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The Rev. H. Brass, B.A., Brompton, Chatham, Kent, was elected a Fellow.

The following communication was read:—

On the Species of MASTODON and ELEPHANT occurring in the fossil state in GREAT BRITAIN. PART I. MASTODON. By H. FALCONER, M.D., F.R.S., F.L.S., & F.G.S.

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Introduction.—It is of the highest importance to Geology, that every mammal found in the fossil state should be defined as regards, 1st, its specific distinctness, and, 2ndly, its range of existence geographically and in time, with as much exactitude as the available materials and the state of our knowledge at the time will admit. Every form well ascertained becomes a powerful exponent; while, ill-determined, it is a fertile source of error. For the pure Geologist, in most of his conclusions where age or climatal conditions are in question, is more or less at the mercy of the Palæontologist, since he must accept the palæontological evidence as it is laid before him, and square his speculations to fit and dovetail into the various mortises which the data inexorably present to him. There is a subordination in the value of the evidence: the higher the form in the scale of organization, the more weighty is the import of its indications.

The difficulty with which the Mammalian-palæontologist has to contend in arriving at satisfactory results depends doubtless in many cases on the imperfect nature and scantiness of his materials. But it is deserving of remark, that the fossil genera and species which are in the most unsatisfactory and unsettled state, as to definition and nomenclature, are not those that are the rarest, but often the reverse. Take *Mastodon* or *Rhinoceros* for example, in which the array and confusion of specific names are signally perplexing. The reason of this apparent anomaly would seem to be this,—when the remains are few and seldom met with, the species are usually limited in number, and thus more easily discriminated; on the other hand, when the remains are very abundant over wide areas, the species are at the same time, as a general rule, numerous: and it is well known among naturalists, that the genera which are the most difficult to disentangle specifically are the most complete and natural, where the species are many, and follow each other with the least amount of difference in serial development; or, in other words, where they are most closely allied to one another.

Remains of either of the Proboscidean genera, *Dinotherium*, *Mastodon*, and *Elephas*, abound in all the Tertiary Formations of Europe, Asia, and America, from the Miocene up to the Post-pliocene; they have been the subject of a vast amount of observation, while it is hardly possible to conceive anything more unsettled and opposed than the generally received opinions respecting the species and their nomenclature in the standard works which are of the greatest authority on the subject. Cuvier, De Blainville, and Owen are agreed in limiting the Elephants and narrow-toothed Mastodons found fossil in Europe each to a single species; while other palæontologists consider that the latter group comprises at least three well-marked specific forms, and the former three or four. This palæontological uncertainty has naturally been reflected in systematic works on Geology, wherever the faunas of the Tertiary Formation are referred to, in statements sufficiently startling, which are repeated at the present day. Thus the Miocene *Mastodon angustidens*, of the Faluns of Touraine, of the Molasse of Switzerland, and of the Sub-Pyrenees, as also the Miocene *Mastodon longirostris* of Eppelsheim, are mentioned by Sir Charles

Lyell, in the 5th edition of his *Manual**, under the comprehensive name (on the authority of Owen) of *Mastodon angustidens*, as occurring in the so-called "Older Pliocene" Red Crag, and in the "Pleistocene" Norwich Crag: while this English species of Mastodon, wherever it has been met with, whether in this country or on the Continent, has been almost invariably found in company with remains of a species of Elephant which Professor Owen has described as identical with the *Elephas primigenius* or Mammoth of the Post-pliocene Drift and the modern Siberian ice-fields.

The object of the present communication is, to endeavour to ascertain what are the species of Mastodon and Elephant found fossil in Britain; what the specific names which ought to be applied to them; and what the principal formations and localities where they are elsewhere met with in Europe. I am the more induced to attempt the task from the circumstance, that Prof. Owen in an important memoir "On some Mammalian Fossils from the Red Crag of Suffolk," which appeared in a late number of the Society's Quarterly Journal†, adheres to the opinion expressed in his Report to the British Association for 1843, and subsequently discussed at greater length in his 'British Fossil Mammalia' in 1846, that the Mastodon of the English Crag is identical with the *Mastodon angustidens* of Cuvier, the *Mastodon longirostris* of Kaup, and the *Mastodon Arvernensis* of Croizet and Jobert. Prof. Owen, on both the occasions here quoted, up to 1846, has maintained the prevalent opinion, that all the Elephant-remains met with in England are referable to a single species, namely *Elephas primigenius*; and I am not aware that he has altered his views upon this point in any subsequent publication. I have devoted much study to the subject, during the last 15 years, in connexion with the numerous fossil species of both genera, which are met with in India, with a view to a monograph of the Proboscidean family, fossil and recent. The results to which I have been conducted, as to the disputed European species, are different from those arrived at by Prof. Owen. The most of those results have been long exhibited, so far as figured evidence goes, in the published illustrations of the 'Fauna Antiqua Sivalensis'‡: but, having devoted the last summer and autumn to a Proboscidean examination, so to speak, of some of the principal collections on the Continent, with special reference to the European fossil species, I have been enabled to confirm or correct previous conclusions on a wider field of observation. In order to avoid needless repetition in the sequel, I may mention that the tour here referred to embraced a detailed study of the very extensive collection of Val d'Arno Proboscidean remains contained in the Museum at Florence; the collections of Turin, Milan, and Pavia; of Geneva, Lausanne, Berne, Zurich, Basle, and Winterthur in Switzerland; of Darmstadt, Mannheim, and Strasbourg on the Rhine; of the Jardin des Plantes and Ecole des Mines in Paris; the Duc de Luynes' fine collection of the Chartres fossil Elephant, in Chateau Dampierre; and the surpassingly rich and unrivalled collection made by my friend

* *Op. cit.* p. 156.

† No. 47, vol. xii. part 3. Aug. 1, 1856, p. 223.

‡ *Fauna Antiq. Sivalensis. Illustr. par. v. pl. 42-45.*

M. Lartet, of the Sub-Pyrenean Proboscidea, at Seissan on the Garonne; together with some of the principal collections at Toulouse. In one or other of these museums I had opportunities of studying all the fossil species hitherto described as having been met with in Europe, together with one fine species of *Mastodon* discovered by M. Lartet, but which has not yet been published.

Generic distinctions and nomenclature of the Proboscidea.—Before entering on the special consideration of the British fossil forms, it will be necessary to give some explanation of the principles on which the genera have been limited, and subdivided into sub-generic groups, in order to comprehend the reasons for the nomenclature adopted in this communication. A detailed palæontological disquisition would be out of place on the present occasion. Such salient points only will be touched upon as are essential to the elucidation of the subject.

The Proboscidean species, fossil and recent, constitute a large group, embracing at least 25 distinct forms, which are comprised under the three genera of *Dinotherium*, *Mastodon*, and *Elephas*. These genera, regarded in a systematic view, are of very unequal value numerically; the first being very limited in the number of ascertained species, but defined by well-marked generic distinctions; while the last two represent a large number of specific forms, which, although their opposite extremes are widely separated, yet are connected together through so complete and natural a series of intermediate specific links, that it has proved difficult to devise good generic characters to distinguish them. Putting aside all other considerations of structure and form, the diagnostic marks will be regarded on the present occasion solely as they are furnished by the teeth and jaws.

(*Dinotherium*.)—The adult dentition of *Dinotherium** is characterized by two vertically succeeding premolars and three true molars, five teeth in all, with transverse crenulated ridges closely resembling those of the Tapir; and by two huge inferior recurved incisors, implanted in an enormously thickened and deflected beak or prolongation of the symphysis of the lower jaw. Most of the molar teeth present the normal Tapir-like crown-character of two ridges; but, when the milk- and permanent dentition are taken together, *Dinotherium* differs from all the non-elephantoid *Pachydermata* in the circumstance that the last milk-molar and antepenultimate true molar (being contiguous teeth in the order of horizontal succession) present a more complex development of three ridges, or, a “ternary-ridged crown-formula” (to use a term which will be found of importance in the sequel). Two species only of *Dinotherium* have, I believe, hitherto been met with; the one in Europe, and the other in India†. The European species, *D. giganteum*, occurs in the

* Kaup, *Akten der Urwelt* (1841), pp. 22–40.

† As in the case of the *Mastodon* of North America, numerous nominal species have been founded by different authors (Kaup, Von Meyer, Eichwald, &c.) upon what would appear to have been merely varieties of the same species, depending on race, sex, &c., as evinced by the comparative size of the teeth. Dr. Kaup now

Older Miocene formations, such as Eppelsheim, the Faluns of Touraine, and the Molasse and lacustrine strata of the Sub-Pyrenees: it has nowhere been met with in Britain.

(*Mastodon and Elephas*.)—Up to the date of the last 4th edition of the 'Ossements Fossiles' published during the author's life in 1825, the species of *Mastodon* and *Elephas* then known were sufficiently well distinguished by the characters indicated by Cuvier*, the founder of the former genus; namely, that the molar teeth of *Mastodon* consisted of a comparatively simple crown, divided into mammillæ or tubercles, arranged in transverse ridges, more or less numerous, and more or less prominent, with corresponding empty valleys or hollows between them; while those of *Elephas* were more complex, consisting of numerous thin transverse plates, having their intervals filled up with cement. The subsequent discovery of the *Mastodon elephantoides* of Clift, in which Cuvier's characters of both genera are blended, and of European and American forms with tusks in the lower jaw (*Mastodon longirostris* and *Mastodon Ohioticus*), led to the necessity of remodelling the technical diagnostic characters of the genera. This was first attempted, so far as I am aware, by Bronn of Heidelberg, in his 'Lethæa Geognostica,' as far back as 1838. In his elaborate definition of the two genera he states (omitting other characters) that *Mastodon* is characterized by lower incisors, and by molars which are replaced from back to front, excepting, however, the most anterior of these teeth, *i. e.* one or more milk-molars; while in *Elephant* there are no inferior incisors, and *all* the molars are replaced in a horizontal direction†. In his remarks upon the species, he mentions that "*Tetracaulodon* (*i. e.* *Mastodon longirostris*), according to Kaup, has premolars in the upper jaw, which are very similar to the back molars of Hippopotamus and are very caducous‡," and in regard to inferior tusks, that "*Mastodon giganteus*, *M. angustidens*, and *M. longirostris* do unquestionably possess such inferior tusks: the other species of *Mastodon* occur more rarely, and we can therefore only by analogy infer their having possessed them also§." The same characters, *i. e.* of premolars and

entertains doubts of there being any other European species than *D. giganteum**; the difference of size between the teeth of *D. giganteum* and *D. Cuvieri* is not greater than is known to occur between homologous teeth from different individuals of *M. (Tetraloph.) longirostris*, dug out of the same deposit at Eppelsheim. The nominal species *D. Kenigii* of Kaup is founded on a single small tooth, and therefore doubtful. I have lately seen well-marked specimens of fossil teeth of a species of *Dinotherium* from Attock in the Punjab, at no great distance from the Sewalik Hills, and, judging from the associated Mammalia, out of beds of the same age with them. The materials are not sufficient to establish whether the species is identical with *D. Indicum* of Perim Island, or distinct. In dimensions the teeth correspond with medium-sized specimens of *D. giganteum*. They were discovered by Lieut. Garnett, of the Bengal Engineers, and are now in the possession of Prof. Oldham, Superintendent of the Geological Survey of India, who has obligingly communicated them to me.—July 1857, H. F.

* Oss. Fossiles, tom. i. p. 205.

† Bronn, Lethæa Geognostica, Band ii. pp. 1233 & 1239 (1st ed.).

‡ Id. loc. cit. p. 1218.

§ Id. loc. cit. p. 1233.

inferior incisors, were several years afterwards advanced by Prof. Owen (who must obviously have overlooked the previous remarks of Bronn) in his 'British Fossil Mammalia*' as being distinctive of Mastodon from Elephant in a well-marked and unequivocal manner. But they are assuredly neither absolute nor constant, whether regarded in a positive or negative view, as generic distinctions. For on the one hand, premolars have not yet been met with in *M. (Trilophodon) Ohioticus*, in place in the jaws, although made a subject of special research by Dr. Warren, Dr. Jackson, and myself, upon a large quantity of materials†, up to a very late date; nor have they been yet met with in certain species of the *Tetralophodon* group; while, so far from being restricted to species of Mastodon, they have been detected by us in a typical fossil Elephant from India, *E. (Loxodon) planifrons*, both in the upper and lower jaws, in as great a number as in any known Mastodon. And as regards inferior tusks, although these have been observed in three species of the *Trilophodon* group, and in two of *Tetralophodon*, there are other species in which, among abundant materials, they have not been noticed up to the present time, even in young individuals, where they might have been with most confidence looked for. This remark applies with especial force to the forms here called *M. (Trilophodon) Humboldtii*, and to *M. (Tetralophodon) Sivalensis* and *M. (Tetralophodon) Arvernensis*.

Swayed by considerations of this nature, and struck more particularly with the identity of general characters, and close similarity of form, running throughout the whole of the osteology of the species of Mastodon and Elephant, with the exception of the molars and inferior incisors, De Blainville‡ abandoned the idea of there being any sufficient generic difference between the two, and made a retrograde step, arranging all the forms in two divisions, *Lamellidontes* and *Mastodontes*, under the common designation of "Elephas." This proposal has deservedly met with little favour among palæontologists and zoologists.

There are characters however, which, when once recognized, are happily of an obvious and readily applicable nature to distinguish Mastodon from Elephant, and which further enable the palæontologist to break up an unwieldy mass of species into subgeneric groups, that are at the same time natural and convenient. Putting aside for the moment, as extraneous, the consideration of incisors and premolars, and, as in the case of *Dinotherium*, taking the milk- and permanent dentition together, the species of both Mastodon and Elephant ordinarily present six molar teeth from first to last, in the order of horizontal succession, *i. e.* three deciduous or milk-molars, and three true molars. It was stated above, that in the *Dinotherium* the last milk-molar and the antepenultimate or first true molar are invariably characterized by a ternary-ridged formula, or in other words, that their crowns are divided into three ridges. Applying this criterion in a similar manner to *Mastodon*, we have found, that not only the last milk- and first or antepenultimate true-molar, but in addition

* Brit. Foss. Mam. p. 274.

† Warren, On *Mastodon giganteus*, p. 80.

‡ De Blainville, *Ostéographie : Des Eléphants*.

the second or penultimate true molar, being three teeth in immediate contiguity, in all the species (with one remarkable exception) are severally characterized in both jaws by an *isomerous* division of the crown into either 3 or 4 ridges. These three isomerous-ridged teeth may, for convenience of description, be referred to in the aggregate as “the intermediate molars,” a term which has been applied to them from their position by Fischer and by Laurillard*. To the species which present the ternary-ridged formula we have assigned the subgeneric name of *Trilophodon*†; and to the quaternary-ridged species, *Tetralophodon*‡. In citing the various forms under discussion in the sequel, these subgeneric terms will, in every case, be used for convenience in designating the species; and the same rule will be followed with the subgeneric divisions of *Elephas*. This will be of obvious use on the present occasion, both as a help to the memory in dealing with a large number of specific names, and as suggestive of broad points of distinction, when referring to the disputed species.

The ternary and quaternary formulæ are, I believe, never found mingled in the intermediate molars of the same species§; *i. e.* a ternary-ridged molar of this series does not occur in the species belonging to *Tetralophodon*, nor a quaternary in *Trilophodon*. The ridge-formula indicates also, with unerring certainty, the composition

* Dictionnaire Universel d'Histoire Naturelle, tom. viii. p. 29.

† From *τρῆς* et *λόφος*, three-ridged.

‡ From *τέσσαρα* et *λόφος*, four-ridged. This difference of *three* and *four* ridges was, so far as I am aware, first pointed out as a distinctive character between two European species, namely *Mastodon angustidens* and *Mastodon Arvernensis*, by Von Meyer as far back as 1834, but without being extended to the three intermediate molars. The name *Mastodon Arvernensis* was applied by him to the Eppelsheim species, *Mastodon longirostris* of Kaup. (Die Fossilen Zahne und Knochen von Georgensgmünd, p. 33.) The ridge-formula in the two subgenera is as follows:—

	Milk-molars.	True molars.
In <i>Trilophodon</i>	$\frac{1+2+3}{1+2+3}$	$\frac{3+3+4}{3+3+4}$
In <i>Tetralophodon</i>	$\frac{2+3+4}{2+3+4}$	$\frac{4+4+5}{4+4+5}$

the numerals exhibiting the ridges in each tooth, exclusive of the “talons.”

