Quarterly Journal of the Geological
Society

**On the Fossil remains of Mammalia
referable to the genus Palæotherium,
and to two genera, Paloplotherium and
Dichodon, hitherto undefined: from the
Eocene Sand at Hordile, Hampshire**

Owen

Quarterly Journal of the Geological Society
1848, v.4; p17-42.
doi: 10.1144/GSL.JGS.1848.004.01-02.11

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Notes

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trawl of an Ostend fishing-smack, about ten or fifteen miles off the island of Texel. The tusk, when fished up, was entire, and measured about 11 feet long, but was broken to pieces by the fishermen. The part obtained by Mr. Dalton is $4\frac{1}{2}$ feet in length, and measures about 8 inches in diameter. When found the enamel was hard and sound, but the whole of the interior in a soft state.

JUNE 16, 1847.

Sir James Ramsey, Bart., of Banff, Forfarshire, William B. Carpenter, M.D., Charles Walker, Esq., and J. H. Norton, M.D., were elected Fellows of the Society.

The following communications were then read :—

1. *A Letter to the PRESIDENT from LEONARD HORNER, Esq., F.R.S. L. & E., dated Bonn, June 1847.*

In this letter Mr. Horner mentions that he had been informed by M. von Dechen, that some well-preserved remains of Saurian reptiles had recently been discovered in the Saarbruck coal-field, celebrated for containing several species of fossil fish. Mr. Horner gives some details of the structure of these Saurians so far as they were then known, and states that the specimens had been entrusted to Prof. Goldfuss for description.

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2. *On the Fossil remains of MAMMALIA referable to the genus PALÆOTHERIUM, and to two genera, PALOPLOTHERIUM and DICHODON, hitherto undefined: from the EOCENE SAND at HORDLE, HAMPSHIRE.* By Professor OWEN, F.R.S., F.G.S.

PART I.—*Description of Teeth of a Palæothere, from Eocene sand, Hordle, resembling those of the species called Palæotherium medium, figured in CUVIER's 'Ossements Fossiles,' t. iii. pl. 42. fig. 1.**

TO ALEXANDER PYTTS FALCONER, Esq. of Beacon, Christchurch, Hants, and to his brother THOMAS FALCONER, Esq. of Wootton in the same county, British Palæontology is much indebted for some new and highly interesting fossil remains, which they have obtained at considerable trouble and expense from the Eocene freshwater formation in the cliffs at Hordle, Hants. I beg to express my sincere acknowledgments to those gentlemen for their liberal transmission to me, from time to time, of their valuable acquisitions from this interesting stratum, of which I purpose on the present occasion to describe the specimens of jaws and teeth of the herbivorous or hoofed Mammalia.

* The quarto edition of 1822 is cited throughout this paper.

Amongst the earliest examples received of this order were molar teeth of a true *Palæotherium*.

A single fragment of an upper molar tooth (fig. 1), with the outer side of the crown broken away at the enamel-line, like the letter W, but including the inner half with the oblique peninsular fold (*e*) and island (*e'*) of enamel, and the two parallel oblique tracts of dentine, *i'*, *i*, presents the typical characters of the upper molars of the genus *Palæotherium*: it was the first evidence of that genus which I had seen from a formation of what, in relation to the Isle of Wight, may be termed continental England. The tooth, when entire, has agreed with the first of the three true molars in fig. 14. pl. 47. and fig. 1. pl. 56. of the 'Ossemens Fossiles,' tom. iii. The ridge *r* at the fore part of the base of the tooth, and the short ridge *e* closing the entry to the oblique fold or valley, are present, as in the true *Palæotheres*. The tooth is smaller than the upper molar represented in fig. 3. pl. 4. tom. cit., and can only be referred to the *Palæotherium medium* as represented in the other plates above-cited, from the immortal work of Cuvier. Some lower molar teeth (figs. 2 & 3) also exhibited all the typical characters of that part of the genus *Palæotherium*: viz. the two semicylindrical lobes, *o*, *o*, the single point at the reunion of their contiguous angles to form the middle lobe on the inner side of the crown (*i*), and the basal ridge (*r*): this is divided into an external and an internal portion, both of which send their anterior and posterior extremities obliquely upwards to corresponding angles of the two lobes. The crown is supported by two strong and long fangs grooved longitudinally on the sides turned towards each other, and with a thick coat of cement at their base, *c*. The tooth figured was much worn; it is but a millimeter less in antero-posterior extent than the penultimate molar of the *Palæotherium medium*, in the portion of lower jaw, fig. 2. pl. 42. of the 'Ossemens Fossiles,' t. iii. It is three millimeters shorter in the same dimension than the corresponding tooth in the lower jaw figured in pl. 40. fig. 1, t. cit., which is also referred by Cuvier to the *Pal. medium*.

Soon after receiving these, the first evidences of a proper English *Palæotherium*, Mr. Pytts Falconer transmitted to me from the same

locality and deposit three portions of the lower jaw of the same species of *Palæotherium*; two of which formed part of the same ramus, the left, and contained three grinders together with the last characteristic three-lobed one (fig. 4, *m* 3), by which the *Palæothere* differs from the *Rhinoceros*, *Hyrax*, *Macrauchenia*, and other Pachyderms with the lower grinders in two semicylindrical lobes. The other teeth in this fragment were the second (*m* 2) and first (*m* 1) true molars and the last premolar (*p* 4). The antero-posterior extent of the series and of each individual tooth very nearly equalled those in the fig. 2. pl. 42. tom. cit., attributed by Cuvier to the *Palæotherium medium*; in which figure, however, the teeth are somewhat smaller than those in the entire jaw, fig. 1. pl. 40. tom. cit., also attributed by Cuvier to the *Pal. medium*.

Thus the antero-posterior extent of the series of three true molars in the Hordle *Palæothere* (fig. 4) is 3 inches 1 line (7 centimeters 11 millimeters), and in fig. 2. pl. 42. tom. cit. it is 3 inches 3 lines (8 centimeters 3 millimeters); whilst in fig. 1. pl. 40. tom. cit. the antero-posterior extent of the corresponding teeth is 3 inches 5 lines (8 centimeters 6 millimeters). The lobes of the molars of the Hordle specimen are also triangular, rather than semicylindrical: the outer convexity, instead of being smoothly rounded presenting a well-marked angle, notwithstanding they are worn nearer to the base than are the teeth attributed to *Pal. medium* in the Cuvierian figures above cited.

The direct view of the grinding surface by which the difference of the Hordle molar teeth in the shape of their lobes could be best tested is not given by Cuvier in regard to the *Palæotherium medium*; those of the *Pal. crassum* figured in pl. 39. fig. 2. most accurately coincide with the semicylindrical form ascribed to the lobes of the lower molars of the *Palæothere* in the text of the 'Ossemens Fossiles,' and differ in a marked manner from the angular form of the same lobes in the Hordle *Palæothere*, as well as by their smaller size. Of the accuracy of the Cuvierian figure we have the opportunity of judging by the beautiful casts of the skull of the *Palæotherium crassum* in the British Museum and other collections in London.

I am led, therefore, to suspect that the species of *Palæothere* represented by the fragments of lower jaw and teeth from Hordle may be distinct from the *Palæotherium medium* represented by the lower jaw from Montmartre, figured in pl. 40, and referred to at p. 67 of the 'Ossemens Fossiles,' tom. iii. as a typical example of that species.

The distinction of the Hordle specimen from the species represented by the portion of lower jaw (pl. 42. fig. 2) is more doubtful: this figure shows, as far as a side-view can, a more angular figure of the molars than in fig. 1. pl. 40. It shows also a smaller size of the molars, though these still slightly surpass those of the Hordle *Palæothere*. Fig. 2. pl. 42. shows a slight difference in the shape of the angle of the jaw as compared with fig. 1. pl. 40; it is however referred to the *Pal. medium* in the description of the plates in the posthumous 8vo edition of the 'Ossemens Fossiles;' and it may have belonged to a female of that species. I purpose, therefore, to

register provisionally the Hordle fossils here described under the name of *Palæotherium medium*.

Fig. 4.

Grinding surface of lower molars. *Palæotherium medium*?

PART II.—Description of Lower Molar Teeth from Hordle, indicative of a distinct generic form in the Palæotherioid family.

SOME fragments of inferior molar teeth of a smaller Palæotherioid, among which was an entire crown (figs. 5 & 6), proved most decidedly the former existence of a species of this family of Pachyderms in the Hordle deposits, distinct from any of those previously recorded by Cuvier or other authors.

Fig. 5.

Fig. 6.

Lower molar. *Paloplotherium*.

The two semicylindrical lobes *o*, *o'*, were less angular than in the preceding species of true Palæothere from Hordle; but the basal ridge was absent from the inner side of the crown (fig. 6), and was reduced at the outer side (fig. 5, *r*) to a rising at the bottom of the median fissure, and to two terminal and very oblique ridges, the posterior of which ended by forming a distinct tubercle (*t*) behind the hinder semicylindrical lobe (*o'*).

These characters indicated something more than a distinct species of *Palæotherium*. But as other and more decisive characters of its generic distinction were afforded by more complete specimens of jaws and teeth of the same species from the same formation and locality, subsequently transmitted to me by the Marchioness of Hastings and Mr. Falconer, I shall proceed to the description of these specimens without further dwelling upon the earlier and more fragmentary evidences.

