, and deposited in the British Museum. The matrix proves them to have been derived from a pale-grey clay, a point which is of considerable importance as marking the relative age of the leptorhine and tichorhine species in that particular locality. The premolar is remarkable for the development of two accessory *combing-plates* from the *median collis*, and their fusion, so that two accessory valleys are mapped off. The crown is uneven, and the *third costa* (*k* 3) strongly marked. The *third collis* is notched and cuspless. The true molar differs from the ordinary type of leptorhine upper molars, and approximates to the megarhine, in the external lamina not being hollowed basally; and were it not for the unequivocal evidence of the premolar 4 that belonged to the same jaw, it would be altogether a doubtful tooth. The Lower Brick-earths of Gray's Thurrock in Essex have furnished a second instance of leptorhine remains being found in the valley of the Thames, in a first upper true molar that agrees in all essential points with that from Clacton, figured by Professor Owen (Foss. Mam. fig. 141). The most remarkable discovery, however, is that made by Mr. Antonio Brady, F.G.S., of a leptorhine skull and lower jaw at Ilford. The former is very nearly perfect, and exhibits the demi-cloison or partially ossified septum between the nares, and the entire upper molar series. It also satisfactorily settles the question of the upper dental formula, as no trace of the premolar 1 is to be found on either side. With the exception of the last upper true molar, the description of the teeth from Lexden applies to these also, the *third collis* in the leptorhine (*M* 3) taking the form of a small cusp on the posterior border of the tooth, while in this it takes the form of a ridge. This variation is found also in the corresponding molars of *R. tichorhinus*. A fragment of the skull of the leptorhine species obtained from the same locality, in the cabinet of Dr. Cotton, F.G.S., exhibits also the entire upper molar dentition. With the exception of premolar 2, the first of the series, all the teeth bear the *third costa* (*k* 3) faintly developed. Leptorhine upper molars have been yielded also by the brick-earth on the south side of the Thames, at Crayford in Kent, and are in the collections of Dr. Spurrill and Mr. Grantham, to whose courtesy I am indebted for their examina-

tion. A last upper true molar, figured by Mr. Trimmer in the "Philosophical Transactions" for 1833, pl. ix., agrees exactly with the homologous leptorhine tooth from Lexden in the possession of the Rev. O. Fisher, F.G.S., and proves the occurrence of that species in the brick-fields of Brentford. It is quoted by Professor Morris*, on Professor Owen's authority, as tichorhine, from which, however, it differs in all the points already enumerated. In the Museum at York I also found evidence of the *R. leptorhinus* of Owen among the remains found at Bielbecks Farm, near Market Weighton, described in the 'Philosophical Magazine' for 1809. The suppression of the *anterior combing-plate*, the large development of the *guard*, the pyramidal shape of the *collis*, and the presence of the *third costa* present a combination of characters found in that species alone. From the same deposit were obtained the remains of the Cave-lion, Wolf, Horse, Mammoth, Bison, Urus, and Red Deer.

5. *Permanent Lower Dentition*.—The upper molar series in all the species of Rhinoceros, both recent and fossil, presents characteristics which enable us to detect the species from the examination of a single isolated tooth. The lower molars, on the other hand, are so remarkably alike in all the species that this is frequently impossible. In this respect, however, the tichorhine can be differentiated from the megarhine Rhinoceros, as I have already shown in my essays on their dentition. The leptorhine lower molars differ from the tichorhine in all those points by which the megarhine are characterized. In both, the obliquity of the wear of the enamel on the outer side of the crown-surface, caused by the overlapping of the upper teeth, contrasts with the even wear of the corresponding part of the tichorhine molars. In both, the first premolar (Pm. 2) is trenchant, and the *external lamina* presents a smooth, horizontally convex surface with a faint apical depression. The *anterior valley* is faintly impressed, the *posterior* is extremely shallow. In premolars 3 and 4 the *median groove* traverses the base of the *external lamina*. The leptorhine lower molars can, however, be differentiated from the megarhine by the coarser enamel-sculpture, and especially by the flattening of the *anterior area* (*m*) of the *external lamina*. These characteristics are found in all the lower teeth of *R. leptorhinus* which have been derived from the bone-caverns of Kirkdale or Durdham Down, and in all those which have been found in association with upper teeth in river-deposits, as in those figured by Professor Owen from Clacton and Walton, in Essex (Foss. Mam. figs. 12-136). Some non-tichorhine lower jaws, however, I am unable to assign with certainty to the leptorhine, megarhine, or Etruscan species.