§ The only apparent exception which has come under my observation, occurs in the dentition of the South American species, to which the name of *Mastodon Andium* (*Tetralophodon* of our arrangement) has been restricted by the French palæontologists, Laurillard and Gervais, as distinct from *M. Humboldtii* (*Trilophodon*). In this species the last ridge in most of the intermediate molars is considerably reduced in size; and the teeth have been, in consequence, described by Gervais (Zoologie de l'expédition dans l'Amérique Méridionale par Le Comte de Castelnau, p. 19) as three-ridged. The specimens represented by him, figs. 2 and 5 of pl. 5 in the ‘Voyage de Castelnau,’ the former an antepenultimate upper true molar, and the latter a penultimate lower, are distinctly four-ridged, while the last lower milk-molar, fig. 4, is apparently three-ridged, with a large talon. My attention was directed to the subject by M. Lartet. More specimens are required for the exact determination of the point than yet exist in any of the European museums; *i. e.* whether in the intermediate molars of the form called *Mastodon Andium* the ternary and quaternary formulæ are mingled. Nine-tenths at least of the specimens of South American Mastodons in the British Museum belong to the other species, *M. (Trilophodon) Humboldtii*.—July 1857, H. F.

of the crown of the tooth which is immediately in front of, and of that which is immediately behind, the three intermediate molars: the former showing invariably *one* ridge less, and the latter *one* ridge more; that is to say, the penultimate or second milk-molar in all the species of *Trilophodon* is invariably two-ridged, and the last true molar four-ridged; while in *Tetralophodon*, in like manner, the former is three-ridged, and the latter five-ridged,—making due allowance in the last true molar for the amount of individual variety presented by the greater or less development of the well-known talon-complication, and for its being usually more complex in the lower jaw. The “ridge-formula” thus determines, with precision, five out of the series of six molars developed in horizontal succession in all the true Mastodons.

For reasons which will be explained in the sequel, it would seem that there has existed in nature another subgeneric group of *Mastodon*, of which only a single form is at present known, in which the crowns of the “intermediate molars” are divided upon a quinary ridge-formula. This group in our arrangement would be characterized, in harmony with the others, as *Pentalophodon*: and it may with some confidence be predicated, that, when the dentition shall have been well determined, the second milk-molar will present four ridges, and the last true molar six ridges in the upper jaw.

The Elephants, on the other hand, are distinguished from the Mastodons by the absence of an isomalous ridge-formula to the three intermediate molars of the upper and lower jaws; and by the circumstance that the ridges, instead of being limited to three or four, range from six up to an indefinite number in these teeth, in the different groups of species. We have found that the numerous forms, fossil and recent, may be conveniently arranged in three natural subgeneric groups, founded upon the ridge-formula, in conjunction with certain other dental characters.

In the first of these groups, corresponding with the forms collectively designated *Mastodon elephantoides* by Clift, the ridge-formula may be said to be *hypisomalous*, as the difference between the crowns of any two of the consecutive intermediate teeth does not exceed more than one ridge, and the ciphers range in the different species from 6 to 8. The ridges are not more elevated than in the true Mastodons, so that, when the teeth are sawn through longitudinally, the section yields a succession of salient and re-entering angles, the height of the chevron-shaped ridges not much exceeding the width of their base. The enamel is very thick, and the coronal interspaces in most of the species are filled up with an enormous quantity of cement. To this group we have assigned the subgeneric name of *Stegodon**. It is limited to extinct forms confined at present to the Indian Tertiaryes. The Stegodons constitute the intermediate group of the Proboscidea from which the other species diverge through their dental characters, on the one side into the Mastodons, and on the other into the typical Elephants.

In the second group, which includes the species allied to the

* From *στέγην tectum*, and *ὄδους dens*, having reference to the gable-end form of the section of the ridges.

African Elephant, the ridge-formula is also hypsimerous, as in the Stegodons, the ciphers ranging from 7 to 9 in the crown-ridges of the intermediate molars of the different species. But the colliculi, instead of yielding a gable-shaped or "tectiform" section as in the Stegodons, are much more elevated and compressed, so that when the teeth are sawn longitudinally and vertically, the ridges present the appearance of elongated wedges, with thinner plates of enamel. For this subgeneric group, the name of *Loxodon**, first indicated by Frederick Cuvier, has been adopted. It comprises both extinct and living species.

The last group, which is numerically the largest and most important, including the Elephants with thin-plated molars, as in the existing Asiatic species, is characterized by the ridge-formula being regulated in the "intermediate molars," not by hypsimerous ciphers, but by progressive increments (*anisomerous*), which may be expressed (*e. g.* for the Indian Elephant) by the series $12 + 14 + 18$ †. These ciphers, be it remarked, are not put forward as being rigidly exact in every case: for the higher the numerical expression of the ridge-formula in the species, the more liable to vary within certain limits, dependent on the race, sex, and size of the individual, is the number of the plates; and they do not rigidly correspond throughout in the upper and lower molars, the latter often exhibiting an excess. But it may safely be asserted that the numbers are never transposed or reversed, *i. e.* the younger tooth among the "intermediate molars" never normally exhibits in the same individual a higher number than the older; the increments may not always be symmetrical, but they are invariably more or less progressive. For this subgeneric group we propose the term of *Euelephas*‡.

[*Note*.—The following systematic Diagnoses of the genera *Mastodon* and *Elephas* were prepared as an Appendix by the author, but their insertion in this place more conveniently elucidates the subject-matter of this memoir. —EDIT.]

* From *λοξός obliquus*, and *δένος dens*, having reference to the rhomb-shaped discs of the worn molars; an adaptation of the term "*Loxodonta*" proposed by Fred. Cuvier, 'Hist. Naturelle des Mammifères,' tom. iii., Article "Éléphant d'Afrique." 1835.

† The illustration in this case is taken from the existing Indian Elephant, *E. (Euelephas) Indicus*, in which the ridge-formula of the whole series is nearly thus:—

Milk-molars.	True molars.
$4 + 8 + 12$	$14 + 18 + 24$
$4 + 8 + 12$	$14 + 18 + 24 - 27$

the numerals representing the ridges in each tooth, exclusive of the talons. A progressive increment runs throughout the series: but the selected numbers refer only to the "intermediate molars." In the species which approach nearest to *Loxodon*, the numerical expression of the ridge-formula is lower.

‡ From *εὖ bene*, and *ἐλέφας*, having reference to the typical Elephants most familiarly known. In the illustrations of the 'Fauna Antiqua Sivalensis,' the term *Elasmodon* was applied to this subgeneric group: but, the designation of *Elasmodus* having been preoccupied by Sir Philip Egerton for a series of fossil fish (Proc. Geol. Soc. vol. iv. p. 163, 1843), to prevent confusion, the term of *Euelephas* has been substituted for it.

Genus MASTODON (Cuv.).

Formula Dentium deciduorum.—*Primores* $\frac{1}{1}$ vel $\frac{1}{6}$; *Laniarii* $\frac{0}{0}$; *Molares* $\frac{3}{3}$ = 8-7.

Formul. Dent. persist.—*Primor.* $\frac{1}{1}$ vel $\frac{1}{6}$; *Lan.* $\frac{0}{0}$; *Præmol.* $\frac{2}{2}$ ($\frac{1}{1}$?) vel $\frac{0}{0}$; *Molares veri* $\frac{3}{3}$ = 12-8.

Primores eburnei plerumque exserti: superiores maximi vario modo porrecti, inferiores horizontales vel leviter deflexi, recti, minores. *Molares* complicati, tritores; *coronidis* rimâ longitudinali obsolete bifidæ *colliculi* concavi e tuberculis mammillaribus per paria transversè aut alternatim dispositis, constantes: *adamante* crasso, *cæmento* in valliculis parco aut subnullo. *Præmolares* aut cæteris formâ simpliciores minores, aut nulli. *Molares veri* 3, deinceps majores, altero alterum extrusum a tergo vicissim excipiente, demum utrinque solitarii.—*Molares* 3 utrinque *intermediû* (nempe deciduorum postremus et verorum antepenultimus penultimusque) *colliculis* isomeris aut 3, 4, aut 5 conformes.

Proboscis longissima, prehensilis. *Corpus* vastum artubus elevatis insistent. *Pedes* 5-dactyli.

Subgenus 1. TRILOPHODON.—Dentium molarium 3, utrinque intermediorum coronis colliculis 3.

Subgenus 2. TETRALOPHODON.—Dent. molar. 3, utrinque intermediorum coronis colliculis 4 (raro 5).

Observations.—The adult dentition varies much in the different species of the genus; the premolars and inferior incisors being inconstant. The typical complete formula is best shown by *M. (Triloph.) angustidens* of Simorre:—*Incis.* $\frac{1}{1}$; *Can.* $\frac{0}{0}$; *Præmol.* $\frac{2}{2}$; *Mol.* $\frac{3}{3}$ = 12, being identical with that of *Dinotherium*, so far as the dentition of the latter has been determined, *i. e.* *Incis.* $\frac{17}{1}$; *Can.* $\frac{0}{0}$; *Præmol.* $\frac{2}{2}$; *Mol.* $\frac{3}{3}$ = 12; the only question being in regard of upper incisors, the presence or absence of which has not yet been clearly ascertained in *Dinotherium*. The affinity indicated by the agreement in number is corroborated by the last milk-molar and ante-penultimate true molar being three-ridged alike in *Dinotherium* and in the section of *Mastodon* here called *Trilophodon*. Premolars have not been met with in *M. (Triloph.) Ohioticus*, which, counting both sides of both jaws, has 8 molars less in the adult state than *M. (Triloph.) angustidens*; nor have they been observed in *M. (Triloph.) Humboldtii*. They occur probably in *M. (Triloph.) tupiroides*. Their presence or absence has not yet been ascertained in the other species of *Trilophodon*. These teeth have been observed *in situ* in the upper and lower jaws of *M. (Tetraloph.) longirostris*, and in the upper of *M. (Tetral.) Arvernensis*. They have not yet been seen *in situ* in the other species of *Tetralophodon*.

Inferior incisors have been discovered in *M. (Triloph.) angustidens*, *M. (Triloph.) Ohioticus*, and *M. (Triloph.) tapiroides*; and also in *M. (Tetraloph.) Andium* and *M. (Tetraloph.) longirostris*, in the first of which they occasionally attain a very large size. They do not appear to occur ever in *M. (Tetraloph.) Sivalensis*, nor in *M. (Tetraloph.) Arvernensis*. Their presence or absence in the two other species of *Tetralophodon* has not yet been satisfactorily determined. The ridge-formula, as being respectively ternary in *Trilophodon* and quaternary in *Tetralophodon*, is very constant, the only doubtful case being presented by the form or forms named *Mastodon Andium* by the French palæontologists. Cement, although quantitatively inconspicuous in most of the species of both subgenera, is present in considerable abundance in the valleys of the crowns of *M. (Tetralophodon) Perimensis* and in *M. (Triloph.) Humboldtii*. In the former it fills up the bottom of the interstices between the mammillæ. The transverse or alternate direction of the mammillæ of the ridges, and the open or interrupted nature of the valleys connected therewith, are not equally defined in all the species, intermediate stages being met with. But the ridges are invariably transverse and the valleys open in *M. (Triloph.) Borsoni*, *Ohioticus*, and *tapiroides*, and in *M. (Tetraloph.) latidens*; while the mammillæ are constantly more or less alternate, and the valleys interrupted among the *Trilophodons* in *M. (Triloph.) angustidens*, *Humboldtii*, and *Pandionis*; and among the *Tetralophodons* in *M. (Tetraloph.) Sivalensis* and *Arvernensis*. The most complex crowns are presented in the *Trilophodons* by *M. (Triloph.) Pandionis* (an Indian fossil species recently discovered and as yet undescribed), and *M. (Triloph.) Humboldtii*; and among the *Tetralophodons* by *M. (Tetraloph.) Sivalensis* and *Arvernensis*. The upper adult molars in several of the species (e. g. *M. (Triloph.) angustidens* and *M. (Tetraloph.) Andium*) were invested with a longitudinal belt of enamel, disposed more or less spirally, and reaching the apex. The lower incisors, according to Lartet, are constantly devoid of any such belt. In *M. (Triloph.) angustidens* inferior incisors would appear to have been common to males and females, and not to have been a mark merely of sexual difference. *Mastodon Sivalensis*, although with five-ridged "intermediate molars," is provisionally included under *Tetralophodon*.

GENUS ELEPHAS (Linn.).

Form. Dent. decid.—*Primor.* $\frac{1}{0}$; *Lan.* $\frac{0}{0}$; *Mol.* $\frac{3}{3} = 7$.

Form. Dent. persist.—*Primor.* $\frac{1}{0}$; *Lan.* $\frac{0}{0}$; *Præmol.* $\frac{2}{2}$ vel $\frac{0}{0}$;
Mol. $\frac{3}{3} = 11-7$.

Primores eburnei plerumque exserti, sursum et antrorsum adscendentes. *Molares* aut complicati aut lamellosi, tritores; *coronidis* longitudinaliter integræ *colliculi* convexi e tuberculis mammillaribus, aut laminis cuneiformibus vel compressis digitatis transversis, constantes: *adamante* illis crasso, his attenuato, *cæmento* in valliculis copioso. *Præmolares* rarissime utrinque 2 (sæpius nulli), cæteris forma simpliciores, minores. *Molares*

veri 3, deinceps majores, altero alterum extrusum a tergo vicissim excipiente, demum utrinque solitarii.—Molares 3 utrinque intermedii (nempe deciduorum postremus et verorum ante-penultimus penultimusque) *colliculis* supra 5 (6–18), aut hypisomeris, aut anisomeris.

Proboscis longissima, prehensilis. *Corpus* vastum artubus elevatis insistent. *Pedes* 5-dactyli.

Subgen. 1. *STEGODON*.—Dentium molarium 3 utrinque intermediorum coronis complicata colliculis hypisomeris (*e. g.* 7+7+8), mammillatis, tectiformibus. Præmolares nondum observati.

Subgen. 2. *LOXODON*.—Dent. molar. 3 utrinque intermediorum coronis lamellosa colliculis hypisomeris (*e. g.* 7+7+8), cuneiformibus. Præmolares raro utrinque 2.

Subgen. 3. *EUELEPHAS*.—Dent. molar. 3 utrinque intermediorum coronis lamellosa colliculis deinceps numero auctis, anisomeris (*e. g.* 12+14+18), attenuatis, compressis. Præmolares nulli.

Observations.—The adult dentition of the Elephants, although typically more aberrant, is more constant than that of the Mastodons. Inferior incisors are wanting in all the species, fossil and recent, at present known; and premolars have as yet only been met with in a single form, *E. (Loxodon) planifrons*. The common formula is, *Incis.* $\frac{1}{0}$; *Can.* $\frac{0}{0}$; *Præmol.* $\frac{0}{0}$; *Mol.* $\frac{3}{3}=7$; but in this exceptional case the premolars are as numerous as in any species of *Mastodon*, the formula being, *Incis.* $\frac{1}{0}$; *Can.* $\frac{0}{0}$; *Præmol.* $\frac{2}{2}$; *Mol.* $\frac{3}{3}=11$. It exceeds the rest of the species by 8 molars in both jaws, as *M. (Triloph.) angustidens* exceeds *M. (Triloph.) Ohoticus*. A longitudinal belt of enamel has not yet been observed on the tusk of any Elephant. The molars are presented under two forms: in the subgenus *Stegodon* as “Dentes complicati,” resembling those of *Mastodon* in the folded form of their crown-eminences, and as “Dentes lamellosi” in *Loxodon* and *Euelephas*. The convexity of the crown-ridges, and the absence of the longitudinal mesial bipartient cleft, so characteristic of the true Mastodons, are very constant in the Elephants, the only exception, limited to the latter character, being indistinctly seen in an *E. (Stegod.) Cliftii*. The passage from the *Stegodons* into the *Loxodons* is effected through *E. (Steg.) insignis* and *E. (Loxod.) planifrons*; and from the *Loxodons* into *Euelephas* through *E. (Lox.) meridionalis* and *E. (Euel.) Hysudricus*. The anisomerous ridge-formula in *Euelephas* is not numerically the same in all the species, being in some higher, in others lower: but they all agree in exhibiting progressive increments. The amount of undulation presented by the worn edges of the enamel-plates furnishes a good means of distinguishing the nearly allied fossil species in *Euelephas*.

The distinctive and specific characters of Mastodon and Elephas.
—A safe criterion by which to test the soundness of any proposed

SYNOPTICAL TABLE OF THE SPECIES OF MASTODON AND ELEPHANT.

Quart. Journ. Geol. Soc. vol. xiii. Opposite page 319.