PART III.—Description of the Lower Jaw with the deciduous and permanent Teeth of a new genus of Palæotherioid, for which the name of *Paloplotherium* is proposed.

(Pl. III. figs. 3 and 4.)

AN almost entire lower jaw (Pl. III. figs. 3 & 4) obtained from Hordle Cliff, and kindly transmitted to me by Alex. Pytts Falconer, Esq., has an uninterrupted series of six entire grinding teeth on each side, se-

parated by a vacant tract from the series of alveoli of the two canines and six incisor teeth ; which series describes two-thirds of a circle at the slightly expanded anterior extremity of the jaw : an interspace of scarcely two lines extent separates the canine on each side from the incisors. The molar teeth progressively increase in size from the first to the sixth : the last four have the crown composed of two crescentic or semicylindrical lobes corresponding with the type of those of the genera *Rhinoceros*, *Hyrax*, *Macrauchenia* and *Palæotherium* : the last (M 2), like the penultimate one, having only a small tubercle (*t*) at its back part, in the place of the third lobe characteristic of the last molar of the true *Palæotheres*.

The first molar (Pl. III. figs. 3 & 4, D 1) has a conical crown, convex externally, flat and slightly indented internally, with a basal ridge or cingulum, which, instead of completing the circle behind, bends upwards to near the summit of the cone : this tooth is implanted by two diverging fangs. The crown of the second molar (*ib.* D 2) also consists chiefly of one conical lobe with two indentations on its inner side ; the cingulum is interrupted at both the outer and inner sides of the base of the cone ; but its posterior part rises, or sends a strong ridge upwards to the inner part of the apex of the cone, and there is a depression both before and behind this ridge. This tooth is implanted by two fangs, as is each of the other grinders. The crown of the third tooth (*ib.* D 3) assumes the general character of those of the *Palæotherium*, consisting of two semi-conical lobes, which from the attrition of their summits and the deep indentation of their inner sides assume the form of half-cylinders ; their contiguous angles are confluent and form the middle lobe (*i*) of the inner surface of the tooth ; there is no ridge at the base of this surface. On the outer side of the crown a ridge extends from the base of the anterior lobe to its anterior upper angle ; and a second ridge curves from the outer part of the base of the hinder lobe upwards to its hinder summit ; a short ridge closes the base of the outer vertical cleft between the two lobes. The fourth molar (*ib.* D 4) shows, in addition to its superior size, a minute worn tubercle (*t*) behind the hinder angle or summit of the hinder lobe *o'* ; and the anterior and posterior oblique ridges are more decidedly distinct from the short middle external basal ridge. The fifth molar (M 1) differs from the fourth in the greater depth of the inner excavations or cavities of the lobes, which partly depends on its having been less worn : the hinder angle of the hinder lobe (*o'*) has not been worn down to the level of the small tubercle (*t*) which forms the summit of the posterior ridge ; which ridge, like the anterior one, is now nearly vertical. The sixth grinder (*m* 2) has only come into use at the fore part of the anterior lobe ; the enamelled summit of the hind lobe is intact, and forms a semicircular ridge slightly mammillated ; its anterior angle is below the level of the posterior one of the anterior lobe, from which it is separated by a tubercle (*i*) formed by the obtuse summit of the middle lobe of the inner surface of the crown. The hinder ridge expands at its summit into an obtuse tubercle (*t*), terminating about two lines below the summit of the hinder lobe.

Had all the molars above described belonged to the permanent series, they would have differed from those of the *Palæothere* not only in their minor number—six instead of seven—but also in the simpler form of the last molar, as well as by the tubercle at the summit of the posterior ridge in the three last molars. A small orifice, however, in the alveolar border (fig. 3, 3), behind the last molar in place, led me to suspect the existence of another molar in a concealed alveolus, and on removing a portion of the outer wall of the jaw, the germ of such a molar was exposed, consisting of the shell of the crown (fig. 4, 3). This seemed to make the number of grinders the same as in the *Palæotherium*, but the hidden grinder resembled the crown of the last one in place, and had not the third lobe which characterizes the last true molar of the *Palæotherium*; whilst the second grinder (D 2) still opposed its small size and unilobate structure to an accordance with the generic dental character of the *Palæotherium*. Observing, next, that the fourth grinder (D 4), in the jaw from Hordle, had been much more worn by mastication than the succeeding tooth (M 1)—now proved to be the first of the three true molars—I was led to suspect that D 4 might be a deciduous tooth, knowing that the permanent one when in this position has its crown less worn in all known *Herbivora* than the first true molar behind it; and that it comes into place either at the same time as the last true molar or a little later. The degree of attrition of the third tooth in place (D 3) indicated that it also might be one of the deciduous series; and the extent to which the fangs of all the four anterior grinders were exposed, together with some minute foramina on the inner border of their sockets, determined me to search for traces of successors beneath them. The search was successful, and the germs of the permanent premolars, not indeed equal in number, but almost co-extensive, with the four anterior grinders which they would have displaced and succeeded, were discovered (fig. 4, P 2, 3, 4). These germs consist of the entire crown widely excavated at the base. The first (*ib.* P 2) is chiefly composed of one semiconical lobe with a basal ridge interrupted at the outside of the base of the cone, but developed behind into a wing-like appendage, *o'*: the apex of the crown points below the interspace of the first and second deciduous molars, both of which it would have displaced. The second premolar (*ib.* P 3) lies beneath the third milk-molar; it resembles the first premolar in shape, but is of larger size, and has the hinder wing-like process (*o'*) more developed: this process presents a flat and nearly vertical surface outwards, and is convex at the inner and back part of its base. The third premolar (*ib.* P 4) consists of two semicylindrical lobes like the true molars and like the last milk-molar which it would have succeeded: like them, also, it has no basal ridge on the inner side of the crown, and that on the outer side is interrupted and represented by the oblique anterior and posterior ridges, the latter of which terminates in the characteristic tubercle *t*. In all existing hoofed quadrupeds (Proboscians excepted), the last milk-molar presents and foreshadows, so to speak, the peculiarity in the form of the last true molar, when this tooth differs from the others;

and it might have been inferred, therefore, from the bilobed figure of the tooth now determined to be the last milk-molar, that the last true molar must also have had a bilobed crown, if even the state of the specimen had not permitted the actual demonstration of this generic distinction from the *Palæotherium*, as in fig. 4, M 3.

Thus the specimen in question having belonged to an individual at almost the greatest age compatible with the retention of the deciduous molars, gives the dental formulæ of the lower jaw of both the immature and adult states of the species: *e. g.*—

Deciduous or milk-teeth : *i.* $\overline{3-3}$; *c.* $\overline{1-1}$; *m.* $\overline{4-4}$.

Permanent teeth : *i.* $\overline{3-3}$; *c.* $\overline{1-1}$; *p.* $\overline{3-3}$; *m.* $\overline{3-3}$.

The animal has perished, in fact, at that age when the jaws contain the greatest number of molar teeth, not less than twenty, for example, being lodged in the lower jaw in question. The teeth in use are the four milk-molars, and the first and second true molars on each side : those still concealed in the jaw are the three premolars and the last true molar. The premolar which is wanting to complete the normal number is that which should have succeeded the first deciduous molar, and which would have answered to the first small premolar in the true *Palæotheria** : I have therefore indicated the three premolars that are developed in *Paloplotherium* by the same signs as those which designate their homologues in the *Palæotherium*†. The non-succession of D 1 by a P 1, and its displacement together with D 2 by P 2, is a modification in which *Paloplotherium* resembles *Equus*‡ : and this instance of affinity is extremely interesting in connexion with the approach made by certain Palæotheres (*Pal. Aurelianense*, *e. g.*) to the monodactyle character of the Horse, by the disproportionate size of the middle of the three toes on each foot.

In the comparison of a detached true molar of the present Palæotherioid with the typical species, since the character of the bifid middle internal lobe would be lost by a moderate amount of wear of the crown, and since the tubercle terminating the hinder ridge would be obliterated by a further extent of abrasion, it may be remarked that lower grinders of the *Paloplotherium* may be distinguished by the absence of the basal ridge along the inner side of the crown, as well as of that which, in the true Palæotheres, unites the anterior and posterior oblique ridges along the outer side of the base of the crown.

A portion of lower jaw from the Hordle Cliff (Pl. IV. fig. 1), of a younger animal than the above-described, having the four milk-molars (D 1-4) and the first true molar (M 1) in place, showed by the character of the crowns of these teeth, and especially by that of the permanent true molar, its distinction from the typical Palæotheres, and its specific identity with the *Paloplotherium* above-described from the same stratum and locality.

The crown of the second true molar was found almost completely

* See my 'Odontography,' pl. 135. fig. 6. p 1.

† *Ib.*

‡ *Ib.* pp. 572, 580, pl. 136. figs. 4 & 5.

formed in its closed alveolus. The crowns of the last two premolars, and of the last true molar, were represented by the detached, first-formed, enamelled summits of their lobes: of that of the first premolar (*p* 2) I could find no trace, but a smooth round cell indicated that a matrix had been developed, and, by its situation beneath the interspace of the first and second milk-molars in place, that the tooth it was destined to form would have displaced and succeeded both those milk-molars. The comparatively little-worn summits of the milk-molars showed the characters of their crowns better than in the more advanced jaw. The posterior oblique ridge in the third and fourth terminates in a minute tubercle. The slightly abraded summit of the first true molar also showed a similar but better-developed tubercular termination of the posterior ridge.