The differences which Professor Owen notes between the lower teeth of the leptorhine and tichorhine species do not apply to their permanent dentition,—the lower rami of the latter species from Lawford and Thame, in the Oxford Museum, containing the milk-series, while the lower rami of the former, with which they are compared, present us with the permanent. While fig. 136 (*op. cit.*)

* Quart. Journ. Geol. Soc. vol. vi. p. 204.

is a most accurate figure of the leptorhine premolar 2, fig. 137 represents the first and second milk-molars, instead of the first and second premolars (Pm. 2 and 3) of the tichorhine Rhinoceros. In my essay on the latter species full evidence is given for this conclusion. In the lower jaw, figured by Professor Owen, from Clacton, the symphysis extends as far back as the middle of premolar 3.

A remarkably fine lower jaw from Lexden, containing the entire permanent set of teeth, with the exception of premolar 2, belongs to the same individual as the upper teeth from that locality described above.

The brickfields of Ilford, which have furnished the most perfect head of the leptorhine Rhinoceros, have yielded also numerous lower jaws belonging to the same species. One, in the possession of Mr. Antonio Brady, F.G.S., consisting of both rami, shows the spatulate termination of the jaw. On the rectangular area, anterior to the first premolars (premolars 2), formed by the horizontally flattened symphysial portions of the rami, are small depressions on the outer border, which probably are traces of embryonic incisors and canines. Several remarkably fine lower rami from the same locality are also in the collection of Dr. Cotton, F.G.S.

6. *Dental Formula*.—Although we have no absolute evidence as to the number of the milk-teeth of *R. leptorhinus*, the fact that in all the cases in which the milk-dentition of the genus *Rhinoceros* has been examined, it consists invariably of four teeth on either side of both jaws, leaves no room to doubt that this extinct species also possessed the same dental formula: $\frac{\text{Dm } 4}{\text{Dm } 4}$.

An examination of the entire dental series of the upper and lower jaws derived from the brick-earths of Lexden and Ilford prove that, like the tichorhine and Etruscan species, the permanent dental formula of the leptorhine was

I. 0	C. 0	Pm. 2.3.4	M. 1.2.3
I. 0	C. 0	Pm. 2.3.4	M. 1.2.3

7. *Measurements*.—The measurements taken at the base of the crown, in inches and tenths, are uniform with those of the preceding essays on the tichorhine and megarhine dentition. They are:—

1. Antero-posterior, taken along the outside of the crown.
2. Antero-transverse, taken across the anterior lobe of the tooth.
3. Postero-transverse, taken across the posterior lobe of the tooth.

A comparison of the Tables of the leptorhine and megarhine measurements proves that the teeth of the former are, on the whole, smaller than those of the latter.

TABLE OF MEASUREMENTS.

Permanent Upper Dentition.

Locality.	Tooth.	1	2.	3.
Lexden (Brit. Mus.)	Pm. 2	1.15	1.4	1.4
	Pm. 3	1.4	1.75	1.7
	Pm. 4	1.51	2.1	1.92
	M. 2	1.93	2.33	2.05
	M. 3	2.51	2.12	0.0
Lexden (Rev. O. Fisher).....	Pm. 2	1.15	1.19	1.28
	Pm. 3	1.26+	1.68	1.8
	Pm. 4	1.35+	2.0	1.81
	M. 3	2.2	2.1	...
Ilford (A. Brady, F.G.S.)	Pm. 2	1.25	0.0	0.0
	Pm. 3	1.51	2.05	2.05
	Pm. 4	1.7	2.4	2.35
	M. 1	1.88	2.55	2.4
	M. 2	2.25	2.73	2.5
Clacton (fig. 141 of Foss. Mam.) ..	M. 3	2.63	2.55	1.7
	M. 1	1.75	2.21	2.70
	M. 2	1.6	2.01	1.98
Grays Thurrock (Brit. Mus.)	Pm. 4	0.0	2.45	2.1
	M. 2	1.95	2.55	2.32
	M. 3	2.63	2.55	1.7
Durdham Down (Bristol Mus.)	Pm. 3	1.4	1.98	1.83
	Pm. 4	1.6	2.28	2.15
	M. 1	1.73	0.0	2.32
	M. 2	2.1	2.7	2.3
Bielbecks Farm (York Mus.)	M. 2	2.24	2.62	2.22

Permanent Lower Dentition.