Genera, Subgenera, and Species.		Geological Age.	Country.	Remarks.
MASTODON	Subgen. 1. TRILOPHODON.....	(a.) Colliculi acuti valliculæque transversi	Spec. 1. M. (Triophodon) " 2. M. (Trioph.) " 3. M. (Trioph.) " 4. M. (Trioph.) " 5. M. (Trioph.) " 6. M. (Trioph.) " 7. M. (Trioph.)	Borsoni (<i>I. Hays</i>) tapiroides (<i>Cuv.</i>) Ohioicus (<i>Blumb.</i>) angustidens (<i>Cuv.</i>) Pyrenæicus (<i>Lart. MSS.</i>) Humboldtii (<i>Cuv.</i>) Pandonis.....
	Subgen. 2. TETRALOPHODON.....	(c.) Colliculi obtusi valliculæque transversi	" 8. M. (Tetralophodon) " 9. M. (Tetraloph.) " 10. M. (Tetraloph.?) (d.) Colliculi obtusi alternatim mammillati, valliculæ interruptæ. (e.) Colliculi numero 5, obtusi alternatim mammillati, valliculæ interruptæ.	longirostris (<i>Kaup</i>) latidens (<i>Clift</i>) Andium (<i>Cuv.</i>) Perimensis Averrhensis (<i>Croizet & Jober</i>) Sivalensis.....
	Subgen. 1. STEGODON.....	(a.) Colliculi circiter 6, cemento in valliculis parco	Spec. 1. E. (Stegodon) " 2. E. (Stegod.) " ? 3. E. (Stegod.) " 4. E. (Stegod.)	Cliftii hombifrons ? Ganesa insignis
	Subgen. 2. LOXODON.....	(c.) Colliculi grossè digitati, adamante crasso. (d.) Colliculi medio angulatum dilatati, machæridibus per detritonem rhomboides.	" 5. E. (Loxodon) " 6. E. (Loxod.) " 7. E. (Loxod.) " 8. E. (Loxod.)	planifrons..... meridionalis (<i>Nesti</i>) priscus (<i>Goldf.</i>) Africanus (<i>Blumb.</i>).....
	Subgen. 3. EULEPHAS.....	(e.) Colliculi subremoti, adamante crassiusculo (f.) Colliculi approximati medio leviter dilatati, machæridibus undulatis. (g.) Colliculi approximati, machæridibus valde undulatis. (h.) Colliculi confertissimi, adamante valde attenuato, machæridibus vix undulatis.	" 9. E. (Eulephas) " 10. E. (Euleph.) " 11. E. (Euleph.) " 12. E. (Euleph.) " 13. E. (Euleph.) " 14. E. (Euleph.) " 15. E. (Euleph.)	Hysudricus antiquus Namadicus Columbi Indicus (<i>Linn.</i>) Armeniacus..... primigenius (<i>Blumb.</i>)
				Miocene Pliocene Pliocene Existing Pliocene Pliocene Post-Pliocene?..... Existing ? Post-Pliocene
				Southern India : Ava..... India : Sewalik Hills. India : Sewalik Hills Sewalik Hills and Central India.. India : Sewalik Hills England ; France ; Italy. England ; Lombardy Africa. India : Sewalik Hills. England ; France ; Italy. Central India Mexico ; Georgia ; Alabama India Armenia : Erzeroom Europe, Asia, and North America.
				Syn. <i>Mastodon latidens</i> (Clift, pro parte). Distinctness as a species doubtful. Found both in the valley of the Nerbudda (<i>Pliocene</i>), and Sewalik Hills (<i>Miocene</i>). The only Elephant in which premolars have been met with. Imperfectly known. Fossil remains rare. Restricted to the <i>Pliocene</i> Fauna of the valley of Nerbudda, Central India. An Syn. <i>E. Jacksoni</i> ? (Sillim. Journ. 1838, vol. xxxiv. p. 363). Syn. <i>E. Sumatranus</i> (Temminck). In the Brit. Mus. Coll. Discovered between Erzeroom and Moosh in 1856. The molar plates closely approximated, and the enamel-edges very undulated.

arrangement in Natural History is, that the technical characters, however abridged, should be exponents, so to speak, of the natural and serial affinities, and in nowise at variance with them. If this test be applied to the ridge-formula, as a consistent basis for the arrangement of the Mastodons and Elephants, it will, we believe, not be found wanting: thus the Mastodons ranged under *Trilophodon* and *Tetralophodon* include all the Elephantoid species which have the crowns of the molars comparatively simple, and uniformly divided into two subequal divisions by a longitudinal line or cleft; the ridges limited in number, each with fewer mammillary eminences, and invariably more or less concave across; the enamel thick and in conical or compressed points; and the valleys between the ridges deep and empty, or with but a sparing quantity of cement. The Elephants, on the other hand, as restricted by the ridge-formula and ranged under *Stegodon*, *Loxodon*, and *Euelephas*, include all the Proboscidean species which have the crowns of the molars more complex, and usually wanting in a longitudinal line of division; the ridges more numerous and less definite, each being composed of a greater number of mammillary or digital points, which are most elevated in the middle, rendering the ridges convex across, instead of concave; the processes of enamel thinner, higher, and more divided; and the deep narrow valleys between them entirely filled up with cement. The limitations of the two genera agree pretty well with the views generally entertained by palæontologists regarding them; with the exception, that the group comprising the collective *Mastodon Elephantoides* of Clift, and by some called *transitional Mastodon**, is here regarded as more properly belonging to the Elephants.

A Synoptical Table is appended of the species of *Mastodon* and *Elephas*, ranged under subgenera, after the manner here indicated. The species were first determined or adopted after a careful examination of all the original materials accessible, in the foreign collections already referred to (p. 309) or in various museums in the United Kingdom. They were then arranged serially, according to their relative affinities, as indicated by the molar teeth; the common characters were next analysed, to furnish a key for breaking up the mass of species into groups representing genera and subgenera; and the synoptical table shows the result. It is put forward as exhibiting a fair representation of the subject so far as the materials and state of knowledge at the present time admit, but with no pretension to being either unexceptionable or complete. The progress of investigation, by the discovery either of new forms, or of more abundant materials of the species which are now the most imperfectly determined, will in all probability modify more or less, or break down, any generic or sub-generic limitations that may be at present devised. For the daily experience of every department of Mammalian palæontology tends to show, that, while the characters of species are persistent over wide areas and through long periods of time, genera are nothing more than ideal or conventional centres, around which groups of species are arranged, subject to incessant modifications through the discovery

* Owen, 'Odontography,' p. 624.

of new forms. It would be foreign to the main object of the present communication, and beyond the limits within which it is necessarily restricted, to discuss in detail the grounds on which the arrangement is founded. As this will be done more fully elsewhere, I shall content myself here with stating them in a general way, and with indicating where the assailable points are. Although the Mastodon of North America and the Mammoth are so widely different in the form of their molar teeth that they must be ranked under distinct genera, the intermediate gradations are so complete as to establish a passage from the one into the other. Failing the characters of premolars and inferior incisors, previously relied upon, as distinctive of the Mastodons, and abundant cement as distinctive of the Elephants, the constancy of the ridge-formula in being isomerous, whether ternary, quaternary, or quinary in the intermediate molars, appeared to furnish a sufficient technical demarcation between *Mastodon* and *Elephas*, and to subdivide the former satisfactorily into the natural subgeneric groups of *Trilophodon* and *Tetralophodon*. It remains to be seen whether there is any intermediate species in which the characters of these two groups are blended.

Mastodon Sivalensis is regarded as having five ridges to the "intermediate molars," instead of four; but this remarkable character, being restricted at present to a single species, it was deemed inexpedient to form a systematic section for it alone; and it is ranged at the end of the *Tetralophodons*.

Although a mesial, bipartient, longitudinal cleft along the summit of the crown is very common in the molars of most of the species of *Mastodon*, and usually absent in the Elephants, there is one species of the former, *M. (Triloph.) Borsoni*, in which the cleft is so obsolete, that Isaac Hays* founded the specific character upon the supposed absence of this cleft. But the cleft, although but slightly pronounced, is distinctly present in unworn germ-teeth of this form; and it is even visible in the original molar described by Abbé Borson, upon which Dr. Hays relied for its absence.

The plurality of the species in the first subgeneric group of *Elephas*, namely *Stegodon*, are sufficiently distinguished from the Mastodons by the higher numerical expression of the crown-formula, in showing 7 or 8 ridges instead of 3 or 4; by the great quantity of laminated cement which fills the transverse valleys; by the ridges being convex as in the typical Elephants; by the greater number of points to each ridge; and by the absence of a mesial dividing furrow. But in one of the species, *E. (Stegodon) Cliftii*, there is an obsolete indication of this furrow; and its affinity to the *Mastodon* is further evinced by the low or senary expression of the ridge-formula. This species constitutes a frontier form, through which the passage between the two genera is effected; but the details of the other dental characters show that it is most nearly allied to the *Stegodons*, and the characters of the subgeneric group were constructed to admit of its reception among them. Two of the *Loxodons*, namely *E. (Lox.) planifrons* and *E. (Lox.) Africanus*, have a ridge-

* Transactions of the American Philosophical Society, ser. 2, vol. iv. p. 334.

formula which is identical or nearly so with that of *Stegodon insignis*; but the separation of the group is indicated by the great increase of vertical height in the colliculi, and by the layers of enamel assuming the character of plates, instead of the mastoid eminences of *Stegodon*. *E. (Lox.) meridionalis* has a higher number of plates in the "intermediate molars" than those two species, and constitutes a frontier form, leading towards the next group, *Euelephas*. But the ridge-formula in this form would appear to be hypsimerous, and the aggregate characters indicate its position among the Loxodons. The majority of the species in the group *Euelephas* are well marked by the progressive increments and high numerical expression of the crown-ridges of the intermediate molars, by the great vertical height of the colliculi, and the attenuated plates of enamel. One species among them, *E. (Eueleph.) Hysudricus*, constitutes a frontier form leading towards *E. (Lox.) meridionalis*. More ample details respecting the Elephants will be given in the Second Part of this memoir, when treating of the European fossil species.

To revert specially to the Mastodons, *Trilophodon* and *Tetralophodon* (including under the latter the exceptional five-ridged *Mastodon Sivalensis*), as regards the number of forms at present known, are of nearly equal value, the former in our view comprising 7, and the latter 6, well-marked species; and they are each divisible into two parallel subordinate groups, the exact appreciation of the characters of which is of much service in the determination of the European fossil species. In the one series, the ridges are broad, transverse, more or less compressed into an edge, with the valleys open throughout and uninterrupted by subordinate tubercles: these are well represented in *Trilophodon* by *M. (Triloph.) Ohioticus*, and in *Tetralophodon* by *M. (Tetral.) latidens*. In the other series, the ridges are composed of blunt conical points, which are fewer in number, more elevated, and flanked in front and behind by one or more subordinate outlying tubercles, which disturb the transverse direction of the ridges, and block up the valleys, interrupting their continuity across. This series is represented in *Trilophodon* by the Miocene European species *M. (Triloph.) angustidens*, and in *Tetralophodon* by the Pliocene *M. (Tetraloph.) Arvernensis* of the Crag (See Plates XI. & XII.). The species with transverse, compressed ridges, in both subgenera, may be compared with *Dinotherium*, as regards their molar crowns; and the other series with *Hippopotamus*.

The European fossil species of *Mastodon* at present known are the following*,—all of which are of Miocene age, with the exception

* M. Aymard has added largely to the nomenclature of the Proboscidea by creating a new genus, and new species for the remains found in the Velay and Auvergne, viz.: *Anancus macroplus*, as a generic form distinct from *Mastodon*; and *M. Vellatus* and *M. Violetti*, regarded by Pomel as synonyms of *M. Borsoni*; also a fossil Elephant, *E. giganteus*, Aym. But the specific distinction of these nominal species is exceedingly doubtful (*vide* Bulletin de la Société Géologique; and Congrès Scientifique de France, 1855, p. 276). The species referred to in a preceding page as having been made out by M. Lartet has not yet been published.

of *M. (Trilophodon) Borsoni* and *M. (Tetralophodon) Arvernensis*, which are Pliocene.

M. (Triloph.) Borsoni, Isaac Hays (Pliocene).

M. (Triloph.) tapiroides, Cuvier.

M. (Triloph.) angustidens, Cuvier, pro parte.

M. (Tetraloph.) longirostris, Kaup.

M. (Tetraloph.) Arvernensis, Croizet & Jobert (Pliocene).

The British fossil Mastodon, and its comparison with M. angustidens, M. Arvernensis, and M. longirostris.—The remains of only one species of *Mastodon* have hitherto been discovered in the British Isles, in what is called the Older Pliocene "Red Crag," at Felixstow and Sutton in Suffolk, and in the Newer Pliocene, "Fluvio-marine," or "Mammaliferous Crag" in various localities near Norwich and in Suffolk. I shall now endeavour to ascertain what this species is; and, as I consider that the question is one of considerable importance, as a turning-point upon which the independent character of the British Pliocene fauna hangs,—that is to say, whether it is distinct or merely a long-lived offset from the Miocene,—I shall not hesitate to enter at length upon the details calculated to throw light upon the subject.

Professor Owen is the only English palæontologist who has undertaken to identify and describe in connexion all the *Mastodon*-remains of the Crag, which he has done very fully in his valuable work 'On the British Fossil Mammalia,' published in 1846. He there designates the species *Mastodon angustidens* or *Mastodonte à dents étroites* of Cuvier; and gives as synonyms, in his opinion, *M. Arvernensis* of Croizet and Jobert, and *M. longirostris* of Kaup. He heads the chapter with a woodcut of the upper and lower jaws of the Eppelsheim *M. longirostris*, after Kaup, under the name of *Mastodon angustidens*; and in his description of the dentition of *M. angustidens* in the 'Odontography*,' he draws his details of the various teeth indifferently from the three nominal species above mentioned, namely, *M. angustidens*, *M. longirostris*, and *M. Arvernensis*. In his memoir on the Crag Mammalia, contained in the 47th number of the 'Quarterly Journal,' published in August of the present year, he reiterates the opinion that *Mastodon angustidens* and *Mastodon longirostris* are synonyms of the English Crag species. Any opinion emanating from so distinguished a palæontologist as Professor Owen, and repeated by him after mature study, at various intervals, between 1843 and 1856, must necessarily carry great weight with it. The first point, therefore, to determine is, what is the species to which Cuvier's name of *M. angustidens* is legitimately applicable.

(*Mastodon angustidens*.)—The fluvatile or lacustrine Molasse of the basin of the Sub-Pyrenees has from a very remote time been worked, at Simorre, by mines for what was called the "*Turquoise de nouvelle Roche*," this substance being the ivory of *Mastodon*-tusks chiefly highly injected with a metallic infiltration, so as to

* *Op. cit.* p. 619 *et seq.*

simulate the natural mineral Turquoise*. The excavations brought to light the numerous Miocene remains found in this rich dépôt, and among others the molars of Mastodon. These were vaguely referred to by the old naturalists, under the name of the "Animal de Simorre†." Some of them found their way, in the progress of time, to the Museum of Natural History in Paris, about the middle of the last century, and Daubenton described them under the title of "petrified teeth having relations to those of Hippopotamus," to which indeed in some important respects they bear a very striking analogy. Cuvier, having established his "grand Mastodonte" of North America, next directed his attention to the European remains of the genus, the first of which he published under the title of 'Mastodonte à dents étroites' or *M. angustidens*. It has been proved upon the clearest evidence, by various palæontologists, and admitted among others by his devoted friend and follower Laurillard‡, that Cuvier has included more than one species under this nominal designation of *M. angustidens*. It is requisite therefore to ascertain precisely what were the original types which suggested a name of such palpable signification to a shrewd and philosophical observer like Cuvier. On referring to his original memoir, it will be found that Cuvier commences §, as his first illustration, with a description of one of the Simorre molars previously described by Daubenton. The second piece is the Dax specimen from near Sort, Département des Landes, and obtained from a fluvio-marine Molasse formation probably of the same age as the Simorre lacustrine beds. The third specimen is a South American fragment, brought to Europe by Humboldt, which has no connexion with the European species: on this head all later palæontologists who have investigated the subject, without exception (exclusive of mere compilers), are agreed; among others, Laurillard||, who identifies it with *M. Andium*, as restricted by him. The fourth specimen which Cuvier quotes is another Simorre fossil. The sixth, a very important and characteristic specimen, is from the same locality. Now, all these Simorre specimens, with the exception of the third, which is a premolar—and therefore a normal exception,—are characterized by having their crowns divided into three principal ridges. "It is therefore," as we have elsewhere¶ stated, "to a species having the intermediate molars distinguished by a ternary division of the crown, as in *M. Ohioticus*, that the specific name of *M. angustidens* is strictly applicable, so far as priority of description and reference to original types can be taken as the guides to a decision on the point." See Plate XI. figs. 3 & 4.

Since the time of Cuvier, Simorre and Sansan have become classical palæontological ground through the important discoveries,

* Reaumur, Mém. de l'Acad. des Sciences, 1715, p. 174; and Lartet, Quelques Aperçus Géologiques dans le Département du Gers," p. 19.

† Id. *op. cit.* p. 24.

‡ Dictionnaire Universel d'Histoire Naturelle, tom. viii. pp. 29–30.

§ Annales du Muséum, tom. viii. p. 412.

|| Dictionnaire Universel d'Histoire Naturelle, tom. viii. p. 29.