The detached molar teeth of the above-described species are intermediate in size between those of the *Palæotherium crassum* and *Palæotherium curtum*. The species to which they most nearly approximate in this respect is that represented by Cuvier in pl. 4. fig. 1. of the 'Ossem. Foss.,' tom. iii, and referred to at p. 67, tom. iii, as one of the types of the *Palæotherium medium**. I so strongly suspect an error in the reference to this species, and perceive so much in the figure that requires further elucidation, that I am disposed here to offer a few remarks respecting it. This remarkable fossil was first described and figured by M. Lamanon, in the 'Journal de Physique' for March 1782: he compares its dentition with that of many known living mammals, and arrives at the conclusion that it belongs to a species which no longer existed on the earth†.

* One of the objects of a recent visit to Paris was to examine the original; but M. Laurillard informed me that the specimen was not in the public collections at the Garden of Plants, and that it had been only temporarily entrusted to Baron Cuvier for description.

† "On ne peut enfin rapporter ces ossements à aucun des animaux terrestres que nous connaissons." (p. 184).—"On est fondé à dire que c'est un animal dont l'espèce est perdue."—"La forme des dents prouve qu'il se nourrissait d'herbes et de poissons; et je juge qu'il était Amphibie." (*ib.* p. 185.)

M. Cuvier, in citing this memoir of Lamanon's, in the third volume of the first edition of the 'Ossements Fossiles,' p. 2, says: "Il décrit des dents, des vertèbres et une moitié de tête dont nous parlerons dans la suite, qu'il jugea venir d'une espèce perdue d'Amphibie." M. de Blainville blames the brevity of this citation, "sans même expliquer ce qu'en France alors on entendait sous ce nom:" and, after quoting Cuvier as having affirmed that Lamanon meant "un amphibie que se nourrissait de chair et de poissons," endeavours to fasten a charge of bad faith upon the author of the 'Ossements Fossiles,' by asserting that Lamanon had determined the fossil in question to be "un herbivore amphibie, comme on appelé alors le Tapir et l'Hippopotame." (Ostéographie, fasc. xxi. p. 13.) What Lamanon understood, or what naturalists generally signified, by the term 'Amphibie' in 1782, it would not be easy to define. In another place, M. de Blainville himself says: "Il faut se rappeler que sous cette dénomination, en France, on comprenait alors les Phoques, les Hippopotames, les Loutres, les Castors." Now, M. Lamanon compares his fossil with the beaver, and concludes by supposing that in addition to herbs, the animal fed, like the seals and otters, on fish. Had Cuvier cited M. Lamanon as affirming his fossil animal to have fed on flesh and fish, he might have been open to the comments in which M. de Blainville indulges. But Cuvier's words are: "Lamanon...conclut que c'était un amphibie que vivait à la fois d'herbe et de poisson." (Ossements Fossiles, 4to, iii. 1822, p. 27.)

But Lamanon imagined it to be an aquatic animal, and calls it an 'amphibiolite sans analogues' (p. 185).

The engraving of the fossil in pl. 2. of the 'Journal de Physique,' Mars 1782, is, as Cuvier rightly observes, reduced one-third; (the original drawing was probably, as Lamanon states, p. 183, of the natural size). The engraving in the 'Ossemens Fossiles' has the superior advantage of both being of the natural size, and of having been drawn by Cuvier's own hand:—"dessinée par moi-même au compas*." The lower jaw shows four entire bilobed molars, *d*, *e*, *f*, *g*, in place, the roots of another anterior to them (*h*), and the germ of a sixth beneath the base of the coronoid process at *m*; which Cuvier describes as the "germe de molaire postérieure inférieure." He does not appear to have determined its tripartite structure. But assuming that so characteristic a form of the last true molar had not escaped, as it was little likely to do, the notice of Cuvier, and that it had afforded him the true ground for his determination of the tooth, then the molars marked *d* and *e* must be the second and first true molars: and as the next tooth in advance, *f*, has but two semicylindrical lobes, it cannot be the last deciduous molar; since this would show the three divisions in a true *Palæotherium*, like the species figured by Lamanon. The teeth, then, that are present in the specimen must be, according to the description given by Cuvier, the following: *g* is *p* 3, *f* is *p* 4, *e* is *m* 1, and *d* is *m* 2; or the series in place consists of the third premolar and the penultimate molar inclusive. Now the antero-posterior extent of these four teeth is 2 inches 5 lines (6 centimeters); that of the same teeth in the *Palæotherium medium* (pl. 40. fig. 1) being 3 inches 6 lines (9 centimeters). Lamanon says the jaw is 6 inches (French) in length (the admeasurement does not include the condyle); that of *Palæotherium medium* in pl. 40. is 9 inches (French) between the same parts.

The difference in the size of the jaws figured in pl. 4. and pl. 40. tom. iii. of the 'Ossemens Fossiles' might be explained by a difference of age in the original specimens; but as the size of the crowns of the teeth do not alter with age, the great discrepancy in this respect between the two specimens seems to be quite incompatible with their specific agreement.

Both specimens are however called *Palæotherium medium* by Cuvier, in his reference to the typical examples of that species at p. 67, tom. cit. and the editors of the posthumous 8vo edition ascribe the figure 1. pl. 4. (their pl. 83) to the 'young *Palæotherium medium*.' The great discrepancy, however, in the size of the permanent molar teeth, is neither accounted for, nor indeed adverted to. The indications of the canine and incisors may be those of the milk-teeth, since these are not shed in Ruminants until the permanent molars and premolars are in place: the much-worn and broken tooth *h* may be the second milk-molar, also not shed; but the four entire and evidently permanent molars indicate a species of *Palæotherium* intermediate in size between the *Pal. crassum* and the *Pal. curtum*; or one of nearly the dimensions of the *Paloplotherium* of Hordle; but differing from

* Annales du Muséum, iii. p. 292.

that species in having the molar teeth of the typical palæotherian form; and in having the third premolar (P 3) bilobed.

I may add that the coronoid process in fig. 1. pl. 4. tom. iii. 'Ossem. Foss.' is 3 inches 1 line in height, whilst that of fig. 2. pl. 42, *ib.*, with much larger molar teeth, is only 2 inches 1 line in height*. The height of the coronoid process in the Hordle Palæotherioid jaw is 2 inches 10 lines; its proportion to the teeth is therefore much nearer that of the Palæotherium in pl. 4, than that of the older and larger Palæotherium in pl. 42. tom. cit.

The *Palæotherium Aurelianense*, the differential characters of whose upper molars from those of the typical Palæotheres will be noticed in connexion with the fossil upper jaw of the *Paloplotherium* from Hordle, presents corresponding differences, as compared with the Montmartre *Palæotheria*, in the molar teeth of the lower jaw; these differences are regarded as of generic value by M. V. Meyer, but by Cuvier as specific distinctions only; and he thus describes them:—"The meeting (rencontre) of the two arches or crescents forms a double point at the middle of the internal surface (of the crown, fig. 5, *i*); whilst that point is always simple in the Palæotheres of the environs of Paris."—"The last lower molar has its third lobe shaped like a cone rather than a crescent."

The complete lower jaw of the immature Palæotherioid from Hordle presents, as we have seen, the four false molars and the first and second true molars in place. The middle inner lobe (Pl. III. fig. 3, *m* 1) is slightly bifid; but this is due to a cleft in the summit of that lobe, and not to an imperfect or interrupted meeting of the two crescents: the posterior crescent *o'* does not rise so high as the anterior one *o*, but terminates by abutting against the middle bifid internal lobe, without forming a distinct point. The bifid character, therefore, is apparently differently produced, and is certainly much less marked in the lower molars of the *Paloplotherium* than it is described to be and is figured in the lower molars of the *Palæotherium Aurelianense* (*An-*

* I regard this difference as decisive of the specific distinction of the two Palæotheres above compared: both, however, are cited as examples of the *Palæoth. medium* in the 'Palæologica' of V. Meyer, p. 84; the 'Fauna der Vorwelt' (1847) of Siebel, p. 188; and other similar compilations.