Locality.	Tooth.	1.	2.	3.
Lexden (Brit. Mus. 37405),.....	Pm. 3	1.1	0.82	0.82
	Pm. 4	1.3	0.9	0.94
	M. 1	1.51	1.08	1.0
	M. 2	1.73	1.08	1.1
	M. 3	1.61	1.05	1.08
Ilford (A. Brady, F.G.S.)	Pm. 2	0.99	0.75	0.75
	Pm. 3	1.24	0.88	0.98
	Pm. 4	1.42	1.06	1.18
	M. 3	1.85	1.26	1.26
Clacton (Brit. Mus.)	Pm. 2	1.08	0.6	0.79
	Pm. 3	1.3	0.8	1.05
	Pm. 4	1.48	1.0	1.21

8. *Range in Britain.*—Of the four British species of *Rhinoceros*, the tichorhine is confined to the Postglacial deposits, and occurs in them throughout Britain, France, Germany, and Northern Russia. The megarhine, on the other hand, abundant in the Pliocene deposits of the Val d'Arno and of central France, has a limited range in this country, being confined to the brick-earths and gravels which occupy the lower part of the Thames valley, and which, from their position beyond the edge of the Boulder-clay, are of equivocal age,

and to the Preglacial Forest-bed on the Norfolk Coast. The fauna, indeed, of the former is more Preglacial than Postglacial in character, and differs from that of any other British river-deposit. The discussion of the Etruscan species we must reserve for a future essay. The range of the fourth, or *R. leptorhinus* of Professor Owen, is worthy of a most careful analysis, because of a current idea that it characterizes an epoch anterior to that of the Mammoth and tichorhine Rhinoceros. In the caverns of Gower*, ably described by Dr. Falconer, it is mentioned (under the name of *R. hemitœchus*) as being found in Minchin and Boscoe's Holes in association with *Elephas antiquus*, which latter species is particularly abundant in the Pliocene deposits of Italy, and in Preglacial British deposits. In Kirkdale Cavern, again, it occurred in association with *Elephas antiquus* and *Hippopotamus major*; and in the cave on Durdham Down the same three species were found associated by Mr. Stutchbury. Are we, then, to infer the Pleistocene deposits in which *Rhinoceros leptorhinus* occurs to be of higher antiquity than those from which it is absent? The evidence afforded by the association of organic remains in other localities seems to me incompatible with any such view. In the brick-earth at Ilford, for example, it is found in association with

<i>Felis spelæa.</i>	<i>Elephas antiquus.</i>
<i>Canis lupus.</i>	— <i>primigenius.</i>
<i>Ursus spelæus.</i>	<i>Equus fossilis.</i>
<i>Bos primigenius.</i>	<i>Rhinoceros megarhinus.</i>
<i>Bison priscus.</i>	<i>Castor Europæus.</i>
<i>Cervus elaphus.</i>	<i>Arvicola amphibia.</i>

From the Hyæna-den of Wokey Hole I have also obtained the leptorhine Rhinoceros under circumstances that do not admit of doubt as to its being of the same relative age as the other animals found in the cave. It was associated with

<i>Homo.</i>	<i>Canis lupus</i>
<i>Felis spelæa.</i>	— <i>vulpes.</i>
<i>Hyæna spelæa.</i>	<i>Meles taxus.</i>
<i>Ursus spelæus.</i>	<i>Cervus elaphus.</i>
— <i>arctos.</i>	— <i>tarandus.</i>
<i>Bison priscus.</i>	<i>Elephas primigenius.</i>
<i>Bos</i> — ?	<i>Equus fossilis.</i>
<i>Megaceros Hibernicus.</i>	<i>Rhinoceros tichorhinus.</i>