¶ Fauna Antiqua Sivalensis, par. i. 1846, p. 57.

made by M. Lartet, of the first announced fossil monkey in Europe, of *Macrotherium*, *Anisodon*, &c. Among others, a vast quantity of Mastodon-remains have been met with, including the whole dentition, from the young sucking-calf up to the adult and old animals. A superb skeleton was disinterred by Laurillard at Seissan, so complete in every respect, that it has been set up in the Paris Museum, alongside of the skeletons of the existing Indian and African Elephants. Two points which have been invariably exhibited by all these teeth are of special importance in their bearing upon the present question; the first is, that the intermediate molars are constantly three-ridged, or, in other words, belong to the *Trilophodon* type; no *Tetralophodon* molars having ever, within the knowledge of M. Lartet, been discovered either at Simorre, Sansan, or Lombez: the second is, that they entirely agree with the original Simorre types described by Cuvier, upon which his *M. angustidens* is founded; and that they are absolutely the narrowest of all known Mastodon-molars. Another remarkable character of the species is this, that, in harmony with the narrow teeth, the horizontal ramus of the lower jaw is more compressed, and higher in relation to the width, than in any other known Mastodon. This is well shown in the Paris skeleton, and in numerous lower jaws contained in the palæontological gallery. M. Lartet possesses, in his rich collection at Seissan, several lower jaws exhibiting the same character. A nearly entire skeleton of this species was discovered in the latter part of 1855, in the sandstone-quarry of Veltheim, near Winterthur in Canton Zurich; this I was enabled to examine minutely through the kindness of M. Ziegler-Ernst of Winterthur. It is the largest specimen of the species that I have anywhere seen. The lower jaw, although in fragments, is nearly complete, and shows the extreme compression of the horizontal ramus, and its great depth. I found, by measurement with the callipers, that this compression was even greater than is seen in *Dinotherium*, while the lower jaws of most of the known Mastodons and Elephants yield more or less of a circular section. This tenuity of form is carried on throughout the skeleton in the Mastodon of Simorre.

From these remarks it would appear sufficiently evident, that, whether we are guided by priority of description and reference to the original specimens, or by the obvious signification of the term, the title of *Mastodon angustidens* is legitimately applicable to the *Trilophodon* of Simorre, and to no other species: for it is, *par excellence*, the "Mastodonte à dents étroites" of Cuvier. The species, thus limited, has nowhere been met with in the fossil state in England.

(*Mastodon Arvernensis* and *M. longirostris*.)—But Cuvier, as already stated, included under this name of *M. angustidens* other remains which do not belong to it. Upon this head nearly all the French palæontologists are agreed, although at variance as to the details. Of the specimens figured in the four plates devoted to "Divers Mastodontes" in the 'Ossements Fossiles,' all those from South America, amounting to 10 in number, are by common consent referred to one or two species peculiar to that country. Seven are referable to the Mastodon of Simorre with narrow molars; one

to *M. tapiroides*; five are doubtful, either from inexact knowledge as to their origin, or from their undecided character; and all the rest, being 11 in the aggregate, are from Italy, with the exception of one specimen from Trevous in France. It is curious to observe the different views that have been taken of them. De Blainville* limits the South American remains to a single species, while Laurillard and Gervais range them under two well-defined forms. De Blainville and Owen agree with Cuvier in referring the so-called narrow-toothed remains from Simorre, Italy, Auvergne, and Eppelsheim also, to a single species. Laurillard, devoted as he was to the traditions of his great leader, was compelled by the evidence to admit two species, namely *M. angustidens*, under which title he included the Italian, Auvergne, and part of the Eppelsheim remains,—and *M. longirostris*, under which he ranged both the principal part of Kaup's Eppelsheim species, and the whole of the Simorre remains†. Misled by the undue importance which he attached to the presence of mandibular incisors common to the two forms, he sunk the characters presented by the molars, and confounded ternary-ridged and quaternary-ridged forms under the same name, although it is distinctly evident that he was aware that two of the European species severally possessed 3 and 4 ridges to their intermediate molars, and that the ternary formula was common to the Mastodons of North America and of Simorre. In 1828, four years before the demise of Cuvier, Croizet and Jobert‡ proposed the name of *M. Arvernensis* for the Auvergne remains, as distinct from *M. angustidens*, and soon afterwards Dr. Kaup§ published his magnificent series of the Eppelsheim form as equally distinct, under the designation of *M. longirostris*, which has been regarded by Herman von Meyer to be identical with *M. Arvernensis*||. Lartet¶ had accurately determined the milk- and permanent dentition (so far as the true molars are concerned) of the Simorre form as far back as 1847. He assigned three ridges to the last milk-molar and to the ante-penultimate and penultimate true molars in both jaws, and in his 'Notice,** published in 1851, he proposes to distinguish it by the name of *Mastodon Simorreense*, retaining the designation of *Mastodon angustidens* for the Italian and Auvergne remains, characterized by four ridges in the penultimate true molar, instead of three. Lartet at the same time †† proposed the name of *Mastodon Gaujaci* for a supposed small form from the same Miocene deposit at Lombez. Laurillard considered it as furnishing a confirmation of the conjectural species named *Mastodon minutus* by Cuvier ‡‡.

Gervais followed Laurillard in considering the Simorre *M. (Triloph.) angustidens* and *M. (Tetraloph.) longirostris* as be-

* Ostéographie: Des Eléphants.

† Dictionnaire Universel d'Histoire Naturelle, tom. viii. p. 29.

‡ Recherches sur les Ossements fossiles du Département du Puy-de-Dôme, p. 133.

§ Ossements Fossiles de Darmstadt, part iv.

|| Nova Acta Acad. Nat. Cur. vol. xvii. p. 113.

¶ Dictionnaire Universelle d'Histoire Naturelle, tom. viii. p. 29.

** Notice sur la Colline de Sansan, p. 24.

†† *Op. cit.* p. 27.

‡‡ Dictionnaire Universel d'Histoire Naturelle, tom. viii. p. 31.

longing to the same species, *Mast. longirostris*; but adopted for the Auvergne form the name of *M. Arvernensis*; and went a step beyond his predecessors in proposing a new name for the Mastodon-remains found in the arenaceous deposits near Montpellier, which he identifies with the Mastodon of the Astesan and the Val d'Arno under the name of *M. brevirostre**. Pomel, in his memoir of 1848, proposes a new name for the Simorre *Trilophodon*, namely *M. Cuvieri*, and he retains that of *M. angustidens* for the Auvergne and Italian forms, admitting their distinctness from *M. longirostris* of Eppelsheim †. In his 'Catalogue Méthodique' of 1854 he adopts the name of *M. Arvernensis* for the Auvergne and Montpellier form, to which he assigns the additional foreign localities of the Val d'Arno, Piedmont, and the Crag in England: but in a remark on the next page he reiterates the view expressed in his previous memoir, that he has retained the name of *M. angustidens* for the species of Italy ‡. Nesti §, in his description of the Tuscan remains, adopts the name of *M. angustidens* (Mastodonte a denti stretti) in the loose comprehensive sense in which it was used by Cuvier; while Eugenio Sismonda, aware of the various and contradictory opinions upon the point, guardedly described the fine skeleton found at Dusino in Piedmont, under the title of 'Osteographia di un Mastodonte angustidente' ||. My friend and collaborateur Colonel Sir Proby Cautley, in 1836, figured and described some teeth of the Indian species to which we subsequently restricted the name of *M. (Tetralophodon) Sivalensis*, as identical with the "Mastodonte à dents étroites" of Cuvier, and he expressed at the same time the opinion that the Italian form which he had more particularly in view would, with the Sewalik one, constitute a subgenus of the *Angustidens* type, in contradistinction to the type of Clift's *M. latidens* ¶.

These, so far as I am aware, are the leading opinions which have been put forward by original writers on this much-disputed question. Those which have been expressed by the compilers of systematic works on Palæontology, however useful, are of little weight in the discussion, as they express more the balance of the authorities numerically, than opinions formed upon independent examination of the subject by themselves. The specific name *Mastodon angustidens* is even struck out of the list of European species, except as a synonym, in the last edition of Bronn's "Lethæa," and replaced by the terms *M. Arvernensis*, *M. longirostris*, and *M. Cuvieri* **. Palæontologists would confer a great boon on Geology, if they could be brought to agree in applying this name (*M. angustidens*) to the Simorre form, for which it was devised by Cuvier.

The views which we entertain were partially disclosed in the first

* Annales des Sciences Naturelles, 3me série, tom. v. p. 268.

† Bull. de la Soc. Géologique, 1848, tom. v. p. 257.

‡ Catal. méthod. et descript. pp. 74, 75.

§ Nuovo Giorn. de Letterat., Pisa, tom. xii. pp. 17-34.

|| Mem. del Reale Accad. di Torino, 1851, pp. 175-235.

¶ Journ. of the Asiat. Soc. of Bengal, vol. v. p. 294.

** Lethæa Geognostica, 3rd edit. vol. iii. pp. 827-832 (1856).

part of the letter-press of the 'Fauna Antiqua Sivalensis,' and fully elucidated in the four plates of outline-heads, from Plate 42 to 45, of Part 5 of the illustrations, where a synopsis is given of all the species, fossil and recent, then known. The forms included under the nominal species of *M. angustidens* of Cuvier are there ranged as distinct species, namely

- M. (Triloph.) angustidens,*
- M. (Triloph.) Andium,*
- M. (Tetraloph.) longirostris,*
- M. (Tetraloph.) Arvernensis.*

The only change which subsequent investigation on fresh materials has led us to make, is to transfer *M. Andium* from the subgenus *Trilophodon* into that of *Tetralophodon*, for reasons which it is not necessary to detail on the present occasion. Of these forms the only one which I believe has been met with in the fossil state in England is *M. (Tetralophodon) Arvernensis* (Pl. XII.); and I shall now proceed to the consideration of the evidence in support of this conclusion.

(*British specimens of Mastodon.*)—Remains of two out of the three species of *Mastodon* with which we are chiefly concerned now, viz. *M. (Trilophodon) angustidens*, *M. (Tetralophodon) longirostris*, and *M. (Tetralophodon) Arvernensis*, have been discovered on the Continent, in the localities where they prevail, in such a perfect condition, that very little remains to be desired in regard to their entire osteology. The skeleton of *M. (Trilophodon) angustidens* from Seissan, set up in the gallery of Comparative Anatomy in Paris, is so complete in every respect, from the cranium down to the digital phalanges, that it may be compared bone for bone, throughout the frame, with the skeletons of the African and Indian Elephants which adjoin it. Of *M. (Tetraloph.) Arvernensis*, a nearly entire skeleton was disclosed by a railway-excavation at Dusino near Asti in Piedmont, and is now deposited in the Turin Museum. It is deficient only in the cranial portion of the head, right hind leg, part of the scapula and pelvis, and some of the bones of the carpus and tarsus. The upper and lower jaws, with the tusks entire to their tips, are preserved; and Prof. Sismonda was only deterred by the brittle condition of the bones, from attempting to reconstruct the whole. A skeleton of the same species nearly as perfect, which I have examined, was discovered in the lower Val d'Arno in a marine stratum, along with the skeleton of a Whale. It is now laid out in the museum at Florence, together with numerous other bones of the same species. From the Miocene sands of Eppelsheim, Kaup disinterred the upper and lower jaws, with an immense quantity of molars, showing the entire dental series, milk and adult, besides various other portions of the skeleton, of *M. (Tetralophodon) longirostris*. The materials are therefore so abundant now, that it is in a measure easy to institute a comparison more or less rigorous between the three species.

But as regards the English remains of *Mastodon*, it is quite the reverse. Only solitary teeth detached from the jaws, or part of a mutilated young cranium, have hitherto been described, and the teeth in most cases mutilated. The beautiful vignette which heads

the chapter upon *Mastodon angustidens* in the 'British Fossil Mammalia' would convey a very exaggerated notion of the English remains as they are ordinarily met with, but that the author takes care to apprise his readers that it is derived from Kaup's figure of the Eppelshheim species. No good specimen of the lower jaw, so far as I am aware, has yet been found in Britain; nor have any of the large bones of the extremities been identified, although it is more than probable that such do exist in the numerous collections which have been formed in Norfolk and Suffolk. The pieces are usually more or less mutilated; and it is clear that the bones have been broken up before the fragments were deposited in the strata where they are now found. Nothing approaching the remains of a perfect skeleton has been seen in any one locality, with the exception of the notable case recorded by the Rev. J. Layton, in which the entire skeleton of a *Mastodon* is stated to have been found lying on its side stretched out between the chalk and gravel, at Horstead near Norwich, on a bed of marl. The bones in this instance were heedlessly broken up by the workmen, or dispersed before any steps could be taken for their preservation*.

The molars or other fragments occur scattered and detached. Prof. Owen mentions a well-preserved atlas of apparently *Mastodon angustidens* as being preserved in the Ipswich Museum†. *Mastodon* molars have been found both in the Red Crag of Suffolk and in the Fluvio-marine Crag of Norfolk and Suffolk; in the former at Sutton and Felixstow, in the latter at Postwick, Whitlingham, Thorpe, Horstead, and Bramerton near Norwich, and at Easton near Southwold. Mr. Charlesworth, in reference to their supposed rarity, mentions, that within the twelve months preceding September 1851, upwards of a dozen of *Mastodon* molars had been discovered, in washing the Crag to get out the phosphatic nodules‡. Prof. Owen notices their occurrence in the Crag-pits of Suffolk§. I am not aware that they have yet been discovered in the Fluvio-marine Crag of Bridlington in Yorkshire, nor in any of the freshwater deposits below the Drift, where remains of Elephant and Hippopotamus are more or less abundant.

It is no part of the object of this communication to describe the numerous remains of *Mastodon* from the Crag, that are to be met with in different English collections. All that is intended, is to determine what the species really is, and only such characteristic specimens will be referred to as exist either in original or as casts in public museums, or as have been so accurately figured and described in works of authority as to be susceptible of satisfactory identification.

First as regards the *Molars*.—The most perfect specimen that has yet been discovered, is the famous Whitlingham tooth, which forms the frontispiece of Mr. W. Smith's 'Strata Identified,' and of which (reversed) a beautiful woodcut is given in fig. 97 of the 'British Fossil Mammalia.' It is also very carefully represented, unreversed, both as regards the plan and profile views of the crown,

* Fairholme's 'Geology of the Scriptures,' p. 281.

† Quart. Journ. Geol. Soc. vol. xii. p. 223.

‡ Warren, 'On *Mastodon giganteus*,' 2nd edit. p. 204.

§ *Op. cit.* p. 223.

in the 'Fauna Antiqua Sivalensis,' pl. 36. figs. 8 and 8*a*. It is the last true molar (upper jaw, right side), being composed of five ridges, with an anterior "talon," and a strong back "talon." The crown is obscurely divided longitudinally by a shallow cleft along its axis. Each ridge consists of about two pairs of thick, high, conical mammillæ, with very thick enamel. Deep clefts or valleys intervene between these ridges; but the valleys, instead of being transverse, are interrupted in the middle by one or more large accessory conical mammillæ, which are interposed between the ridges, and alternate with the outer and inner divisions. These mammillæ are usually connected with the inner division of each ridge in the upper jaw, and with the outer in the lower. They are much thicker than in the other species of Mastodon which possess them, and have a large conical core of ivory. The consequence of this complex composition of the crown is, that, when the ridges have been worn down by continued grinding, they present a great number of distinct *alternate* trefoil discs, surrounded by a ring or belt of enamel, instead of the single or double transverse disc exhibited by the Mastodon of Eppelsheim, *M. (Tetralophodon) longirostris*, or by the *M. (Trilophodon) augustidens* of Simorre. In the Eppelsheim species, of which I have carefully examined all the molars contained in the rich collection at Darmstadt, there is a considerable range of variety as regards the accessory tubercles which flank the main ridges. In some of the last molars, the main ridges are perfectly free from any outlying or flanking mammillæ; they are regularly transverse, and the valleys between are equally transverse, and open throughout. In others, the ridges bear numerous small warty tubercles of enamel, which jut into the valleys and distort them. But the transverse continuity of the valleys is never blocked up by the large conical mastoid mammillæ which in the molars of *M. (Tetralophodon) Arvernensis* invariably alternate with the main ridges, and reduce the valleys to disconnected gorges, occupying the outer and inner sides of the crown. The accessory tubercles in the Eppelsheim species are so unimportant, that their only effect, after advanced wear, is to expand the diameter of the disc, or communicate to it something of a trefoil pattern. The discs are always transverse, while in the English Crag Mastodon they are invariably more or less alternate. In illustration of this very obvious differential character in *M. (Tetralophodon) longirostris*, the beautiful series of figures given by Kaup in the 'Ossements Fossiles de Darmstadt,' from plates 16 to 21 inclusive, may be quoted; but I would more especially refer to figs. 4 and 5 of pl. 16, figs. 1, 3, 4, and 9 of pl. 18, and figs. 2, 6, and 7 of pl. 21.