M. de Blainville, in the Critique on the Cuvierian species of *Palæotherium*, does not notice any of the differences between the skull and teeth figured in pl. 4, and the specimens figured in pls. 40 and 42, tom. iii. of the 'Ossem. Fossiles': he states, however, that the original of Lamanon's figure had recently been acquired for the Museum of the Jardin des Plantes (Ostéographie, fasc. xxi. p. 26): so that the comparisons which I had hoped to have made in August 1847 may still be carried out. M. de Blainville throws some doubt upon the specific distinction between *Pal. medium* and *Pal. crassum*, and ventures to affirm that all the species "n'ont réellement été définies par M. G. Cuvier que d'après la grandeur relative," *l. c.* p. 66. But if even the differences of proportion by which Cuvier characterized his *Palæotherium crassum* (t. iii. p. 127) and *Pal. latum* (t. iii. p. 131) were not indicated in the above-cited and other passages of the 'Ossemens Fossiles' with a precision and frequency which makes one astonished at M. de Blainville's assertion to the contrary, the naturalist might cite the Horse, the Zebra, the Ziggetai, and the common Ass, as accepted species, whose teeth and bones would yield less decisive evidence of specific distinction than those which Cuvier has so ably pointed out in the fossil remains of the *Palæotheria*.

chitherium, V. Meyer). The true molars of the lower jaw of the *Paloplothorium* also differ in the absence of the cingulum or basal ridge, and in the presence of the cusp terminating the posterior oblique ridge; at least neither Cuvier nor M. V. Meyer allude to this character in the molars of the Orleans or Madrid Palæotherioid; although something like it is indicated in the lower molars of fig. 17. pl. 67. 'Ossemens Fossiles,' tom. iii.* But the most decisive distinction in the dentition of the lower jaw of the Hordle *Paloplothorium* is the unilobate structure of the second premolar (*p* 3), and its smaller size as compared with the first (*p* 2); a difference which will be at once appreciated by comparing the figure in Pl. III. fig. 4, P 2, with that given by Cuvier in figs. 3 and 13 *b.* of the plate 67, above-cited. This difference would have decided the distinction of the species, if even subsequent discoveries had not proved the generic difference of *Paloplothorium*, by showing that the *Palæotherium Aurelianense* resembled the typical Palæotheres in the number of its inferior grinding teeth.

Another known Palæotherioid pachyderm with which the Hordle species might be confounded, is that to which the left ramus of the fossil lower jaw from the tertiary deposits at Buenos Ayres, now in the British Museum, belongs, and which I have provisionally referred to the genus *Macrauchenia*. This portion of jaw contains six molar teeth, three true and three false; and the last molar differs, like that in the *Paloplothorium*, from the typical Palæotheres by the absence of the third lobe: but it likewise differs from the species under consideration in the absence of the posterior tubercle, which is equally wanting in the other true molars of the *Macrauchenia*: the premolar answering to P 2, in figs. 2 and 4. Pl. III., is more compressed and more extended from before backwards, as is also P 3†, which shows a fold of enamel along its inner side which would not be present in the corresponding tooth of the *Paloplothorium*. Nevertheless this genus resembles the *Macrauchenia* in the more simple form of P 2 and P 3; in which we may discern an approximation to the Anoplothorian type, as in the number of the premolars we discern a character of the Equine and Ruminant dental formulæ. In the figure of the lower jaw of the *Macrauchenia* in my 'Odontography' (pl. 135. fig. 7), the outline of *p* 1 "is hypothetically added to the series" (*ib.* p. 603): but this tooth may have been normally absent, as it is in the *Paloplothorium*, the Horse, and in existing Ruminants‡. The only known species of *Macrauchenia* much surpasses the *Paloplothorium annectens* in size.

* M. de Blainville is equally silent in respect to this character in his recent work on the *Palæotheria*: but I observed it in the specimens of the *Pal. Aurelianense* from Sansans.

† See *Odontography*, pl. 135. fig. 7.

‡ In an extinct antelope (*Dorcatherium*, Kaup) the first milk-molar was succeeded by *p* 1, and the number of premolars was four.

PART IV.—*Description of a portion of the Skull and Upper Teeth of the same species of Palæotherium (P. annectens).*

(Pl. III. figs. 1 & 2.)

THE *Palæotherium* which Cuvier found to deviate most from the generic characters of those of Montmartre (*Pal. magnum*, *P. crassum*, *P. medium*, *P. curtum*), which may be viewed as the types of the genus, is the species from Orleans already referred to (*l'espèce d'Orléans* of the 'Ossements Fossiles,' iii. p. 254; *Palæotherium Aurelianense*, Auct. De Bl. Ostéog. fasc. xxi. (1847) p. 43).

The differences specified by Cuvier are those presented by the molar teeth. In the upper (true) molars 'the distinctive character' of the 'Pal. d'Orléans' consists in this, that the lobes or ridges (Pl. III. fig. 6 *i*, *z*) (collines) which extend from the external border, at their arrival at the internal border do not come back; and in this, that there is at the posterior border a little insulated 'colline' in the form of a chevron*.

It is assumed in the 'Ossements Fossiles' that the number of the permanent molars in the *Pal. Aurelianense* is the same as in the other species; in short, that it presents the numerical formula of the genus *Palæotherium*: and Cuvier, therefore, interprets the modifications of the grinding surface of the upper molar as a specific difference.

M. Hermann V. Meyer, on the other hand, has founded a genus† on a few fossil teeth, from the tertiary deposits near Madrid, which present the same modifications of the grinding surface, and belong apparently to the same species as the *Palæotherium Aurelianense*.

Not any of the fossils, however, described and figured by Cuvier, Guettard, or M. V. Meyer, and which are referred in the systematic Palæontological Treatises‡ to the *Palæotherium Aurelianense*, exhibit the whole series of molars in either upper or lower jaw. The question of the generic distinction of this Palæotherioid must therefore remain in abeyance until further evidence, and especially the important character of the dental formula is determined; for few anatomists or naturalists, I apprehend, will be found to regard as generic the distinctive characters of the Orleans Palæothere, specified by Cuvier.

Ample grounds, however, for so interpreting the fossil cranium under consideration (Pl. III. figs. 1 & 2) are furnished by the entire series of molar teeth in the upper jaw, which consist on each side of three molars (M 1, 2 & 3) and of but three premolars (P 2, 3 & 4), instead of four premolars as in the typical *Palæotheria*: the sockets

* Tom. cit. p. 255, pl. 67. figs. 11 and 12. Cuvier also cites a figure by Guettard of one of these molars, in the 'Mémoires sur les Arts et les Sciences,' tom. v. pl. 7. fig. 1;—a work which I have not had the opportunity of consulting.

† *Anchitherium Equerræ*; Jahrbuch für Mineralogie, 1844, p. 298.

‡ PICTET, 'Traité Élémentaire de Paléontologie,' t. i. (1844) p. 274. GIEBEL, 'Die Säugethiere der Vorwelt,' 8vo. (1847) p. 189.

of the canines and incisors are also preserved, showing the dental formula of the upper jaw of the present genus to be—

$$i \frac{3-3}{-}, c \frac{1-1}{-}, p \frac{3-3}{-}, m \frac{3-3}{-}.$$

The grinding surface of the true molars differs from that of the same teeth in the *Palæotherium Aurelianense*: the penultimate molar M 2 in the specimen (fig. 2) has the enamelled summits of the ridges abraded to the same extent as in the (apparently) penultimate molar of the *Palæotherium Aurelianense* figured by Cuvier* (fig. 6); and shows the following distinctions:—there is no small insulated chevron-shaped lobe like that marked *c*, fig. 6, in the depression at the posterior borders between the ridges *o'* and *i'*: the anterior ridge (fig. 2, M 2, *i*) is divided by a notch, and its inner lobate termination (*p*) presents on its summit a distinct island of dentine surrounded by enamel: the anterior and external angle is not produced forwards, as represented in Cuvier's figure, which gives a peculiar character to that tooth not alluded to by Cuvier, but which I have not observed in any specimens or figures of the corresponding molar in any known species of *Palæotherium*. The Palæotherioid from Hordle is also smaller than the Orleans species.

Nothing, therefore, can be inferred as to the true dental formula of the *Palæotherium Aurelianense*, or of its claims to the generic appellation of *Anchitherium*, from the ascertained dental formula of the upper jaw of the *Paloplotherium* from Hordle†.

That this formula accurately gives the number and kind of the teeth of the upper jaw is proved by the following facts. The edentulous border of the jaw between the first premolar and the canine is entire on both sides, is sharp until its expansion to form the socket of the canine, and shows no trace of the socket of a shed or abortive false molar. The alveolar tract or 'process' is also entire and terminates behind the last molar; it does not bulge out backwards, as it would do if the germ of another molar had there been present. The fourth grinder (M 1, figs. 1 & 2) counting backwards is more worn than the three which precede it, showing that they had come later into place; and, to determine whether the worn fourth grinder was the last of four milk-molars, or the first of the three true molars, I

* Annales du Muséum, iii. (1804) pl. 35. fig. 10. Ossements Fossiles, pl. 67. fig. 11.

† Since this paper was read at the Meeting of the Geological Society, I have had the opportunity of inspecting at Paris, through the kindness of M. Laurillard, the series of fossils of the *Palæotherium Aurelianense*, which has been enriched, since the time of Cuvier, by the discoveries of the zealous and learned M. Lartet of remains of the same or a very closely allied species in the Eocene deposits at Sansans. These remains, some of which M. de Blainville has recently described and figured in the last published (21st) fasciculus of his 'Ostéographie' (pp. 51, 75, pl. 3.), prove the number of premolars to be the same in both jaws as in the typical Palæotheres, viz. $\frac{4-4}{-}$. The indefatigable author of that beautiful work, though recognising the specific identity of the *Palæotherium equinum* of Lartet with the *Palæotherium Aurelianense*, Cuvier, proposes nevertheless another synonym—*Palæotherium hippoides*—for the species.—December 1847.

excavated the upper jaw, above it, but found no trace of a successional tooth; the air-cavities of the maxillary sinus were exposed.