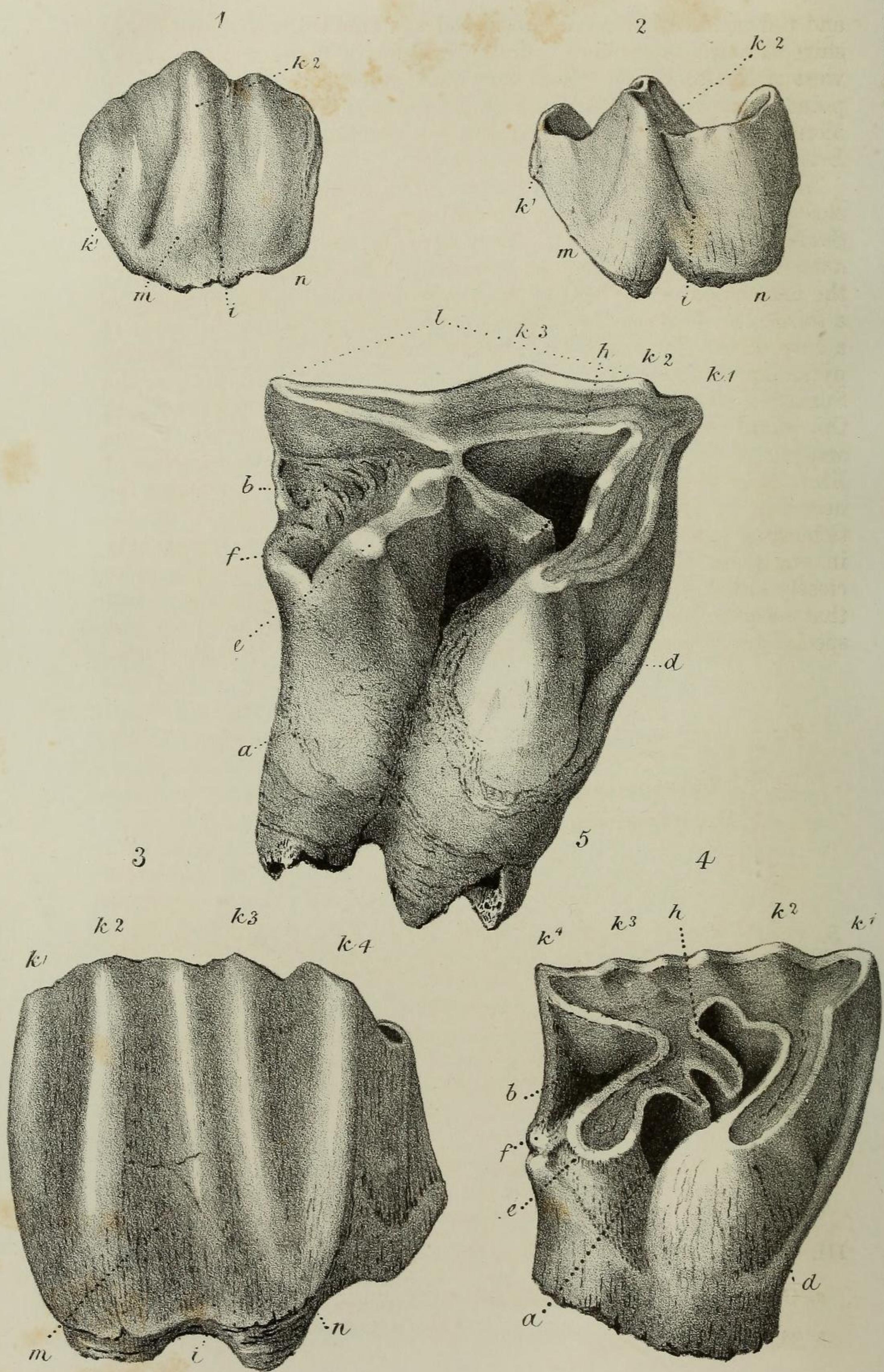
In both these cases it is found side by side with nearly the whole of the species which characterize the British Pleistocene period—*Elephas primigenius*, *Rhinoceros tichorhinus*, the spelæan Bear, Lion, and Hyæna. In the first, the leptorhine carcasses were borne down by the floods along with those of the other animals, and covered up by the silt or brick-earth which those floods deposited at Ilford. In the second, a young individual of the species happened to fall a prey to the Hyænas of Wokey Hole, and its remains have been preserved along with those of the other victims of different species that lived in the same Geological Epoch. A third instance of its occurrence,

* Quart. Journ. Geol. Soc. vol. xvi. p. 489.

at Peckham, places its relative age beyond all doubt. For the particulars of its "gisement" I am indebted to Mr. Davis, of the British Museum. In the construction of the sewer at Rye Lane, near Peckham, in 1862, the following strata were cut through:—

Vegetable soil.
3. Sandy gravel, 3 to 4 feet.
2. Light banded clay, 10 to 12 feet.
1. Peat, containing fragments of trees.