We have endeavoured to exhibit these differences in a well-marked and obvious manner, by contrasted figures (drawn with the greatest care and fidelity by Mr. George Ford) of the same tooth in three species, placed side by side, in pl. 36 of the 'Fauna Antiqua Sivalensis.' Figs. 6 and 6*a* represent in plan and profile the last molar (upper jaw, left side) of *M. (Tetralophodon) Sivalensis*, an Indian fossil species, which is the most nearly allied to the English Crag

Mastodon so far as the alternate disposition of the crown-mammillæ is concerned, but differing in the ridge-formula. Figs. 8 and 9 represent two specimens of the same tooth of *M. (Tetralophodon) Arvernensis*, the one being Mr. William Smith's Whitlingham fossil, and the other, fig. 9, Captain Alexander's specimen, dredged up between Southwold and Easton, of which there is a cast in the Geological Society's Museum. Figs. 12 and 13 represent two specimens, of different races or sexes, of the same tooth of *M. (Tetralophodon) longirostris*, from Eppelsheim. The Sewalik molar, fig. 6, exhibits six ridges and a hind "talon"; the Crag and Eppelsheim molars show only five ridges and the "talon." In the Eppelsheim teeth, figs. 12 and 13, the crown is broad, the mammillæ are thicker in proportion to their height, the ridges are less elevated, and consist of a greater number of coronal points (there being often as many as six or seven to each ridge), the outer and inner lines of points converge less towards the apex of the crown as they rise upwards, and the valleys are either entirely open and transverse, or interrupted only by an insignificant amount of warty tubercles. In the Crag fossils, figs. 8 and 9, the crown is narrower in proportion, the mammillæ form more attenuated cones, and are more elevated; the ridges consist of fewer coronal points, which, instead of running across in a wide crest, appear, so to speak, as if they had been squeezed together, and their transversality disturbed; the outer and inner lines of points, especially the latter, converge rapidly as they ascend, rendering the apex of the crown much narrower than the base; the outer and inner divisions of the crown are more or less alternate, and the vallicular mammillæ that flank and alternate with them are large conical points, which yield discs of wear approaching in size to those of the principal points; the valleys are completely obstructed by these mammillæ, and reduced to a gorge on either side of them. When the teeth are viewed in profile, such as fig. 8, on the above-mentioned plate, compared with fig. 13, the difference is very marked, the latter yielding a series of salient and re-entering angles, corresponding with the prominent points and valleys, which the former does not, the re-entering angles being intercepted by a dark shade, which represents the accessory mammillæ. If the eye is next directed to figs. 6 and 6a, the differences are still more marked, *M. (Tetralophodon) Sivalensis* exhibiting a greater amount of alternation of the crown-mammillæ, and more complexity of pattern, than is even seen in the English Crag Mastodon. To summarize the distinctive characters of the two European species, it may be stated, that *M. (Tetr.) Arvernensis* (Pl. XII.), with *M. (Tetr.) Sivalensis*, resemble the Hippopotamoid type, and *M. (Tetr.) longirostris* (Pl. XI. fig. 1), with the Indian species *M. (Tetr.) latidens*, the Dinotherian type, in so far as the form of the crowns of the molar teeth is concerned.

Of the last true molar of the lower jaw no good entire specimen, so far as I am aware, has yet been published as having been yielded by the English Crag. But in the Museum of the Geological Society there is a cast of a very fine specimen of this tooth from the left

side of the lower jaw, which, according to the label on the cast, was found in the Crag of Suffolk (see Plate XII. figs. 3, 4). It is a nearly unworn germ, measuring about $8\frac{1}{2}$ inches long, by 3 in width in front; without fangs; and the anterior ridge alone being slightly touched by wear. It is composed of five ridges and a talon of two mammillæ. The anterior ridge shows two pairs of mammillæ; the next four ridges present only two large conical mammillæ each, which converge rapidly towards the summit of the crown, and are disposed in an alternate manner. One or more large accessory mammillæ are interposed between the ridges, blocking up valleys in the manner described as characteristic of the species, and the ridges are inclined with a slope which increases successively backwards. The talon appears to have been composed of a pair of points, one of which is mutilated on the inner side, and a small portion of the back end of the tooth is wanting. The slope of the posterior ridges is so pronounced as to approach nearly to the character of "imbrication." In this respect the specimen closely resembles the Val d'Arno molar figured by Cuvier (*Divers Mastodontes*, pl. 4. f. 7), which he describes as the last of the upper jaw*; but it would seem, from the form and contour, to be an entire germ of the last inferior molar, and, in our opinion, of the same species as the Crag Mastodon, namely *M. (Tetraloph.) Arvernensis*.

A fragment composing the posterior half of the last inferior true molar has been noticed and figured by Mr. S. Woodward†. It is composed of seven prominent conical mammillæ, disposed in three ridges, which contract very much behind, and terminate in an odd talon-tubercle. These tubercles form two lines, an outer and inner, and they are placed in regular alternation with each other. A corresponding fragment, of which there is a cast in the Geological Society's Museum, is represented by pl. 37. f. 9 & 9* of the 'Fauna Antiqua Sivalensis.' The mammillæ, in this case also, form two alternate rows, each ridge being composed of a pair of points.

The finest detached specimen of the Crag species that I have anywhere seen is a last lower molar, left side, found below the citadel of Montpellier, and which has been figured and described by Gervais‡. Casts of this piece are to be met with in many of the principal European Museums. It is of large size, being about $9\frac{1}{2}$ inches long by $3\frac{1}{4}$ wide at its anterior end, and consists of five principal ridges and a double talon. The five anterior ridges are well-worn, and exhibit the characteristic alternation of the discs in a very prominent manner, nothing approaching which has ever been seen in an Eppelsheim specimen. M. Gervais refers this tooth to his *Mastodon brevirostris*, as distinguished from *Mastodon Arvernensis*; but the grounds upon which he has attempted this separation are wholly insufficient.

The same peculiar characters in the alternate disposition of the

* Oss. Foss. 4to edit. tom. i. p. 258.

† Mag. of Nat. Hist. 1836, vol. ix. p. 152, fig. 22.

‡ Annales des Sciences Naturelles, 3me sér. t. v. p. 268, and Paléontol. Française, p. 38, tab. 3. fig. 7.

mammillæ of the crown are finely exhibited in the last lower molar of the nearly allied Indian *M. (Tetraloph.) Sivalensis*, as represented in pl. 37. f. 8 & 8* of the 'Fauna Antiqua.' The specimens resemble each other so closely, that my colleague Sir Proby Cautley *, in his earliest description, considered them to be identical species.

If, on the other hand, we examine the equivalent teeth in the lower jaw of *M. (Tetralophodon) longirostris* of Eppelsheim, the same differences as occur in the upper molars are constantly presented. The ridges are transverse, and the coronal eminences in a greater number than a pair of mammillæ, which latter, on the outer and inner sides, are opposed, and not alternate. Figs. 1, 2, & 3 of pl. 19. of Kaup's 'Ossements Fossiles' furnish excellent illustrations.

When these molars, upper and lower, are ground down by well-advanced use, the alternation of the discs in the one species, and their transversality in the other, become still more conspicuous. The former character is exhibited in a very marked manner by figs. 1, 3, & 6 of Cuvier's pl. 4 of "Divers Mastodontes," above referred to. All the specimens are of Italian origin, being either from the Val d'Arno or from the plains of Lombardy and Liguria. Cuvier remarks upon one of them † (f. 6), that it is "remarquable par des festons plus nombreux que dans les autres." They are all referable to *M. (Tetralophodon) Arvernensis*. The alternate disposition of the discs of wear is also seen well in the specimens of *M. (Tetraloph.) Arvernensis* discovered in the Artesan near Dusino, and figured and described by Sismonda ‡; while the transverse discs of the Eppelsheim species are more or less apparent throughout Kaup's Illustrations, and more especially in figs. 4 & 5 of pl. 16, figs. 1, 2, 3, & 5 of pl. 19, and figs. 2 & 6 of pl. 21 of his work above quoted.

Of the other true molars, *i. e.* the antepenultimate and penultimate, various specimens, more or less perfect, have been yielded by the Crag. Several existed in Mr. Robert Fitch's interesting collection at Norwich when I examined it in 1846, and probably a considerable addition has been made to it since. Two of these are figured in the 'British Fossil Mammalia' (pp. 280, 281). Fig. 98 is described by Professor Owen as the penultimate upper. The anterior portion is broken off; what remains of the crown shows four ridges and a talon. But for the position assigned to it by so able and practised a palæontologist, the figure would convey the impression of its being a lower instead of an upper molar, from the narrowness of the crown in comparison with the width, and from the form of the hind talon. Fig. 99 represents a corresponding penultimate lower molar, also from Mr. Fitch's collection. Both teeth—the one of which has the crown represented in plan, the other in profile—show in a strongly marked manner the characteristic alternation of the mammillæ, which is never seen in the corresponding molars of the Eppelsheim

* Journ. Asiat. Society of Beng. vol. v. p. 294.

† Oss. Fossiles, 4to edit. tom. i. p. 259.

‡ Osteograph. di un Mastodonte angustidente, tab. 1. figs. 2, 3 (Mem. R. Accad. Sc. Torino. sér. 2. vol. xii.).

species. Moreover, the mammillæ are more elevated, their conical isolation more defined, and the enamel-layer thicker than in *M. (Tetraloph.) longirostris*. There is a peculiar wavy and finely grooved rugosity of surface, which is seen on the enamel near the base of the crown and "bourrelet" where it exists in the molars of the Crag Mastodon (see Pl. XI. fig. 4) and of the nearly allied Indian species *M. (Tetralophodon) Sivalensis*. It may be compared to the appearance yielded by a bound book when the edges of the leaves slightly overlap, and they are bent in a flexuous curve. This peculiar rugosity is not nearly so conspicuous in the Eppelsheim species, nor in the *M. (Trilophodon) angustidens* of Simorre.

The finest English specimen of one of the "intermediate molars" of the Crag Mastodon that has come under my observation is a germ of the penultimate true molar (upper jaw, right side), lately discovered by the Rev. Mr. Marsden in the bed of coprolitic or phosphatic nodules in the parish of Ramsey in Essex, about three miles west of Harwich, and kindly lent to us for description. It is represented (one-third of the natural size) by figs. 1 & 2, Pl. XII. of the accompanying illustrations. It consists of the shell of the crown quite entire, the nucleus of the ivory core not having become fully calcified, nor any of the fangs developed. The crown presents four intact ridges, with a front and a back talon. The mammillæ of the outer and inner lines are very high, and converge as they ascend, so that the apex of the crown is much narrower than the base. Two large outlying mammillæ are interposed between the first and second ridges; one between the second and third, and one between the third and fourth. A large tubercle, flanking the inner division of the first ridge, forms the commencement of the anterior talon. The posterior talon consists of a line of about six low tubercles. The intermediate flanking mammillæ, as is usual in the species, interrupt the transverse continuity of the valleys, which are reduced to an outer and inner gorge. It is manifest that, if the crown were ground down by wear, the disposition of the tubercles is such that a series of trefoil discs, more or less alternate, would be the result. The dimensions of this specimen are—length 4·9 inches, width of crown in front 2·6 inches, width at the last ridge 2·9 inches.

Premolars.—That vertically successional teeth replace one or more of the milk-molars in *M. (Tetraloph.) Arvernensis*, has been proved by the original specimens from Auvergne, upon which the species was founded by Croizet and Jobert. Fig. 7 of pl. 11 of their work * exhibits an upper jaw of a very young animal, containing the antepenultimate and penultimate milk-molars *in situ*, the former consisting of two pairs of points, disposed in two ridges, the latter showing three ridges. Behind the second tooth there is introduced, in the figure above referred to, a germ-fragment consisting of two ridges (marked A), as if of the third milk-molar; but Abbé Croizet states, in the descriptive details, that the fragment was found detached, and that for various reasons, which are detailed, he considers it to be incorrectly placed in the figure. In the original specimen, which I

* Oss. Fossiles du Départ. du Puy-de-Dôme, pp. 134, 135.

had an opportunity of examining at Paris, the remains of part of the alveolus of a vertical premolar were distinctly visible above the penultimate milk-molar; and M. Laurillard informed me that he had seen the germ of this premolar, the tooth "A" above referred to being the one in question, *i. e.* the penultimate premolar. The last premolar, which is the vertical successor of the last milk-molar, has not as yet been observed *in situ*, so far as I have had the means of ascertaining.

No premolars of the Crag Mastodon, from English localities, have either been figured or described in the 'British Fossil Mammalia,' or elsewhere, up to the present time. This is of little moment, in so far as the mere identification of the species is concerned. Premolar specimens may probably be found either in Mr. Fitch's * or in some other of the Norfolk collections.

Milk-molars.—Of the milk-series it is not necessary on the present occasion to enter on many details. I will refer only to one or two characteristic specimens. The most perfect and instructive yet met with was discovered in the Crag at Postwick by Mr. Wigham, to whom I was indebted for the means of comparing it carefully with a corresponding specimen of *M. (Tetraloph.) longirostris* from Eppelsheim, belonging to the Earl of Enniskillen. It consists of the left upper jaw of a calf Crag Mastodon, with the last milk-molar beautifully preserved *in situ*, and the remains of the empty alveolus of the penultimate milk-molar in front of it. The tooth is stated, in Sir Charles Lyell's memoir on the "Relative Ages of the Tertiary Deposits of Norfolk †," to be the "second true molar." But it is really the last milk-molar. He adds:—"This fragment was sufficiently perfect to enable Mr. Owen, to whom I submitted it, to refer it to *Mastodon longirostris*, a species also found at Eppelsheim." The crown measures 3 inches long by 1·8 inch broad, and is composed of four ridges, with a front and hind talon, and a well-pronounced basal "bourrelet." The three anterior ridges are more or less worn, especially along the inner division; the last ridge is nearly intact. Two views of this tooth, drawn with the utmost care by an artist of well-known power and fidelity, Mr. George Ford, are shown in the 'Fauna Antiqua Sivalensis,' pl. 36. f. 7 & 7^a. The ridges are seen to be connected by one or two stout conical mammillæ, which occupy the middle of the valleys, interrupting their transverse continuity, and alternating with the divisions of the main ridges, in the manner characteristic of the older or true molars previously described. If these figures are compared with figs. 6 & 6^a of the same work, by the same artist, which represent Lord Enniskillen's very beautiful specimen of the young calf Mastodon from Eppelsheim, the distinctive characters of the two species will be found to be carried on throughout. The Eppelsheim specimen is a little younger than the Crag fragment; it shows the series of three milk-molars *in situ*. The third milk-molar is nearly intact; the

* The specimen referred to by Mr. Fitch, as cited in the 'British Fossil Mammalia,' p. 290, is not a premolar of the Crag Mastodon.

† Mag. of Nat. Hist. 1839, p. 318.

four ridges of which it is composed are seen to be transverse, compressed, and composed of a number of little points; the valleys are open, with the exception of a tubercle in the first and two or three minute tubercles in the last valley, which nowise intercept their transverse continuity. The back talon forms a low transverse free ridgelet, as in *M. (Tetralophodon) latidens* of India; while in *M. (Tetralophodon) Arvernensis* the talon-tubercles are huddled together and accrete to the last ridge.

Sir Charles Lyell, in his 'Manual*,' gives a figure of Mr. Wigham's tooth of the natural size, in which a very notable character of the young molars is well brought out. The enamel of the mammillæ is seen to be furrowed vertically by numerous deep parallel grooves, presenting the appearance of a reeded column or of a number of cords pressed close together, and disposed around a thick central axis. The shell of enamel shows as if it were composed of distinct narrow pieces glued together. The same character is attempted to be represented by *b* & *c* of fig. 7, pl. 36. of the 'Fauna Antiq. Siv.,' also of the natural size. It does not occur in the corresponding young molars of *M. (Tetralophodon) longirostris*. The enamel-surface in these is superficially wrinkled and furrowed with numerous irregularities, without however exhibiting the symmetrical fluting observable in the Crag Mastodon. So conspicuous is this character, that I believe that the young teeth of the two species could be distinguished from each other by portions of their enamel alone, occurring mixed in a collection. I would refer to a figure given by Kaup of the dentition of a young *Mastodon longirostris* in pl. 16. f. 1 of his 'Ossements Fossiles,' for the comparison. It is of the natural size, and the last milk-molar may be contrasted with the corresponding tooth of the Crag species figured by Sir Charles Lyell. It was this character in the young teeth which chiefly led Croizet and Jobert †, in 1828, to propose *Mastodon Arvernensis* as a distinct species. They met with specimens in Auvergne, mostly of very young animals, of both the upper and lower jaws, in which the last milk-molar was unworn, and they were struck with the remarkable complexity of the crown-ridges, composed of a great number of small wart-like cones, separated by the decurrent vertical grooves, which we have referred to. But the indicated character was not accepted by Cuvier as of sufficient importance to distinguish the species from his too comprehensive *Mastodon angustidens*.

Another fine specimen of the last upper milk-molar, from Mr. Fitch's collection, is figured in the 'British Fossil Mammalia' (fig. 100, p. 284). Like Mr. Wigham's specimen, the crown is composed of four ridges and a talon, with the same complexity of pattern, alternation of the flanking tubercles, and interruption of the valleys. It is only necessary to cite it here, as proving the constancy of the characters of the Crag specimens. Prof. Owen describes this tooth as the "fourth upper molar;" while he assigns a different

* Manual of Element. Geol. 5th edit. 1855, p. 166, fig. 133.

† Croizet et Jobert, Oss. Foss. du Départ. du Puy-de-Dôme, 1828, p. 133.

position and value to Mr. Wigham's specimen, considering the latter to be the "second true molar." In our view they are both last milk-molars, which would be the equivalent of what Prof. Owen designates as "the fourth in the order of size, and the third in the order of position, counting backwards in the upper jaw, before any of the teeth are shed *."