The animal to which this cranium belonged was not quite of mature age when it perished. The last true molar M 3, though through the gum, has had the summits of the outer crescents very slightly abraded; and the first (P 2) and second (P 3) premolars in place are but little worn. The characters of the grinding surfaces are, therefore, beautifully manifested, and in degrees of attrition that almost correspond with those of the upper molars of the *Palæotherium crassum* figured by Cuvier in the 'Ossements Fossiles,' t. iii. pl. 48. fig. 2; with which, therefore, I shall proceed to compare the molars of the *Paloplotherium*. The antero-posterior extent of the six molars of *Palæotherium crassum* (the first being wanting) is 4 inches $5\frac{1}{2}$ lines (11 centimeters 3 millimeters, Fr.), that of the six molars (the entire series) in *Paloplotherium* (Pl. III. figs. 1 & 2, M 3 to P 2) is 3 inches 1 line (7 centimeters 7 millimeters, Fr.). The first grinder in *Paloplotherium* answers to the second premolar in *Palæotherium*: its antero-posterior extent is 9 millimeters, that of the second premolar in *Pal. crassum* is 16 millimeters.

This tooth P 2, in *Paloplotherium* (ib. figs. 1 & 2), presents, like P 1 in *Palæotherium*, one conical lobe externally: there is a second smaller compressed lobe *p* at the fore-part of the inner side of the tooth, and the crown is surrounded by a strong basal ridge, interrupted only at the anterior angle of the inner lobe and at the back part of the tooth in contact with the next. The form of the grinding surface is triangular, broad, and excavated behind; it is implanted by three fangs: but in its general character P 2 in *Paloplotherium* corresponds with P 1 in *Palæotherium magnum**; with this difference, that there is an inner lobe near the back part of the grinding surface in *Pal. magnum*.

The second premolar in the upper jaw of *Paloplotherium* differs from both P 2 in *Palæotherium*† and its proper homologue P 3 in *Palæotherium*, in having, like the tooth before it, but one external conical lobe; it presents, however, a third lobule at the fore-part of the crown, wedged between the outer lobe *o* and inner tubercle *p*: this tubercle is relatively thicker than in *p* 2, but is still at the fore-part of the inner half of the grinding surface: the back part being widely excavated; but showing a rudimental oblique tubercle (*?*). The basal ridge is interrupted at the inner side of the base of the inner lobe. This tooth is implanted by three fangs.

The last upper premolar (P 4) in *Paloplotherium* resembles each of the three posterior premolars of *Palæotherium* in having, like the true molars, two exterior conical crescentic lobes *o*, *o'*, divided by a vertical ridge extending from the external basal ridge, but not quite reaching the summit of the grinding surface; a second parallel ridge bounds the fore-part of the outer surface of this premolar, as in *Palæo-*

* Cuv. l. c. pl. 43. fig. 1, *δ*.

† See my 'Odontography,' pl. 135. figs. 5 & 6, where the homologies of the individual molars are determined, and expressed by the letters and numbers used throughout the present memoir.

therium. The oblique tubercle, *z*, is now developed into a compressed lobe or ridge; in other respects P 4 resembles P 3, but is larger. It is implanted by four fangs.

The first true molar (M 1) deviates least from the *Palæotherian* type; the worn summits of the two conical and subcrescentic outer lobes present the two zigzag lines of enamel which Cuvier compares to a double W, and the vertical ridge dividing them on the outer surface of the tooth reaches the margin of the grinding surface: the concavities in the outer surface bounded by the above-described ridge, and the anterior vertical ridge, show a slight median rising. The oblique ridge of the lobe *z* on the grinding surface, being worn, presents a narrow tract of dentine, extending from the posterior and internal angle of the crown to near the interspace of the two outer lobes *o*, *o'*: it answers to "l'autre ligne pareille qui part du milieu de la ligne en W," &c. in the *Palæotheres**.

The summits of the tubercle *p* and of the antero-internal lobe (*i*) are blended together by attrition, and show a tract of dentine parallel with *z*, but thicker and of a bilobed form; extending from the anterior and external angle to the middle of the internal border of the crown. The oblique peninsular fold of enamel (*e*), penetrating from the inner side of the crown and dividing the before-named tracts, doubles the extremity of the posterior tract (*i*) and communicates with the posterior depression or fold of enamel: in equally worn molars of *Palæotherium* that fold (*a*) is cut off, and forms an island. There is a ridge at the fore-part of the base of the inner lobe *p*; and also a slight remnant of the cingulum at the entry of the fold *e*.

The molar fig. 2. M 2 has had merely the summits of the highest lobes and ridges of the grinding surface abraded; the tubercle *p* and the antero-internal lobe *i* continue distinct. The posterior boundary of the posterior depression is unworn.

The last grinder, M 3, has just cut the gum, and almost corresponds in growth with the last upper molar of the *Palæotherium medium*, figured in the 'Ossements Fossiles,' pl. 47. fig. 14; and with that of the *Palæotherium crassum*, figured in my 'Brit. Foss. Mamm.,' fig. 112. p. 319. The generic distinctions are accordingly well-displayed in the comparison of the germ of the last molar of the *Palæotheres* with those in the true *Palæotheres* above-cited. The antero-internal lobe (*i*) rises quite independently between the crescentic lobe *o* and the large inner tubercle *p*. The posterior inner lobe *i* extends forwards and outwards as an oblique ridge to the entering angle of the anterior and external crescent. The remnant of the cingulum at the base of the fissure *e* does not rise above that part, and its communication with the basal ridge at the fore-part of the lobe *p* is interrupted. The two outer vertical channels are less deep than in the *Palæotheres*, and the bottom of each is gently convex in both directions.

Each of the true molars is implanted by four fangs, the two inner ones appearing to be connate, and the two posterior ones in the last

* Ossem. Foss. iii. p. 9.

molar being closely approximated, in conformity with the contracted breadth of that part of the crown.

The enamel which invests the crown is almost a millimeter in thickness: the fine striae indicative of its successive formation are obvious; but otherwise its surface is smooth and polished. The cement covering the fangs is thinner; the coronal cement does not fill up any of the cavities of the crown. The molar teeth in relation to each other hold the same slightly oblique position and zigzag outer contour as in *Palæotherium*; the anterior and external angle of the hinder molar projecting outwards beyond the crown of the next molar in advance, and so with the rest. The six grinders progressively increase in antero-posterior extent as they recede in position, from P 2 to M 3.

The chief distinctive character of the true molars, as compared with those of the genus *Palæotherium*, is the detachment of the inner portion of the antero-internal oblique ridge ('colline transversale antérieure,' Cuv.) as a distinct lobe or tubercle *p*, and its superior thickness to the other part of the ridge *i*. It is not so thick and round as the homologous lobe in the *Anoplotherium* (fig. 5, *p*), and it forms an oval instead of a rounded disc of dentine when moderately worn, as in *m* 2, fig. 2; but it then gives the crown of the tooth a character which brings it very close to that in the *Anoplotherium*: for which indeed it might, if insulated, be mistaken, according to the differential character laid down by Cuvier*. The entire molar series in the upper jaw resembles that of the *Anoplotherium* in the progressive increase of the size of the crown from the foremost to the hindmost tooth: the molars are more equal in *Palæotherium*. The premolars differ in their smaller number from both *Palæotherium* and *Anoplotherium*; but those answering to *p* 2 and *p* 3 (Odontography, pl. 135. fig. 2) resemble in their smaller size and comparatively simple structure the corresponding teeth of the *Anoplotherium* more than they do those of the *Palæotherium*.

The true molars not only differ from those of the *Anoplotherium* (Pl. III. fig. 5) in the comparatively smaller size and more compressed form of the conical tubercle *p*, but in the more open angles of the outer lobes *o*, *o'*, and in the less curved form of the ridge *i*, which is separated from the posterior outer crescent by the deep fissure (*a*). In these latter differences the *Paloplotherium* resembles the *Palæotherium*, to which genus it approximates in the development of the canine teeth, and their separation, in the upper jaw, by a diastema from the premolars. But in the characters above specified, by which the *Paloplothere* differs from the *Palæothere*, it approaches the *Anoplothere*; it differs, however, from both genera in the absence of the first premolar (P 1): of which not a rudiment or trace is present, although the last molar has not come into use.

One may associate with the absence of this premolar the relatively longer interspace which divides the first of these teeth (P 2) from the canine in the upper jaw of *Paloplotherium*: in the specimen under description this space measures 9 lines (2 centimeters), which

* Tom. cit. p. 21.

is equal to the antero-posterior extent of the last two premolars. In *Palæotherium crassum* (Cuv. l. c. pl. 53. fig. 1) the same space measures $4\frac{1}{2}$ lines (1 centimeter), or little more than half the antero-posterior extent of the last premolar: and the proportions of the diastema are nearly the same in the other known species of typical Palæotheres.

The antero-posterior extent of the oval outlet of the socket of the canine (fig. 1, c) is $4\frac{1}{2}$ lines (9 millimeters). This socket is separated from the outer incisor (*i* 3) by a diastema of $2\frac{1}{4}$ lines (5 millimeters). The three subequal incisors are juxtaposed, and the inner one (*i*) is close to the premaxillary symphysis.

The canines seem to have been rather smaller proportionally than in the typical *Palæotheres*, but there is no specimen either of these or of the incisive teeth by which the characters of their crowns can be given; their relative size and position are indicated only by the sockets.