The remains obtained from the light clay, and preserved in the British Museum, comprise the incisor and canine of *Hippopotamus major*, the humeri of *Bos urus* and *Bison priscus*, the antler of a Deer, and two teeth and a tibia of *Rhinoceros leptorhinus*. The matrix still adherent to the specimens proves conclusively that they were derived from the pale-grey clay (2). From the peat which underlies, and which therefore is older than, the clay, was obtained the fine series of teeth of *Rhinoceros tichorhinus*. The deep-black colour of these, places the fact of their having been imbedded in the peat beyond all doubt. In this particular case, then, the remains of the tichorhine were deposited in the peat (1) before those of the leptorhine species in the clay (2). Had there been no other evidence of the date of the latter, this section might have been cited to prove that the leptorhine was of more modern date than the tichorhine Rhinoceros. Checked by other discoveries, it is a warning against too hasty generalizations. The sum, indeed, of the evidence of the range of the species, both in space and time, is simply this:—While it is perfectly true that in several instances the species has been found associated with the Pliocene *Elephas antiquus* and *Hippopotamus major*, as in the caves of Kirkdale, Durdham Down, and Gower, and in the Lexden Brickfields, the most common and characteristic Pleistocene mammals being absent, viz. the Mammoth and tichorhine Rhinoceros, its occurrence, in the Hyæna-den at Wokey and in the brick-earth of Crayford, with these latter two species forbids the hypothesis of its characterizing an epoch *anterior to the spread of these animals over Britain*. The "gisement" of the remains of Rhinoceros at Peckham would prove that, in some particular places, the leptorhine was imbedded in deposits of absolutely later date than the tichorhine species. At Brentford it is associated with Reindeer, and at Bielbecks with Cave-Lion and Mammoth. Whether or not, like the *Hippopotamus major* and *Elephas antiquus*, it lived in Pliocene times, and can be viewed as an animal that lingered on into the Pleistocene, is altogether an open question, as its correlation with the continental species is by no means satisfactorily decided. There is no proof of its having inhabited Preglacial Britain, as the remains from the Forest-bed on the Cromer shore in the collection of Mr. Fitch, of Norwich, ascribed by Professor Owen to *R. leptorhinus*, viewed by the light of other remains in the cabinets of the Rev. S. W. King and the Rev. J. Gunn, belong to the new and undescribed Pliocene species the *Rhinoceros Etruscus* of Dr. Falconer. In a word, the localities in Britain in which *Rhinoceros leptorhinus* has been found, and its association with other spe-



and tichorhine Rhinoceros, that it had an extended range from Yorkshire, through the eastern counties, into South Wales and the southwest of England, that it was very much inferior to those species in point of numbers, and, lastly, that it lived in the valley of the Thames along with *R. megarhinus* and *Elephas priscus*, and throughout its British range with *Hippopotamus major*.

9. *Living Representative Species.*—The living species that most closely resembles the extinct leptorhine is the bicorn Rhinoceros of Sumatra (*R. Sumatrana*). They agree in the suppression of the *anterior combing-plate* (*g*), so persistent in the tichorhine species, in the excavation of the base of the *external lamina*, in the presence of a *third costa* (*k 3*) in the upper premolar series, in the presence of a cusp on the *third collis* (*f*), in the stoutness of the guard, and the pyramidal shape of the *colles* (*d, e, f*). They differ in that in the Sumatran species the *posterior combing-plate* (*h*) is suppressed, and the guard is feeble in the upper premolars. A reference to the analysis of the dental peculiarities of the other existing species of Rhinoceros in the article on the megarhine Rhinoceros obviates the necessity of its repetition in this place. The dentition of the tichorhine agrees with that of the leptorhine Rhinoceros remarkably in one point, that it is more specialized, or, in other words, more closely allied to that of living species than the megarhine,—a fact that seems to me to indicate that both came into being after the less specialized *R. megarhinus* had existed for some time upon the earth.

EXPLANATION OF PLATE X.

Fig. 1. Right upper milk-molar 2, nat. size. Wokey Hole.
 2. Left lower milk-molar 3, nat. size. Wokey Hole.
 3. } Right upper premolar 4, nat. size. Crawley Rocks.
 4. }
 5. Upper true molar 2, nat. size. Peckham.

3. On the STRATA which form the BASE of the LINCOLNSHIRE WOLDS. By JOHN W. JUDD, Esq., F.G.S.

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