There is some intricacy in the terms expressive of the numerical values which Prof. Owen assigns to the different molars of *Mastodon* in his descriptions, both in the 'British Fossil Mammalia,' and in the 'Odontography.' This, I believe, has arisen from the peculiar views there advanced, as to the order of succession of the premolar teeth in this genus; and, as it is a point of systematic and palæontological importance in reference to the disputed affinities between *Mastodon* and *Dinotherium*, I think it desirable to make a few remarks on the subject. In both the works here cited †, it is affirmed that *Mastodon* is distinguished from Elephant, in a well-marked and unequivocal manner, by two dental characters: the first is the presence of tusks in the lower jaw; the second "is the displacement of the first and second molars" (meaning milk-molars) "in the vertical direction by a tooth of simpler form than the second, a true *dent de remplacement*, developed above the deciduous teeth in the upper, and below them in the under jaw." Prof. Owen, in his remarks upon Mr. Fitch's specimen of the last milk-molar (fig. 100), goes on to say, "In Dr. Kaup's figure the tooth in question" (*i. e.* the third) "is associated with the first and second molars of the *Mastodon angustidens*, which are much worn, and are true deciduous teeth, the only ones, in fact, which strictly correspond with the deciduous teeth of ordinary Pachyderms ‡." In this view, when the ante-penultimate and penultimate milk-molars are shed, and the penultimate premolar has made its appearance, he designates the latter as the "third molar tooth;" and the last milk-molar, which is behind it in position, but anterior in appearance, he calls the "fourth molar tooth," although fully aware that there were good grounds for regarding it "as the last of the theoretically deciduous series, although it has no vertical successor." But this conclusion as to the absence of a vertical successor to the tooth in question was premature; I detected both the penultimate and last premolars *in situ* in the jaws of *E. (Loxodon) planifrons*, a Sewalik fossil Elephant, upwards of twelve years ago. The evidence is published in the 'Fauna Antiqua Sivalensis' §. M. Lartet has found the same two premolars repeatedly in the upper and lower jaws of *M. (Trilophodon) angustidens* ||. In a manuscript note appended to the work here quoted, with which I have been favoured by M. Lartet, he adds, "J'ai pu depuis lors vérifier plusieurs fois le remplacement effectif de la 2^{me} et de la 3^{me} molaire de lait, tant à la machoire supérieure qu'à

* *Loc. cit.*

† Brit. Foss. Mamm. p. 274, and Odontography, p. 615.

‡ Brit. Foss. Mamm. p. 284.

§ *Op. cit.* p. 31, pl. 6. f. 4-6; pl. 12. f. 8-11.

|| Lartet, Notice sur la Colline de Sansan, 1851, p. 25.

l'inférieure comme cela a lieu dans le *Dinotherium* ; la première n'est jamais remplacée." In a beautiful specimen of the lower jaw of a young *M. (Trilophodon) angustidens*, belonging to M. Ziegler-Ernst of Winterthur, I found both the penultimate and last premolars present, the former protruded, the latter in germ. When a single premolar is developed, it is the successor to the last milk-molar, and not to the penultimate, as stated by Prof. Owen in the passages above referred to*. I have seen detached specimens of this last premolar, both of the upper and lower jaws of *M. (Tetralophodon) longirostris* of Eppelsheim, in the Museum at Darmstadt. The order of succession here indicated is alone consistent with what occurs in other Pachyderms, where, when suppression in either of the milk- or premolar series takes place, it is constantly the anterior or feebly developed and rudimentary teeth that are suppressed. In them we never find the last premolar suppressed while the penultimate is developed, but the reverse. The penultimate premolar replaces only the corresponding milk-molar: the ante-penultimate milk-tooth is never replaced in *Mastodon* or *Elephas*, so far as observation has yet shown. The molar dentition of the permanent or second set (*i. e.* the premolars and true molars) in *M. (Triloph.) angustidens* and *Dinotherium* is numerically identical, consisting of two premolars and three true molars; each of these having also two well-developed mandibular tusks: and the close affinity thus indicated by the number of teeth is further borne out by the correspondence of a ternary-ridged formula in two of their "intermediate molars," and by other osteological characters†, which leave little room for doubt that they were both Proboscidean genera, *Dinotherium* having close affinities to the Tapirs, as Cuvier sagaciously inferred in his earliest memoir on 'Les Tapirs Gigantesques ‡.'

Of the ante-penultimate and penultimate milk-molars no speci-

* In his subsequent memoir on the molar teeth of *Phacochærus*, &c. (Phil. Trans. 1850, p. 496), Professor Owen takes a different view of the premolar teeth in *Mastodon* from that set forth in the 'British Fossil Mammalia' and the 'Odontography.' It is expressed thus:—"The existing species of the gigantic Proboscidean family, viz. the Asiatic and African Elephants, are totally devoid of incisors on the lower jaw, and all their grinding teeth succeed each other horizontally; so that it is only by a more than proportional increase of size that the ante-penultimate grinder is recognizable as the first of the true molar series, and the antecedent smaller grinders, as the homologues of the milk-molars of other Diphyodonts, which milk-molars have no successors in the Elephants. In certain Mastodons, however, which are the earliest known forms of the Proboscidean family, the last milk-molar was displaced by a vertical successor or premolar." The tooth, which, in his earliest descriptions, was considered as the successor of the ante-penultimate and penultimate (first and second) milk-molars, is here regarded as the successor of the last milk-molar. But the presence of both the penultimate and last premolars in *Mastodon angustidens* is not recognized.

† In M. Ziegler-Ernst's Winterthur specimen of the young lower jaw above referred to, five molar teeth are present, viz. the penultimate and last premolars—the former extruded, the latter imbedded; the last milk-molar far advanced in wear, and immediately over the last premolar; and the ante-penultimate and penultimate true molars both in germ, but the former partially emerged and in incipient use.

‡ Annales du Muséum, tom. iii. p. 132.

mens from the Crag have been as yet figured or described; but the characters presented by these teeth in *M. (Tetraloph.) Arvernensis* are well known, both in the upper and lower jaws, through the specimens discovered by Croizet and Jobert, Bravard, and others in Auvergne or the Velay. The ante-penultimate presents two ridges, and the penultimate three ridges, with the usual talon-complications. They are readily distinguishable—the upper from the lower—when met with detached, from the circumstance that the milk-molars of the lower jaw are narrower and more compressed, the ante-penultimate being reduced to a single cusp. Figures of these teeth are given by Croizet and Jobert in the work already referred to*.

The ridge-formula in the molar teeth of the Crag Mastodon, including milk- and true molars, but exclusive of premolars, as inferred from the various data detailed in the previous pages, is—

$$\begin{array}{c} \text{Milk-molars.} \\ \overbrace{2+3+4} \\ 2+3+4 \end{array} : \begin{array}{c} \text{True molars.} \\ \overbrace{4+4+5} \\ 4+4+5 \end{array}$$

The assigned numbers have not been verified in every instance upon Crag remains; but they are all founded on an examination of specimens, of which some were of foreign origin, when materials were not available from the Crag†.

* Oss. Foss. du Puy-de-Dôme, pl. 1. figs. 1-3 and pl. 2. fig. 7.

† In the descriptions of the various teeth throughout this memoir, the terms *ante-penultimate*, *penultimate*, and *last* have been used, instead of the numeral expressions of *first*, *second*, and *third*, when designating the position either of the milk- or of the permanent molars. This would seem indispensable when symbols are not employed, to avoid confusion in the designation of the milk-molars, since the typical *first* or most anterior of the milk-molar series, which is present in many other pachydermatous genera, is constantly suppressed in the Mastodons and generally also in the Elephants. When, therefore, the terms *first*, *second*, and *third* milk-molars are applied to *Mastodon*, they are not the equivalents of the same numerals applied to *Rhinoceros* or *Hippopotamus*, in which all the four milk-molars are developed; whereas the terms *ante-penultimate*, *penultimate*, and *last* in every case represent homologous teeth in the milk-molars of all the ungulate genera. This is the more necessary, as the theoretical *first* or *pre-ante-penultimate* milk-molar is occasionally met with in the African Elephant. De Blainville (*Ostéographie: Des Eléphants*, tab. ix. p. 81) has given an illustration of its presence in the latter species, on one side of the lower jaw, regarding it as a "supernumerary" tooth; and a corresponding occurrence in the lower jaw of the same species is represented in the 'Fauna Antiqua Sivalensis' (pl. 14. fig. 4 a). It is usually restricted to one side; and I regard it as not very uncommon. As the true molars never exceed, nor are below, three in number in the Pachydermata and Ruminantia, the same terms may be conveniently used in describing them. The inconvenience of designating the molars in *Mastodon* and *Elephas* by successive numbers ranging from 1 to 6 or 7, which include both milk- and true molars without distinction in the same numerical category, is exhibited in the descriptions of the Elephants given throughout by De Blainville in his '*Ostéographie*;' and more recently in the otherwise excellent descriptions by Gervais of the dentition of *Mastodon Audium* in the '*Expédition de Castelnau*.' The penultimate and last milk-molars are there figured and described as the "third and fourth" molars, involving a confusion of the ridge-formula, which is seen to be of so much importance in the subgeneric distinctions (*Recherches sur les Mammifères Fossiles de l'Amérique Méridionale*, 1855, pl. 20-22, pl. 5. figs. 1-5).

Lower jaw.—The characters furnished by the lower jaw are of great significance in distinguishing the nearly allied species of *Mastodon*, more especially in what relates to the form of the symphysis and the presence or absence of mandibular incisors. The differences between the lower jaws of *M. (Trilophodon) angustidens*, *M. (Tetraloph.) longirostris*, and *M. (Tetraloph.) Arvernensis* are so pronounced, that they would have been sufficient to discriminate the species, supposing the molar teeth were unknown to us. As above stated, no good specimen, so far as I am aware, has hitherto been discovered of the lower jaw of the Crag species, *M. (Tetr.) Arvernensis*, in England; but several have been met with in the Pliocene strata of Italy and France; while abundant remains of the lower jaw of *M. (Tetraloph.) longirostris* have been disinterred from the Eppelsheim sands by Dr. Kaup; and of *M. (Trilophodon) angustidens* by MM. Lartet and Laurillard from the Falunian deposits of the Sub-Pyrenees.

First in regard to *M. (Triloph.) angustidens*. The lower jaw of this species is at once distinguished by the great elongation, downward direction, and slender form of the symphyseal portion which contains the sockets of the two inferior incisors*. The ascending ramus is of moderate height, corresponding in that respect with *M. (Trilophodon) Ohioticus*, and approaching that of *Dinotherium giganteum*. The horizontal ramus is very high in front, in a line with the mentary foramen, and low behind; the anterior portion is compressed; and the lower margin stretches some way in front of the mentary foramen, in a straight line; it is then bent a little downwards, and continued forwards in nearly the same straight line; the under surface of the elongated portion forming an obtuse angle with the corresponding surface of the horizontal ramus. The elongation of the symphyseal beak is enormous, far exceeding that of *M. (Tetralophodon) longirostris*, or even of *Dinotherium*; the length from the mentary foramen forwards being more than double that of the horizontal ramus, measured from the same point backwards to the base of the anterior margin of the coronoid process. A constant character of the species is the presence in both sexes of two long, closely adpressed, and straight, or but slightly curved, incisors. This fact has been established by M. Lartet upon a very large number of specimens†.

These lower incisors differ notably in form from the upper. In the adult specimens they are nearly of uniform diameter from the base to the point, which is bevelled on the upper side by wear, so as to yield a flat or spatulate surface. In section they are pyriform, with frequently a longitudinal channel on the upper and inner side. The section closely approaches that of the inferior canines of the fossil *Hippopotamus* named *Hexaprotodon Sivalensis*. The tusks or upper incisors of this species are nearly circular in section, and taper gradually to a conical point. They are invested along their length on the inner side by a broad band of enamel, which runs in an obsolete

* De Blainville, Ostéographie : Des Eléphants, pl. 14.

† Lartet, Notice sur la Colline de Sansan, p. 24.

spire, so as to be presented on the upper surface near the tip. *M. Lartet* has never observed any indication of a belt of enamel on the lower incisors. In the superb complete skeleton which was disinterred by Laurillard at Seissan, the extruded portion of these lower incisors measures $20\frac{1}{2}$ inches, that of the upper tusks being 41 inches. The characters above indicated are constant, wherever the lower jaw of this species has been discovered, whether in the Faluns of the Orleanais and Touraine, in the Lacustrine deposits of Gascony and Languedoc, or in the Miocene Molasse of Switzerland, where I found them confirmed by the examination of two very fine specimens, young and old, found in the neighbourhood of Winterthur. They are well shown by the representations given in De Blainville's '*Ostéographie: des Eléphants*,' pl. 14. The molar teeth in all these specimens have constantly presented the normal marks of the *Trilophodon*-division, namely three ridges to the last milk-molar, and to the ante-penultimate and penultimate true molars.

In *M. (Tetralophodon) longirostris* the ascending ramus is considerably more elevated than in *M. (Triloph.) angustidens*, approaching more the character which is seen in the Elephants proper; the horizontal ramus is less compressed and more circular in section; instead of presenting the greatest height in a line with the commencement of the alveolar border, or mentary foramen, it is contracted there, in consequence of the lower margin rising upwards to slope off into the base of the symphysial beak*. This beak is very massive and comparatively short, not exceeding the length of the horizontal ramus, from the mentary foramen to the anterior margin of the ascending ramus. Instead of being, as it were, a deflected continuation of the inferior border of the jaw, as is seen in *M. (Trilophodon) angustidens*, the beak in the Eppelsheim species is thrown off in a plane nearly parallel with the inferior border, but separated from it and raised above it by a step. It is deflected slightly downwards; but, instead of forming a long slender apophysis as in the other species, it shows a thick mass traversed by a broad gutter. The greater extent of the beak is made up of the alveoli of two mandibular incisors, as in *M. (Trilophodon) angustidens*. These teeth have not yet been found *in situ*. Kaup has figured three specimens† which he conjecturally considers to be lower incisors. The greatest diameter of the largest he states to be 2.75 inches. The molars of these Eppelsheim jaws have constantly exhibited the *Tetralophodon*-character of four ridges to the crowns of the intermediate teeth; the ridges being transverse, with the valleys nearly uninterrupted.

In the Pliocene *M. (Tetraloph.) Arvernensis*, the lower jaw differs widely from that of the other two species. The ascending ramus is well elevated above the grinding-plane of the teeth, as in *M. (Tetraloph.) longirostris*. The horizontal ramus is very massive, without compression, and yields a section which is nearly circular, as in that

* Kaup, Oss. Foss. de Darmst. tab. 19. fig. 1.

† Ossemens Fossiles de Darmstadt, tab. 3. figs. 1, 2, 3.

species. But the symphysis, instead of being elongated into a process composed of the alveoli of two mandibular incisors, terminates suddenly in a short beak, as in the Elephants and other Proboscidean species that are destitute of inferior tusks. This beak does not project much more beyond the anterior rounded surface of the jaw than in the African Elephant, or in *M. (Trilophodon) Humboldtii*, also a species without mandibular incisors; but it differs from them and all other known species in the diastemal ridges expanding at the point, so as to form a short, blunt, dilated spout. This character is well shown by the Val d'Arno specimen delineated by Cuvier in the 'Ossements Fossiles,' tom. i. t. 9. f. 5 & 6, after Nesti. It is one of the pieces upon which Nesti founded his *Elephas meridionalis*; but which, although the molars are wanting, Cuvier sagaciously inferred, from the general form, to belong to a *Mastodon*. I was enabled, by the obliging permission of Professor Gaspero Mazzi, to examine the specimen minutely, and to compare it with the numerous lower jaws of *E. (Loxodon) meridionalis* and of *M. (Tetraloph.) Arvernensis* contained in the Natural History Museum at Florence, and was satisfied that it belonged to the latter species, as Cuvier had inferred from the drawing. The same Museum contains the greater part of a skeleton of this *Mastodon*, found in a marine deposit of the lower Val d'Arno above Leghorn. The lower jaw of this specimen presents the same character of a short symphyseal beak without incisors. The same is exhibited by the lower jaw of the Dusino skeleton from the Astesan, described by Prof. Eugenio Sismonda*. They all agree in the common characters, so far as these are shown, of a *Tetralophodon*-formula to the crown-ridges of the three molars here called intermediate; of alternate mammillæ to the ridges, with blocked-up valleys; and of a short obtuse beak with no incisors.

Sismonda describes and figures the lower jaw of the Dusino specimen as being without tusks, or remains of their sockets. But, predisposed to believe that they must have been present at some period of the animal's existence, from their occurrence in other *Mastodons*, he conjectures that those tusks had fallen out early, and that the alveoli had been obliterated by filling up; and he has given a representation of a very mutilated fragment of a Proboscidean symphysis of the lower jaw, as exhibiting the alveoli of two mandibular incisors†. I was enabled, by the obliging kindness of Signor Bartolomeo Gastaldi of Turin, to examine the specimen in question, which is very much rolled, and in a different mineral condition from the fossils of the Dusino *Mastodon*-bed, and found that the supposed incisive alveoli were only the anterior terminations of the dentary canals, which are of large size in all the Proboscidea. The form impressed me with the conviction that it was more probably the symphysis of an Elephant than of a *Mastodon*. This case, therefore, gives no support to the belief that *M. (Tetralophodon) Arvernensis* had lower incisors.

* Osteograph. di un Mastod. angustidente, tab. 1. fig. 1.