If we compare now the characters of the dentition of the upper jaw with those of the under jaw of the Hordle Palæotherioid previously described, we shall find that they agree with each other both in the antero-posterior extent of the molar series and in that of each individual tooth. They further exhibit the more important concordance in the number and kinds of those teeth, viz. $p \frac{3-3}{3-3}$, $m \frac{3-3}{3-3}$: the two first teeth (P 2 & 3, fig. 1) show the same comparative simplicity of structure, and consequently the same deviation from the character of those teeth in the *Palæotherium*; and if the other grinders of the lower jaw differ less from their homologues in *Palæotherium* and less resemble those in *Anoplotherium* than do those of the upper jaw, we shall not find that this opposes any real difficulty to their association with such upper jaw, when we observe that the differential characters between *Palæotherium* and *Anoplotherium* are much less marked in the lower than in the upper grinders; just as the difference between *Charopotamus* and *Dicotyles* is less marked in the dentition of the lower than in that of the upper jaw. The extent of deviation therefore, though small, in the true molars of the lower jaw of the Hordle Palæotherioid from those of the true *Palæotherium*, accords with or is proportional to those greater differences which we observe in the true molars of the upper jaw*. When however we find superadded to the degree of concordance between the true molars of the upper and lower jaws of the Hordle Palæotherioid, and to their differences from those teeth in the Palæotheres and Anoplotheres, a common manifestation of the more striking and important differences in the minor number and simpler structure of the premolars, no reasonable doubt can be enter-

* The bony arch supporting the upper molars being more remote from the centre of life than that supporting the lower molars, being in fact the anterior terminal arch of the hæmal series, is the seat of a greater amount of adaptive variation than the succeeding arch, and the teeth which it supports are in like manner more varied. This principle is well-illustrated by comparing the upper molars of the odd-toed Ungulates generally with the lower molars of the same natural group.

tained that both the upper and the lower jaws above described belong to the same genus and the same species. For the genus I propose the name of *Paloplotherium*; its dental formula is $i \frac{3-3}{3-3}; c \frac{1-1}{1-1};$

$p \frac{3-3}{3-3}; m \frac{3-3}{3-3} = 40$; with the specific name *annectens* for the

present known representative, as indicative of the transitional characters which to a certain degree connect the *Palæotherium* with its eocene contemporary the *Anoplotherium*. The *Paloplotherium* has however several characters by which it differs from both; amongst which may be mentioned, besides the absence of $p 1$ in both jaws, the reduction of the third lobe in the last molar of the lower jaw to the tubercle t , in which simplification of $m 3$, the *Paloplothere* resembles the *Macrauchenia* and *Rhinoceros*.

The bones which contain the perfect series of the upper molar teeth form the middle and anterior thirds of the skull. Only the rhinencephalic compartment of the cranial cavity is preserved with the facial division: but the bones, though crushed and fractured, permit of many instructive comparisons being made with the *Anoplothere* and *Palæotherium*, in regard to this part of their osteology. The orbits are relatively larger than in the *Palæoth. crassum*; and owing to the flattening of the frontals at the interorbital region, they have not so low a position as that which peculiarly characterises the *Palæotherium*. In this respect, as well as in the minor convexity of the interfrontal region, the *Paloplothere* resembles the *Anoplothere*. The postorbital process of the frontal descends lower than in the *Palæotherium*, and in this character the skull resembles that of the *Anoplothere*.

The curvature of the moderately strong malar bone forming the lower boundary of the orbit is convex downwards; it is relatively less deep anteriorly than in the *Anoplothere*. The orbit is on the same vertical parallel as the last two molar teeth. The ridges continued backwards from the postorbital processes, curving and converging upon the frontal bone, are strongly marked by the sudden sinking of the temporal fossa which they define, but they do not rise above the level of the frontals: they converge at a less acute angle than in the *Palæotherium crassum*.

The lachrymal bone is perforated by two foramina, defended externally by a small projecting tubercle. The rhinencephalic depressions* of the cranial cavity are vertically oblong, divided from the prosencephalic chamber by descending superior ridges, and from each other by a sharp vertical ridge (*crista galli*) formed by the hinder margin of the coalesced prefrontals (*lamina media æthmoidæ*). The posterior parts of the ossified olfactory capsules close the anterior outlets of the rhinencephalic depressions, and were perforated, as usual, by the numerous filaments of the olfactory nerves, forming

* I restrict the term 'olfactory' to the chambers of the face containing the turbinal and other parts of the olfactory capsules.

the *lamina cribriformis æthmoidei*. The frontal sinuses do not extend further backwards in this cranium than above the rhinencephalic chamber.

The frontonasal suture runs, with a very slight bend backwards, across the cranium, parallel with the fore-part of the orbits. The nasal bones are as broad at their origin as the frontals, and are bent down externally to join the lachrymals: their apices are broken off. The anterior border of the maxillaries is entire, and so much of the premaxillaries is preserved as demonstrates that they were separated from the nasals by about an inch of the maxillaries, and that these concurred with the premaxillaries and nasals to form the contour of the anterior bony nostrils, which were thus surrounded by six bones, as in the Palæotheres, instead of by four, as in the Anoplotheres. The maxillaries ascend more rapidly, or with a nearer approach to verticality, in joining the nasals than in the Palæotheres: so that with regard to the osseous walls of the face anterior to the orbits and to the shape of the anterior nostril, the Paloplothere manifests again a character intermediate between the Palæothere and Anoplothere. The facial plate of the maxillary is perforated by a single antorbital foramen 5 millimeters in diameter, situated 1 inch ($2\frac{1}{2}$ centimeters) anterior to the orbit, and 14 lines (3 centimeters) behind the nasal border, and 7 lines ($1\frac{1}{2}$ centimeter) above the alveolar border of the maxillary. The bony palate is much crushed, but seems to have terminated by a concave border opposite the interspace between the penultimate and last molar.

The premaxillaries are long, slender, destined almost exclusively to the support of the six incisors, and to give passage to the incisive or prepalatine nerves and vessels, which impressed their mesial sides with an oblique channel. The symphysis of the premaxillaries had not been obliterated, as it becomes in the Tapir; and the premaxillaries had been divaricated by external pressure or violence before the surrounding matrix had hardened and fixed them in that position. There are other marks of violence which have evidently been left upon this skull before it became enveloped by the matrix, which fills the cracks and crevices of the crushed parts. Over the left frontonasal suture there is a depression and comminuted fracture of the skull, inflicted as it seems by the blow or pressure of a conical instrument of the size of a large tooth of a crocodile: a similarly comminuted fracture exists on the bony palate a little behind the vertical parallel of the upper one. The opposite sides of the facial bones have been partially crushed and similarly driven in, just in front of the orbits; and this latter compression seems to have started asunder and opened the symphysis of the premaxillary bones. I strongly suspect that these injuries were inflicted on the recent head by the jaws and teeth of a crocodile. The great inferior canine tusk, penetrating the interspace of the rami of the lower jaw, would crush the palate in the attempt to meet the upper canine, which would drive in the opposing upper part of the skull by the same bite. Before or after this the head has been turned half round, and the same teeth have left the traces of another bite at the opposite sides of the face. At all events

it is plain that the violence inflicted upon the head of this young *Pachyderm* has been received before the skull became imbedded in the eocene mud, and that the matrix hardening around it has preserved the evidence of the nature of the injuries received to this day. The points of the great canine teeth of old crocodiles not unfrequently become so blunted as would produce such crushed and depressed fractures without penetrating more deeply. The remains of an extinct species of *Crocodile* are common in the same formation as that in which the debris of their prey have been buried. I have received many detached teeth and bones through the kindness of the Messrs. Falconer, and Lady Hastings has generously confided to me for description the unique and almost perfect skull of a crocodile from the Hordle sands, which demonstrates, by the exterior position of the lower canines in the grooves on the outer border of the upper jaw, its true crocodilian character. The Sheppey crocodile also belongs to the subgenus *Crocodilus*, but approximates closely to the Bornean species, whilst the Hordle crocodile much more closely resembles the crocodile of the Nile. As Dr. Buckland has given the name of *Crocodilus Spencersi* to the Sheppey species, I propose to call the coeval species from the Hordle eocene *Crocodilus Hastingsæ*, in honour of its accomplished possessor, whose zeal in the collection of the fossils in her Ladyship's vicinity has contributed so much to advance our scientific knowledge of them.

DESCRIPTION OF PLATE III.

- Fig. 1. Side view of mutilated cranium with permanent series of grinders; and those of the lower jaw, of *Paloplotherium annectens*, nat. size.
- Fig. 2. Grinding surface of upper premolars and molars and alveoli of canine and incisors, left side, of ditto.
- Fig. 3. Horizontal rami of lower jaw, showing symphysis and sockets of incisors and canines, and grinding surface, deciduous and persistent molars, of ditto.
- Fig. 4. Side view of left ramus of lower jaw with deciduous molars and two permanent molars in place, and with the premolars and last molar exposed in the formative cells, of ditto.
- Fig. 5. Grinding surface of an upper true molar of *Anoplotherium commune*: after CUVIER.
- Fig. 6. Grinding surface of an upper true molar of *Palæotherium Aurelianense*: after CUVIER.

In the figures of the *Paloplotherium* I 1, 2, 3 indicates the first, second and third incisive sockets; C, the socket of the canine; P 2, 3, 4, the premolars; M 1, 2, 3, the molars; D 1, 2, 3, 4, the deciduous molars. The letters of the lobes and ridges are explained in the text.