† *Op. cit.* tab. 1. fig. 7.

Professor Owen, in his 'British Fossil Mammalia,' gives a very beautiful representation (p. 291, fig. 101) of a fragment of a tusk discovered by Mr. Fitch in the Mammaliferous Crag-pits near Norwich. He describes it as a portion of the lower tusk of the *Mastodon angustidens*. The specimen is about 15 inches long, with a greatest diameter of $3\frac{1}{2}$ inches. It is of a straight, compressed, conical form. The fragment is crushed, and it is manifest that the outer layers of the ivory are detached, and that the original tusk was of a larger diameter than the specimen now exhibits. The marked conical form and great size are irreconcilable with this fragment being referable to an inferior incisor of the Simorre *M. (Triloph.) angustidens* of Cuvier: and it would seem to me that it is equally irreconcilable with being considered as a lower tusk of *M. (Tetralophodon) longirostris*, for the symphysial beak required for the implantation of a tusk of such magnitude would be enormous, and is unknown among any of the species of Mastodon. Professor Owen describes the specimen as being traversed from end to end by a sub-central canal. The same character has been observed in the upper tusks of other fossil Proboscidea, and is nowise characteristic of a lower incisor. I consider that the specimen in question is not a fragment of a lower, but of an upper tusk near the point; and it differs in no important respect from the undoubted upper tusks of *M. (Tetralophodon) Arvernensis* seen in the Museums of Florence and Turin, which are either slightly curved or twisted in a gentle spiral direction, as represented in the figure given by Sismonda * of the Dusino skeleton.

In corroboration of this view, it may be stated, that the Indian fossil species which we have named *M. (Tetralophodon) Sivalensis* is in some respects more nearly allied to the Crag species than the latter is to either *M. (Trilophodon) angustidens* or *M. (Tetralophodon) longirostris*. It shows the same alternate character of the mammillæ of the ridges of the "intermediate molars," and it appears to have been equally destitute of inferior incisors. I have examined a large number of lower jaws of this species, of all ages, from the sucking calf up to the adult animal, specially with a view to the detection of these teeth, and never observed the slightest indication of their presence in any specimen, whether in the Indian fossil collection of the British Museum, at the India House, or in the rich series belonging to the Asiatic Society of Calcutta.

This completes what I have to bring forward in the shape of descriptive and comparative details, in order to indicate the most prominent diagnostic characters derivable from the teeth and jaws of the Crag Mastodon. I believe that the differences of the three species included by Cuvier under the name of *Mastodon angustidens* will be found to be carried out through all the principal bones of the skeleton. It would be wholly out of place to enter upon such osteographical particulars on the present occasion; but a good idea of

* *Op. cit.* tab. 1. figs. 4 & 5.

the general character of the skeleton in each may be attained by a reference to two well-known standards of comparison, namely, the existing Indian Elephant and the Mastodon of North America, *M. (Trilophodon) Ohioticus*. Cuvier found that the latter differed from the Elephant in having a more elongated carcass sustained upon shorter, thicker, and more robust legs*. The Crag *M. (Tetralophodon) Arvernensis* appears to have had a heavy carcass, with legs still shorter in proportion, approaching more the character of the Hippopotamus, and to have been without lower tusks. The Eppelsheim Miocene species, *M. (Tetralophodon) longirostris*, would appear to have resembled the Crag species in its general proportions; but the necessary detailed comparison has not yet been sufficiently carried out; it is distinguished at once by the possession of inferior tusks. On the other hand, the Miocene *M. (Trilophodon) angustidens* differed remarkably from both, in presenting a comparatively slender build throughout; so that it stood higher in proportion, and with longer limbs, than either the Indian or African Elephants. This is well exhibited by the mounted skeleton in the Paris Museum.

Geological age of the Mastodons (M. angustidens, M. longirostris, and M. Arvernensis).—I shall now consider the geological age and associated faunas of the formations in which these species severally occur.

M. (Trilophodon) angustidens is a characteristic species of the Miocene Falunian beds throughout Europe. It has been met with in immense abundance in the lacustrine deposits of Gascony and Languedoc; in the Faluns of Touraine and the Orleanais; in the Miocene Molasse of Switzerland, more especially in the lignites of Ellg, Kœpfnach and Buchberg, and in the sandstone in the neighbourhood of Winterthur; in the Georgensgmünd Miocene in Germany; and in the lignite of Gandino in the Val Seriana of Lombardy. The mammalian genera and species with which it was associated are very constant, although, for obvious reasons, they have not been found equally or uniformly distributed all over the area. In the French Falunian deposits there occur *M. (Trilophodon) tapiroides*, a species first conjecturally named by Cuvier, but subsequently made out well by MM. Pomel, Lartet, and other French palæontologists, *Dinotherium giganteum*, or the smaller variety, as I consider it, called *D. Cuvieri*, *Chalicotherium Goldfussi*, *Anchitherium Aurelianense*, *Aceratherium incisivum* (*Rhinoceros tetradactylus*, Lartet), *Aceratherium Goldfussi* (*Rhinoc. brachypus*, Lartet), *Rhinoceros Sansaniensis*, *Lophiochaerus Blainvillii*, *Macrotherium giganteum*, *Dicrocercus* and *Dorcatherium*, &c., besides various Carnivorous forms, large and small, with remains of Chelonian genera, together with scanty indications of Crocodile †.

In the Upper freshwater Molasse of Switzerland *M. (Trilophodon) angustidens* occurs along with *M. (Triloph.) tapiroides* (which has been named *Mastodon Turicensis*, as a distinct species, by Schinz

* Oss. Foss. 4to edit. tom. i. p. 249.

† Lartet, Notice sur la Colline de Sans m.

and Von Meyer), *Aceratherium incisivum*, *Acerather. Goldfussi*, *Dinotherium giganteum*, *Lophiochærus Blainvillii*, a species of *Tapir*, *Palæomeryx* and other Ruminants, &c., with several species of Chelonians.

M. (Tetralophodon) longirostris occurs abundantly in the sands of Eppelsheim, associated with *Dinotherium giganteum*, *Chalicotherium Goldfussi*, *Rhinoceros Schleiermacheri*, *Aceratherium incisivum*, *Acerath. Goldfussi*, *Macrotherium giganteum*, *Hippotherium gracile*, and species of *Dorcatherium*, *Machairodus*, *Amphicyon*, &c.

The agreement in so many remarkable generic and specific mammalian forms leaves little room for doubt that the Eppelsheim sands and the lacustrine deposits of the Garonne and other parts of France are of the same Miocene age. But there are some notable peculiarities in the Eppelsheim fauna. No well-marked specimen, so far as I am aware, of *M. (Tetralophodon) longirostris*, as here defined, has hitherto been met with beyond the limited area of the Eppelsheim sands, and probably the valley of the Danube; nor has either *M. (Trilophodon) angustidens* or *M. (Triloph.) tapiroides*—which usually go together—been discovered within it. It is very improbable that the range of this species should have been confined to a small district in the valley of the Rhine; but the fact is undoubted, that it occurs there in great abundance, and has either not yet been found, or is very rare, elsewhere. The only exception out of Germany, with which I am acquainted, is a specimen of unknown origin in the Museum of the Faculty of Sciences at Toulouse, which, on the indication of M. Lartet, I was enabled to examine by the kindness of M. Leymerie. It consists of an upper right maxillary containing the penultimate and last molars *in situ*. They present all the characters of *M. (Tetralophodon) longirostris*, as distinguished from *M. (Tetraloph.) angustidens*. M. Leymerie informed me that the specimen is supposed to have been found either in Gascony or Languedoc, but that there was no record of the exact locality. It is not improbable that another exception is formed by the specimens mentioned by Cuvier (Oss. Foss. additions, 4to edit. tom. iii. p. 318) as having been discovered by M. Lourteau at Sairac in the Subpyrenees. Two of the molars are described as having the *Tetralophodon*-character of four ridges; but, no figures having been given, the details are not sufficiently precise or exact to admit of any decided opinion upon the subject.

A satisfactory geological limitation of the Eppelsheim deposit and its organic contents is attended with some difficulty. The loose incoherent sand of which it is composed is spread out horizontally like the Löss, and the margin thins out to spread over a portion of the "Lower Miocene" Mayence Basin; so that where the beds are in contact the fossil remains of the two are liable to be confounded. But in all its leading features the Mammalian Fauna of Eppelsheim resembles that of the Falunian deposits of France and Switzerland.

I shall now consider the relations of the Pliocene fauna in which

the Crag Mastodon occurs. *M. (Tetraloph.) Arvernensis*, as here defined, had a wide range of habitat in Europe, embracing Italy, France, and England. The principal localities in which it has been found are—in Italy, the Val d'Arno (in great abundance), associated with the Elephant called *E. meridionalis* by Nesti (*Loxod. meridionalis*), *Rhinoceros leptorhinus*, *Hippopotamus major*, with species of *Tapirus*, *Sus*, *Equus*, *Ursus*, *Hyæna*, *Felis*, *Machairodus*, &c.*; in the marine “Panchina inferiore,” of the Lower Val d'Arno, an entire Mastodon skeleton was found along with those of extinct Whales; in Piedmont and Lombardy, in various localities in the Subapennine strata along the Valley of the Po, but more especially in the Astesan, Romagnano, and Duchy of Piacenza, along with the *M. (Triloph.) Borsoni* (*M. Buffonis* of Pomel), a well-marked ternary-ridged species, first brought to notice by Abbé Borson, and the extinct Elephants *E. (Loxod.) meridionalis*, *E. (Loxod.) priscus*, and *E. (Euelephas) antiquus*, and *Rhinoc. leptorhinus*, *Hippopotamus major*, &c. which occur in some places in fluvial deposits along with species of *Helix*, *Paludina*, and *Clausilia*, and in others in marine deposits along with sea-shells; in France, in various parts of the southern Departments, in Pliocene strata, such as the marine sands of Montpellier and its vicinity, the valley of the Rhone near Lyons and Trevaux, the Vivarais, Velay, Auvergne, &c.

Great diversity of opinion holds among the French palæontologists as to the association of the mammalian species among which *M. (Tetraloph.) Arvernensis* occurs in French deposits. I shall refer briefly, on the present occasion, to the disputed cases at Montpellier or its vicinity, and in Auvergne. De Christol† has described the marine sands of Montpellier and the gravel-beds of the contiguous basin of Pézénas as of the same age. From the latter he procured remains of Elephant which he ascribed to the *Eleph. meridionalis* of Nesti, *Hippopotamus major*, two species of *Equus*, one of *Bos*, and two of *Cervus*. Gervais, on the other hand, insists that the gravels of Pézénas are of the age of the Diluvian fauna (Pleistocene), the sands of Montpellier being Pliocene. To the former‡ he attributes *Elephas primigenius*, *Hippopotamus major*, two species of *Equus*, *Bos priscus*, and *Cervus martialis*; and to the latter § *Mastodon brevirostre* (*Tetraloph. Arvernensis*), *Rhinoceros megarhinus*, *Tapirus minor*, with species of *Sus*, *Cervus*, *Ursus*, *Machairodus*, *Halitherium*, *Hoplocetus*, &c. M. Gervais does not admit Elephant-remains in the Pliocene fauna of Montpellier; but there are two circumstances which diminish the authority of this opinion upon the subject,—the first being, that he refers all the fossil elephants found in the south of France to the mammoth, *E. primigenius*, of the Diluvian fauna, of which he considers *E. meridionalis* to be a variety; the second, that he does not admit that any species of fossil Elephant have been discovered anywhere in Pliocene strata in Europe. He considers that

* Savi e Meneghini sulla Geolog. Stratigraph. della Toscana, p. 508.

† Annales des Scien. Natur. 2 sér. tom. iv. p. 193.

‡ Paléontol. Franç. tom. ii. descript. pl. 21.

§ *Op. cit.* tom. ii. descript. pl. 30.

in the instances asserted by Croizet, Christol, Marcel de Serres, and others, Mastodon bones have been mistaken for those of Elephant*. But, putting aside the disputed French cases, it will be seen in the sequel that there are undoubted instances of the occurrence of remains of Mastodon and Elephant in the same strata in the Subapennine beds of Italy, and in the Crag of Norfolk. In Auvergne and the Velay, the lacustrine and regenerated alluvial strata of all ages, from the Miocene up to the Postpliocene, have undergone such complicated disturbances from successive volcanic eruptions, that great difficulty has been experienced in separating the members of the various faunas, more especially of the subdivisions of the Pliocene and later period. The utmost diversity of opinion holds among the palæontologists who have paid most attention to the later types of the fossil Mammalia of Auvergne, regarding the groups of species which were co-existent at different times. Without going into details, I may observe, that Bravard has endeavoured to make out three distinct faunas after the Miocene lacustrine beds of the Limagne: 1st, a *Mastozoic*, or Pliocene fauna, characterized by the presence of species of *Mastodon* and the absence of Elephants, Horse, and Hippopotamus; 2nd, an *Elephantine* fauna, comprising these genera; and 3rd, a *Diluvian* fauna, in which Elephants and Rhinoceros, &c. are wanting†. Pomel, on the other hand, in his last detailed memoir, has attempted to distinguish after the Miocene lacustrine deposits of the Limagne, 1st, a Pliocene fauna, characterized by two species of *Mastodon*, a Rhinoceros, Sus, Tapir, and twelve or fourteen species of *Cervus*, but no Elephants; 2nd, an alluvial fauna, which he divides into two distinct series of different ages: the one more ancient, comprising *Elephas meridionalis*, *Rhinoceros leptorhinus* and *Rhinoc. Aymardi*, *Hippopotamus major*, *Tapirus elegans*, *Ursus spelæus*, *Bos priscus*, *Megantæreon latidens*, and two species of Deer, &c.; the other, more modern, consisting of *Eleph. primigenius*, *E. priscus*, *Rhinoceros tichorhinus*, *Hyæna spelæa*, *Cervus Guettardi*, &c.‡ But there are grave objections to both these arrangements, inasmuch as the association of the species does not correspond with what holds elsewhere in the Pliocene and Postpliocene deposits of Italy, England, and Germany, which are free from the volcanic intrusions that have overwhelmed and confused the deposits of Auvergne. It suffices for my purpose on the present occasion, to state that, where *M. (Tetralophodon) Arvernensis* occurs in Auvergne and the Velay, the same species are met with in different localities as are found together in the same Pliocene stratum in the plains of Piedmont and Lombardy, namely, *M. (Trilophodon) Borsoni*, *Rhinoceros leptorhinus*, *Hippopotamus major*, and the Elephants called *E. (Loxodon) meridionalis* and *E. (Loxodon) priscus* (?), with species of *Tapirus*, *Sus*, *Cervus*, &c. The numerical agreement of the Auvergne fossil species with those which occur in the richer fauna of the Val d'Arno is still more

* Gervais, *op. cit.* tom. i. p. 36.

† Bravard, cited by Pomel, 'Bulet. de la Soc. Géolog. de France,' 2 sér. tom. iii. p. 178 *et seq.*

‡ Pomel, *loc. cit.* and Catalog. Méthod. et Descriptif, &c. 1854, pp. 172-184.

considerable. But it is, at the same time, to be remarked, that at the late Meeting of the "Congrès Scientifique" of France, held at Puy in Sept. 1855, MM. Croizet, Aymard, and Pichot* were agreed that the Mastodon-remains in the Velay and Auvergne were of an older age than the beds containing Elephant-remains.

(*Mastodon of the Crag.*)—I shall now pass under review the circumstances under which *M. (Tetralophodon) Arvernensis* occurs in British strata.

First, in the "Fluvio-marine" or "Norwich Crag." Undoubted remains of this species have been discovered in this deposit: at Whitlingham by Mr. William Smith; at Horstead by Messrs. Layton, S. Woodward, and Gunn; at Postwick, Thorpe, and Norwich by Messrs. Fitch and Wigham; at Bramerton by Mr. S. Woodward and Capt. Alexander; and in Suffolk, at Easton and Sizewell Gap by Capt. Alexander. The entire skeleton, of which so circumstantial an account has been given by the Rev. Mr. Layton, is stated to have been found on the surface of a bed of marl, "between the chalk and gravel," at Horstead, without indicating the precise relation of the bed to the Crag and the superincumbent blue clay or submerged forest-bed. I have examined the most of these specimens, either in original or as casts, at the museums in Norwich and London, and found them all referable to the species, as here limited.

Various statements have been made by different writers regarding the fossil Mammalia associated in the Fluvio-marine Crag, with the *Mastodon* or without it. Mr. William Smith's celebrated Whitlingham specimen is said to have been found along with the horns of Deer, and Crag-shells†. Mr. R. C. Taylor‡ mentions that the Crag of Bramerton has yielded "the Mastodon, the Elephant, the Gigantic Elk and the Enormous-horned Bison." Mr. Charlesworth§ states, that bones of Elephant and other herbivorous animals are more frequently associated with shells in the Mammaliferous than in the Red Crag, but he does not mention what the species are. Sir Charles Lyell||, in his memoir on the "Relative Ages of the Norfolk and Suffolk Crag," states that the Fluvio-marine Crag, near Southwold, has yielded the remains of the Elephant, Rhinoceros, Horse, and Deer, mixed with marine, terrestrial, and freshwater shells; and that in the inland pits near the same place he found mammalian remains associated with the *Cyrena trigonula* of Grays and elsewhere. He mentions, that "the horns of Stags, bones and teeth of Horse, Pig, Elephant, and other quadrupeds," associated with *Mastodon*, had been obtained at Postwick, Thorpe, Bramerton, and other localities near Norwich. The tusk of an Elephant was obtained at Bramerton, covered with *Serpulae*, showing that it had lain for some time at the bottom of the sea of the Norwich Crag¶.