PART V.—*Description of the Teeth and the Lower Jaw of an extinct species of Mammal belonging to the section of Hoofed Quadrupeds (Ungulata) having molar teeth with the principal lobes in symmetrical pairs, and forming the type of a new genus (Dichodon) in that section.*

THE existing *Ungulata*, which have the principal lobes of the true molar teeth arranged in symmetrical or subsymmetrical pairs, are the *Ruminantia* and the genera *Sus*, *Dicotyles* and *Hippopotamus*, with

which I have associated, as members of the same great natural group of mammals*, the extinct genera *Hippohyus*, *Hyracotherium*, *Chæropotamus*, *Anthracotherium*, *Merycopotamus*, *Dichobunes* and *Anoplotherium*, although the symmetrical or parial character of the crown of the tooth, as shown by the normal lobes *o i*, and *o' i* (Pl. III. fig. 5), in *Anoplotherium* is disturbed by the excessive development of the accessory tubercle *p*.

The fossils about to be described give evidence of the former existence of another of these interesting annectent links that once filled up the interval that now almost insulates the Ruminants from the few remaining members of the Ungulates with the lobes of the grinders and the toes of the feet in symmetrical pairs. These fossils, discovered by Alexander Pytts Falconer, Esq., in the eocene sand-bed at Hordle, consist of a portion of the upper jaw, with the three true molars, the third and fourth premolars, the canine and three incisors; and a nearly entire under jaw, with the whole dental series of one side and a large proportion of it on the opposite side (Pl. IV. figs. 2, 3, 4, 5). The genus established by the peculiarities of this dentition, and which I propose to call *Dichodon*†, makes the nearest approach by its upper true molars to the *Merycopotamus* of Messrs. Cautley and Falconer (Pl. IV. fig. 7), and to that smaller allied extinct Indian quadruped called '*Anthracotherium silistrense*' in the second volume of the Second Series of the Geological Transactions (p. 392, pl. 45. figs. 2 & 3).

In the true molars of the lower jaw the genus *Dichodon* closely resembles the genus *Dichobune*; and it manifests a striking affinity to the Anoplotherioids in the low development of the canine teeth and in the number and uninterrupted contiguity of the entire dental series. But *Dichodon* presents peculiar modifications of the molar and especially of the premolar teeth, which distinguish it from all known genera of fossil and recent Mammalia.

The crowns of the upper true molars of *Dichodon* (Pl. IV. fig. 3. M 1, 2 & 3) are subquadrate and four-lobed, and the antero-posterior cleft describes two strong curves, concave outwards, as in fig. 3. pl. 45. of the 'Geol. Trans.' above-cited, and as in *Merycopotamus*‡ (Pl. IV. fig. 7) and *Dichobunes*§; but there is no depression or fold of enamel that would mark off in the abraded crown a lobe of dentine answering to that marked *p* in fig. 1. p. 420 of the 'Geol. Proceedings' above-cited; and by this difference, as well as other characters, the molars of *Dichodon* more resemble those of *Merycopotamus* and of the little so-called *Anthracotherium silistrense*.

The outer sides of the outer lobes (fig. 2. *o'*, *o*) of *Dichodon* are

* Odontography, pp. 523, 571.

† The numerous sharp and well-defined divisions of the crowns of both upper and lower molar teeth suggested the term '*Dichodon*' (διχάω, *divido*; δδούς, *dens*), expressive of this character, and of the sharp incisive nature of most of the teeth; the human cutting-teeth were called διχαστήρες ὀδόντες, *incisivi dentes*, by the Greek anatomists.

‡ Odontography, p. 566, pl. 140. fig. 8.

§ Proceedings of Geol. Society, May 1846, p. 420, fig. 1.

less deeply indented than in *Merycopotamus*, but show a trace of a longitudinal rising at their middle part. The inner sides of both outer and inner lobes (fig. 5. *i*, *z*) are strongly convex, and more angular than in *Merycopotamus*. Attrition of the summits of these semiconical lobes would, however, produce the same double crescentic islands of enamel which characterize the upper molars of *Merycopotamus* and *Dichobunes*; and were once supposed to be a peculiar characteristic of the *Ruminantia**.

In the young animal under consideration the lobes of all the molars terminate in sharp enamelled points; those of the first true molar (*m* 1) being slightly abraded at their summits and anterior angles. The upper true molars differ from those of *Merycopotamus* in the absence of the "strong rugged ridge" (fig. 7. *r*) "along the inner side of the base of the crown†," and in the presence of the series of five small but sharp accessory cusps (*a*, *b*, *c*, *d*, *e*, M 2, fig. 3, Pl. IV.) along the outer side of the base: one of these cusps (*a*) terminates externally the sharp ridge continued from the anterior angle of the base of the inner and interior lobe (*i*) along the anterior side of the base of the crown: the other four cusps are placed at the angles of the bases of the outer sides of the two external lobes, and answer to the corresponding angles of the outer lobes in *Merycopotamus*, which angles are, as it were, pinched up and pulled outwards in that genus.

A sharp ridge is continued from the posterior angle of the base of the posterior and inner lobe, along the posterior part of the base of the crown, to the corresponding angle of the posterior and external lobe; but there is no ridge beneath this, as in *Merycopotamus*. The contiguous angles of the bases of the two inner lobes (*i*, *z*, M 2, fig. 3) are prolonged outwards far into the interspace between the two outer lobes. A small tubercle (*p*) is situated at the inner entry to the fissure between the two inner lobes: a ridge penetrates this fissure in *Merycopotamus*.

The three upper true molars progressively increase in size from the first (M 1) to the last (M 3) in *Dichodon*; they are equal-sized in *Merycopotamus*. All the lobes and ridges are remarkably sharp, and the fissures are deep and neatly defined in the molars of *Dichodon*; and the enamel is smooth, not rugous as in *Merycopotamus*. Each true molar is implanted by four fangs. The first true molar (M 1) has its outer side relatively longer than the others, by reason of the larger size of the anterior basal cusp. The characteristic modification of the last premolar (P 4, fig. 3) may be understood by supposing the homologue of the anterior and external basal cusp (*a*) to have been

* "Order RUMINANTIA :—

"The molars, almost always six in number on each side of both jaws, have their crowns marked by two double crescents, the convexity of which is turned inwards in the upper jaw and outwards in the lower jaw." (Règne Animal, ed. 1829, vol. i. p. 254.) And again, defining the supposed peculiarities of the Ruminantia, "Les trois arrière-molaires supérieures des ruminans semblent être des inférieures retournées; elles sont de même formées de deux demi-cylindres, présentant chacun un double croissant, mais dont la convexité regarde en dedans." (Cuvier, Ossements Fossiles, t. iv. p. 7.)

† Odontography, 4to, p. 566.

developed at the expense of the anterior and internal lobe (*i*, M 1) which has disappeared: the crown of the tooth is thereby extended from behind forwards and diminished in breadth: it presents also a trilobed character externally, but has a fourth lobe, *z*, at the inner side of the posterior and external one, answering to the hinder and inner lobe *z* of the true molars. The base of the outer side of the hinder and outer lobe (*o'*) has its two tubercles like those of the true molars, and its inner convex base is similarly girt by the outwardly prolonged angles of the base of the inner lobe *z*. From the inner side of the base of this lobe a ridge is continued forwards along the inner sides of the middle (*o*) and anterior (*a*) lobes. This tooth is implanted by one anterior and two posterior long fangs: there was no cavity of reserve, or germ of a successor, in the substance of the jaw above it.

The upper penultimate premolar (P 3) has also a long and narrow crown, three-lobed externally, but with the fourth posterior and inner lobe (*i*) reduced to a simple cusp: a ridge is continued from the hind part of its base to the hinder angle of that of the lobe (*o'*) external to it, and a second ridge extends from the fore-part of its base forwards to the anterior lobe (*a*). The middle of the three outer lobes (*o*) is the largest; they are all conical and pointed: there is a rudiment of the cusp answering to *e* in the true molars; the others are suppressed. This tooth is implanted by two long and divergent fangs.

The premolars corresponding to the first and second below have not been obtained; but a single-fanged tooth (fig. 2, C) with a simple trenchant crown appears to be the canine of this species, and it will be shown to belong to the upper jaw. The antero-posterior diameter of the crown of this tooth, C, is more than double its vertical extent; its chief summit is followed by a lower rising of a trenchant edge: the fang is grooved longitudinally on the outer side, indicating it to consist of two connate fangs, one for each division or rising of the crown.

The left premaxillary bone supports three incisors; their crowns, like the canine, are low but long, with a slight obtuse point near their fore-part, trenchant behind; convex outwardly, concave and with a basal ridge on the inside; the three teeth are set close together, the second slightly overlapping the third.

Thus of the dentition of the upper jaw of *Dichodon* we have the three true molars and last premolar *in situ* with a portion of the upper jaw, the penultimate premolar and the canine detached, and the three incisors with the premaxillary bone. The true molars manifest the type of crown most allied to that of the *Merycopotamus*, *Anthracotherium*, and other genera closely approximating to the Ruminant type; while the premolars have peculiarities of form and structure quite different from those in any known recent or extinct Herbivorous Mammal. In *Merycopotamus* the canines and incisors closely accord with the hippopotamic type of those teeth: in *Dichodon* they offer a nearer resemblance to the anoplotherian type.

The dentition of the lower jaw corresponds as closely with that of the upper jaw as it does in *Merycopotamus* or *Dichobune*, and the true molar teeth present a strong resemblance to those of the latter Anoplotherioid subgenus. The inferior teeth are beautifully displayed

in an entire right ramus and in a nearly entire left ramus of the same lower jaw (Pl. IV. figs. 2 & 3).

The first and second true molars (fig. 4, M 1 & 2) consist each of four semiconical high and sharp-pointed lobes, in two transverse pairs, with the convex sides turned outwards. The inner sides of the outer lobes *o*, *o'*, are smooth and nearly flat; the basal angles extend inwards, embracing the base of the inner lobes *i*, *i'*; and the ridge from the hind angle of the base of the hinder and outer lobe terminates by expanding into a small cusp behind the base of the hinder and inner lobe; from this cusp a sharp ridge extends not quite across the hind part of the base of the crown. The inner surface of the inner lobes is sinuous, convex in the middle, concave before and behind this part: each angle of the base is produced into a small ear-like lobule or cusp: thus there are five basal cusps along the inner side of the base of the crown, besides the two lofty pointed conical lobes (M 1, *i* and *i'*).

As the number of the restored annectant links increases in the Ungulate series of *Mammalia*, the marks of distinction become less salient, and the necessity for more minute attention to them is entailed upon the describer. The anterior margin of the outer and anterior lobe is slightly raised and swollen at its termination upon the fore-part of the base of the inner lobe: below this margin the fore-part of the base of the crown is traversed by a thin but sharp ridge (Pl. IV. fig. 6). There is a mere rudiment of a tubercle at the outer entry of the great median transverse cleft dividing the two pairs of lobes. The outer convexities (*o*, *o'*) of the principal lobes are subangular. Each lower true molar is implanted by two long fangs. The distinction between the four-lobed lower molars of *Dichodon* and those of *Dichobunus* is shown by the fifth inner basal cusp (fig. 5, M 1) posterior to the one at the back part of the base of the second inner lobe, and in the anterior and posterior basal ridges.

The premolars of *Dichodon* deviate still further from those of *Dichobunus*. I at first thought that the tooth (P 4) must be the last of the deciduous series, and that it indicated, as in the *Anoplotherium* and Ruminants, a third posterior division of the last molar tooth; but on excavating the jaw beneath it (as shown at P 4, fig. 2), not the slightest trace of either the germ of a successor or of the cavity for its matrix appeared, and it was evident from the length of the fangs and the small depth of the jaw,—only half that of the same part in the young *Paloplothere*,—that the tooth in place was destined to have no successor. This tooth agrees moreover in the antero-posterior extent of the crown and its three chief divisions with the last premolar above; the slightly-worn summits of which concurred, with the absence of any trace of a successor, in showing that it likewise could not have been in use during the period of the milk-dentition.

The last premolar (fig. 4. P 4) in the lower jaw has six semiconical lobes in three transverse pairs, slightly decreasing in size as they advance forwards, but repeating the characters of those of the true molars; the inner side of the base of each of the three inner lobes having the ear-like cusp on each side, and the posterior basal ridge terminating on the inner side in a smaller seventh cusp. There is a

mere rudiment of the anterior basal ridge. The summits and sharp borders of each of the six lobes have been slightly abraded, and the dentine exposed, but along a mere linear tract in each lobe.

The penultimate premolar (P 3) retains only the hinder transverse pair of lobes; the middle and anterior lobes are single, subcompressed, convex on both inner and outer sides, which meet at trenchant and slightly-worn edges, trending away from before and behind the summit. The posterior cusp is present at the back part of the base of the inner and posterior lobe, but not at the fore part; the cusp behind the preceding is also wanting; there is a trace of the posterior basal ridge, and an obtuse belt at the inner side of the base of the anterior lobe which terminates in a feeble prominence anteriorly. This tooth has two long slightly diverging fangs.

The antepenultimate or second premolar (P 2) is three-lobed, the mid-lobe being the longest, the hind-lobe the thickest: this has a well-defined vertical ridge, with a notch behind it on its inner side; it is simply convex externally: the mid-lobe is less deeply indented on the back part of its inner side, is convex on the rest of that side, and on the outer side; the fore and hind sloping borders are trenchant: the front lobe is concave on the inner side, which has an obtuse border at its base: the antero-posterior extent of the crown of this tooth is thrice the vertical extent. It is implanted by two fangs.

The anterior premolar (P 1) is situated directly above the back part of the symphysis of the jaw: its crown is more compressed and trenchant than the second, and the anterior and posterior lobes are reduced to accessory basal cusps of the middle lobe: they are all so compressed as to produce an undulating trenchant summit, rising to a higher point at the middle: there is no indent dividing the anterior from the posterior lobe on the outer side; but their distinction is indicated by a depression on the inner side. This tooth is implanted by two fangs.

The left ramus of the lower jaw of the *Dichodon* includes a great portion of the symphysis, with the sockets of the canine and of two incisors, with a part of that of the anterior incisor, I 1. A detached single-fanged tooth which fits the socket of the canine (C), and one of the incisors equally fitting the vacant socket of the third of this series (I 3), accompanied this specimen. In both rami the canine precedes the premolar without any interval, and is as directly preceded by the third incisor, so that the whole series of teeth is uninterrupted, as in the extinct genera *Dichobunus*, *Anoplotherium*, and *Nesodon*.

The canine has a low but long trenchant crown, not rising into a point, resembling in its harmless character that of the *Anoplotheriidae*: its outer side is gently convex; its inner side has two indentations.

The incisor has a smaller but more quadrate and truncate trenchant crown; it is also gently convex externally, and with two concavities internally.

A gubernacular orifice behind the rising crown of the second true molar indicated the concealed alveolus of the third molar, which I exposed in the ramus of the jaw (fig. 2, M 3). The matrix had either not begun to be calcified, or in such detached portions of the summits

of the lobes that they had been lost: the chamber was filled with the fine eocene sand, and by its size indicated a rather larger development of the tubercle *e* than the first and second molars.

Thus the dental formula of the lower jaw of the present Mammal is proved to consist of three incisors, one canine, four premolars, and three true molars, in a continuous series in each ramus; and we must conclude that they were opposed by the same number of teeth in the upper jaw. The detached premaxillary demonstrates in fact the number and shape of the incisors of that jaw; the crowns of these incisors being, as in the Anoplothere, somewhat larger than those below. The single-fanged tooth which I have described as the upper canine shows the same proportional superiority of size over that of the lower jaw, with a correspondence of form which leaves no doubt in my mind of its being the opposing tooth of such lower canine. There are wanting, therefore, to establish *ex visu* the entire dental series, only the first and second premolars of the upper jaw and the last true molar of the lower jaw, the germ of which had not been sufficiently calcified at the time of the animal's death to yield satisfactory evidence of its true form.

The dental formula therefore of the genus *Dichodon* is:—

$$i \frac{3-3}{3-3}; c \frac{1-1}{1-1}; p \frac{4-4}{4-4}; m \frac{3-3}{3-3} = 44.$$

From the trenchant character of the ridges and the sharp points of the lobes of all the teeth, which in the molar series are bristled with cusps like those of some Insectivores, the food of the *Dichodon* would seem to have been of a peculiar character, perhaps not exclusively of a vegetable nature, but different from that of any of the small Ruminants or Pachyderms of the existing creation. From the number and sharpness of the pointed cusps of the teeth in the present species, I propose to call it *Dichodon cuspidatus*.

DESCRIPTION OF PLATE IV.

Fig. 1. Portion of lower jaw of *Paloplothorium*, with the four deciduous molars and first permanent molar, one canine and one incisor.

Fig. 2. Outside view of the lower jaw and teeth and parts of the upper jaw and teeth of *Dichodon cuspidatus*, nat. size.

Fig. 3. Grinding surface of most of the teeth of the upper jaw of ditto.

Fig. 4. Grinding surface of the teeth (M 3 excepted) of the under jaw of ditto.

Fig. 5. Inside view of the lower jaw and teeth and parts of the upper jaw and teeth of ditto.

Fig. 6. Hind view of the crown of the second upper molar of ditto.

Fig. 7. Grinding surface of second upper molar of *Merycopotamus*.

In each figure, I 1, 2, 3, indicates the first, second and third incisors; C the canine; P 1, 2, 3, 4, the premolars; M 1, 2 & 3, the molars. The letters of the lobes and cusps are explained in the text.

3. Notice of the occurrence of Fossil Remains of the MEGACEROS HIBERNICUS and of CASTOR EUROPÆUS in the Pleistocene deposits forming the Brick-fields at ILFORD and GRAYS-THURROCK, ESSEX. By PROF. OWEN, F.R.S., F.G.S.

SINCE the publication of my 'British Fossil Mammalia,' two of the conclusions touching the so-called 'Irish Elk,'—viz. first, that its re-

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Library on June 27, 2014

From Nature on Zinc by J. Erxleben.

Day & Son Lith. to the Queen.

Fig. 1 *Palaeotherium*. Figs. 2, 6. *Dichodon*. Fig. 7. *Merycopotamus*.