* Congrès Scientifique de France, 1855, tom. i. p. 325.

† Taylor, Geology of East Norfolk, 1827, p. 14.

‡ *Loc. cit.*

§ Phil. Mag. 3rd ser. vol. vii. 1835, p. 89.

|| Geol. Proc. vol. iii. p. 127; and Mag. Nat. Hist. new ser. vol. iii. p. 316.

¶ *Op. cit.* p. 128.

Professor Owen, in the conspectus of genera and species contained in the introduction to his 'British Fossil Mammalia,' enumerates in the list of the fossils of the Pliocene Fluvio-marine Crag the following genera and species, viz. *Mastodon angustidens*, *Elephas primigenius*, *Rhinoceros tichorhinus*, *Equus fossilis*, *Cervus elaphus*, *Arvicola*, and *Lutra*. But, influenced probably by the opinion at which he had arrived, that the Crag *Mastodon* was identical with the *M. angustidens* of Cuvier and *M. longirostris* of Kaup, he adds, in a note, that all the other species, except *Mastodon*, were probably derived from the overlying blue clay*. The contemporaneous association of these species is unquestionably in the highest degree improbable, as it would include a Miocene *Mastodon*, along with a Post-pliocene Elephant and Rhinoceros, and the existing Red Deer, in the same fauna. But it admits of no doubt that species of the genera above enumerated have been found in the Fluvio-marine Crag, and it is of importance to ascertain what these species really are. I carefully examined the Elephant-molars from the Crag, blue clay, or submerged forest-bed, contained in the different collections at Norwich, and arrived at the conclusion that none of them belonged to *E. primigenius*, the Mammoth of Siberia, properly so called; but to two distinct species, the one, *E. (Loxodon) meridionalis*, which occurs in vast abundance in the Val d'Arno; and the other, *E. (Elephas) antiquus*, which is found in the plains of the Astésan, in Piedmont, in various other parts of Europe, and in the so-called "Newer Pliocene" freshwater deposits and caves of England. The evidence upon which these species are founded will be considered in the sequel. The occurrence of the Siberian *Rhinoceros tichorhinus* (*Rhin. antiquitatis* of Blumenbach) in the Crag would seem exceedingly improbable; for, elsewhere, it has invariably been met with in company with the Mammoth, in the northern fauna of the Glacial Drift period, and nowhere as yet, upon undoubted evidence, in Pliocene formations. Professor Owen (Brit. Foss. Mamm. p. 381) states, that "Mr. Fitch of Norwich possesses specimens of upper and lower molar teeth of the *Rh. leptorhinus* from the freshwater (lignite) beds on the Norfolk coast near Cromer, which demonstrate the occurrence of this species in the same deposit with the *Rh. tichorhinus*." The contemporaneous association of the two species in these beds would seem as improbable as the occurrence of *Rh. tichorhinus* in the Crag, and the explanation may be sought for in an adventitious mixing of the specimens†. The evidence adduced in support of the existing common Otter (*Lutra vulgaris*‡) and Red Deer (*Cervus elaphus*) having also been found in the same deposit, would require to be very

* *Op. cit.* p. xlvii.

† Mr. Charlesworth, in remarking that the bones of Elephants and other quadrupeds are more frequently associated with the shells of the Crag in Norfolk, adds that, "in that county the formation in many places exhibits such irregularities, and is sometimes so mingled with immense accumulations of sand and gravel, that it becomes almost impossible to distinguish the specific crag-deposit from the accompanying diluvial strata."—Phil. Mag. 3rd ser. vol. vii. p. 89.

‡ Owen, Brit. Foss. Mamm. p. 121.

conclusive before the facts alleged could be received as well-established. For no fewer than eight species of *Cervus*, belonging to the subgenera *Rusa* and *Strongyloceros*, with round antlers, have been described by the French palæontologists as occurring in the Velay and Auvergne, besides eleven other species in Pliocene or Post-pliocene strata*. Several species with round-antlered horns have also been obtained from the Val d'Arno, which would seem to be identical with Auvergne forms (making liberal allowance for *doubles emplois* in the specific names), and it is much more probable, from the agreement in the other associated mammals, that the Crag species belonged to one of these than to the existing *Cervus elaphus*†. *Hippopotamus major* and *Rhinoceros leptorhinus*, if not hitherto obtained from the Fluvio-marine Crag, occur in abundance either in the blue clay or in the ancient forest or lignite-bed, which immediately overlies the Crag in the sections along the Norfolk coast; and evidence will be adduced in the sequel, that these beds are of the same Pliocene age, in so far as is shown by the paramount proof of identity of mammalian fauna. Taking together the ascertained fossil Mammalia of these two beds, they agree very closely with the Pliocene fauna of the Subapennines, viz. *M. (Tetralophodon) Arvernensis*, *E. (Loxodon) meridionalis*, *E. (Euelephas) antiquus*, *Rhinoceros leptorhinus*, *Hippopotamus major*, large Bovidae, and large Deer with round-antlered horns. Among the Proboscidean forms the principal exception is the absence of the *Mastodon* here called *M. (Trilophodon) Borsoni* from the Crag and blue clay. This species, which occurs both in the Astesan and in Auvergne and other parts of France, is so nearly allied to the *Mastodon* of North America, that the first discovered European specimens were regarded by Cuvier ‡ as belonging to that species; but its specific distinctness has been clearly established by the French palæontologists, and its occurrence in the Crag or overlying beds may yet be expected, if it has not been heretofore overlooked by collectors. The species would seem to be exceedingly rare in Italy, since tooth-specimens referable to it are either unique or nearly so in the public collections there.

Next, as regards the "Red Crag" of Suffolk. Mammalian remains were formerly so rare in the "Red Crag," that their abun-

* Pomel, Catal. Méthod. et Descript. p. 103.

† Gervais has expressed doubts respecting the veritable association of these living with extinct forms:—

"Il est également à supposer, que les nouvelles recherches des géologues d'Angleterre démontreront aux paléontologistes de ce pays que certains animaux reconnus par M. Owen comme étant d'espèces actuelles n'ont pas appartenu, comme ils le supposent, à l'époque pliocène. Tels sont le Cerf, la Loutre, et le Sanglier ordinaires. Le *Rhinoceros tichorhinus*, que nous considérons comme caractéristique du pléistocène, nous paraît aussi devoir être rayé de la liste des animaux pliocènes. On pourrait supposer qu'il s'est glissé quelque erreur dans la détermination des pièces osseuses regardées comme telles, mais cette détermination est garantie par la citation que M. Owen fait de cette espèce dans sa liste chronologique des Mammifères fossiles en Angleterre, et il est plus probable que c'est sur l'âge du terrain lui-même que l'on s'est trompé."—Gervais, Paléontol. Française, tom. i. p. 180.

‡ Oss. Foss. 4th edit. tom. iii. p. 375.

dance in the Norwich Crag was seized upon by Mr. Charlesworth, as furnishing a significant designation for the latter under the name of "Mammaliferous Crag." But latterly, the excavations for phosphatic nodules have led to the discovery of these remains in abundance. Among others, molars of *M. (Tetralophodon) Arvernensis* have been obtained in very considerable numbers. By the liberal kindness of Professor Henslow, I have been enabled to examine at leisure those which are contained in the Ipswich Museum, presented to that institution by Mr. George Ransome. They were found in the Red Crag pits. Some of these remains are now on the table before the Society. One, a very characteristic specimen, consists of the greater part of the last true molar, upper jaw, left side. It presents all the distinctive marks of *M. (Tetralophodon) Arvernensis*, namely, the discs of the worn tubercles decidedly alternate, and the valleys blocked up by large outlying tubercles. These "Red Crag" molars differ in no respect specifically from those found in the Fluvio-marine Crag. They are highly impregnated with ferruginous infiltration, and present a vitreous polish, very much like that of the Mastodon-molars from Perim Island on the western coast of India. They are mutilated by fracture, but do not present the appearance of having been rolled. The fractured edges of the enamel are sharp; and the only indications of abrasion which the teeth present are the natural results of wear, from long service as grinders. This is a point of some importance, as indicative that they were not washed into the Red Crag out of some older Miocene deposit.

Mr. Charlesworth, in his memoir on the "Crag of Suffolk," &c., after enumerating the genera of fossil fish that prevailed in the ocean of the Red Crag, adds—"It is here also that we first meet with the higher orders of the animal kingdom. The teeth of the Mastodon, Elephant, Hippopotamus, and other *Mammalia* are deposited with the *Mollusca* of this period, and in addition to them I may mention the bones of *Birds*, which I have recently obtained from several localities*."

Professor Owen has on three occasions described the fossil mammalia of the Red Crag: first, in 1840†; next, in his 'British Fossil Mammalia' in 1846; and latterly, as a Supplement, in No. 47 of the Quarterly Journal of the Geological Society‡. In neither has he included two of the genera cited by Mr. Charlesworth, viz. *Elephas* and *Hippopotamus*, both being of great significance as diagnostic of the age of European tertiary strata. No specimen of a tooth of *Hippopotamus* from a Red Crag locality, so far as I am aware, has hitherto been figured or described; and the occurrence of this genus in the deposit cannot at present be regarded as an established fact; but several molars of fossil *Elephas*, presenting the characteristic mineral condition of the mammalian remains of the Red Crag, have long been deposited in public and private collections, bearing labels as being from Red Crag localities in Suffolk. One specimen,

* Phil. Mag. 3rd ser. vol. viii. p. 535.

† Ann. & Mag. of Nat. Hist. vol. iv. p. 186.

‡ Op. cit. 1856, vol. xii. p. 217.

in particular, in the Museum of Practical Geology, is marked as being from Felixstow, and other reputed instances of the same kind will be noticed in the sequel.

In the "Conspicuous" contained in the 'British Fossil Mammalia,' Prof. Owen enumerates, as Mammalia of the "Miocene Red Crag," remains of *Ursus*, *Meles*, *Felis pardoides*, *Sus*, and *Cervus*. But he adds in a note, that "the nature of the stratum renders the actual age of these fossils doubtful." To the enumeration of the five Eocene species of *Cetacea* in the same conspectus, he appends a note, "that most of them occur in the Miocene Crag, but there is little doubt that they were washed out of the underlying Eocene clay." The "Cetotolithes" in question were discovered by Professor Henslow in the Red Crag at Felixstow *, which has yielded abundant mammalian remains of herbivorous quadrupeds. In his late paper, Professor Owen gives an account, more or less detailed, of the remains of twelve species of Mammalia (exclusive of *Cetacea*) from the Red Crag, belonging to the genera *Rhinoceros*, *Tapirus*, *Sus*, *Equus* and probably *Hipparion*, *Mastodon*, *Cervus* (of the subgenera *Dicranoceros* and *Megaceros*), *Felis* (two species), *Canis*, and *Ursus*. He sums up with the following conclusion, which, from its importance, I quote *in extenso* :—

"From the foregoing details it will be seen that the researches now applied during fifteen years to the mammalian fossils of the Red Crag of Suffolk have led to the very interesting result, that the majority of them are identical, or closely correspond, with miocene forms of Mammalia, and especially with those from the Eppelsheim locality, described by Prof. Kaup. In Suffolk, as in Darmstadt, we find the *Mastodon longirostris*, *Rhinoceros Schleiermacheri*, *Tapirus priscus*, *Sus palæochærus*, and *Cervus dicranoceros*, associated together in the same formation; and, with these miocene forms of extinct Mammalia in the Red Crag, we have likewise a Cetacean which most closely resembles a miocene species of that order, previously recognized in the Crag or Molasse of the Continent. At the same time there are, as *e. g.* in the *Megaceros*, specimens of newer pliocene or pleistocene forms of Mammalia mingled with the older tertiary species; whilst, on the other hand, eocene forms of fish, as *e. g.* *Edaphodon*, with *Myliobatidae* and eocene Crustacea, have been obtained from the Red Crag pits.

"As, however, several of the Mammalia which occur in miocene formations are also found in the older pliocene deposits in parts of France, it would be rash, perhaps, to pronounce positively on the miocene age of any of the above-cited crag-fossils; but it is certain that the majority of those mammalian fossils, and by far the greatest proportion of individual specimens, belong to an older tertiary period than the Mammalia of the newer pliocene drifts, gravels, brick-earths, and bone-caves." (*Loc. cit.* p. 229.)

In this view, regarded in the most restricted sense, a very mixed origin and complex character are attributed to the Mammalian fossils of the Red Crag, and it would seem to be open to several objections,

* Quart. Journ. Geol. Soc. vol. i. p. 37.

some of which I shall now state. Professor Owen, having satisfied himself that the Mastodon of the Crag was identical with the Miocene species of Eppelsheim, was naturally predisposed, where the evidence was at all ambiguous or indecisive, to regard the remains of the other fossil Mammalia with a leaning towards a Miocene origin. First, as regards the *Rhinoceros*; the European fossil species of this genus, including *Acerotherium*, are at present involved in such a maze of confused synonymy that no two living palæontologists are agreed about the number, or upon the names which ought to be applied to them. In consequence, it is exceedingly difficult to arrive at any satisfactory conclusion where a fossil *Rhinoceros* older than the Siberian species forms an element of the discussion. In the 'British Fossil Mammalia*,' Professor Owen adopts the opinion of Christol, that *Rh. Schleiermachi* and *Rh. megarhinus* are synonyms of the same species, the former having been founded by Kaup upon Miocene remains discovered at Eppelsheim, the latter by Christol upon Pliocene remains from Montpellier: from his late memoir it would appear that he now considers them distinct, and he leans doubtfully towards the opinion that the Crag molars of this genus, upper and lower, belong to the Miocene *Rhin. Schleiermachi*, rather than to *Rh. megarhinus*. But without going into details, it may be stated that these teeth present no characters, so far as they have been described, inconsistent with their being referred to the so-called *Rhin. megarhinus* of the South of France and Italy. The premolars possess the basal "bourrelet" which Christol pointed out as one of the distinguishing marks of his *Rhin. megarhinus*: it occurs, as stated by Professor Owen, in the same teeth of *Rhin. Schleiermachi*, and it is met with also in the premolars of the *Rhin. leptorhinus* of Cuvier. Further, it would seem to be clearly established now, that Cuvier was quite correct in characterizing his *Rhin. leptorhinus* as destitute of a nasal bony septum, and that Christol was misled by the deceptive appearance of a drawing in assigning this peculiarity to the original Italian specimen, and confounding it with *Rhin. tichorhinus*†. There are also the strongest grounds for believing that the *Rhin. megarhinus* of the Pliocene sands of Montpellier is specifically identical with *Rhin. leptorhinus* of Cuvier. The Red Crag specimens, figured and described by Professor Owen, are undoubtedly very like the corresponding teeth of *Rhin. Schleiermachi*; but it seems to me that the materials are not sufficient to establish a satisfactory palæontological identification, and that it is at present an open question whether they belong to *Rhin. leptorhinus* of Cuvier, or to *Rhin. Schleiermachi* of Kaup. The same remark applies to the Tapir of

* *Op. cit.* p. 370.

† Cornalia, in Duvernoy's "Nouvelles Études sur les Rhinoc. Fossiles" (Archiv. du Muséum, tom. vii. p. 99). He describes the original specimen, which is deposited in the Natural History Museum at Milan, as perfectly free from any trace of a bony septum, whether along the median line of the nasals, or upon the floor of the nasal cavity. Christol, not having had access to the specimen, misinterpreted a shaded portion of a drawing of it as a representation of the septum. Dr. Cornalia's remarks confirm, in every essential respect, the previous description by Cuvier.

the Red Crag, which Prof. Owen refers, on the evidence of a single upper and single lower molar, to the Miocene *Tapirus priscus* of Kaup. Pliocene species of Tapir have been met with both in Italy and France, one of which has been named *T. Arvernensis* (Croizet and Jobert), and the other *T. elegans** (Pomel); and a supposed third species, *T. minor* of Marcel de Serres, has been yielded by the marine sands of Montpellier†. The adduced evidence would seem hardly sufficient to establish that the Crag molars do not belong to either of these. And so also in regard to the Crag *Suidæ* referred by Professor Owen to the Eppelsheim species, *Sus palæochærus* and *Sus antiquus* of Kaup. The Crag specimens upon which the identification is founded are limited in each case to a single detached upper molar. The tooth referred by Prof. Owen to *Sus palæochærus* assuredly bears a very close resemblance to the figure of that of the Eppelsheim species with which he compares it: but the evidence, it must be admitted, is too limited to bear out a satisfactory specific identification; for aught that is shown to the contrary, except a slight difference of size, both of the Crag teeth may belong to the same species. An extinct species of *Sus*, *S. Arvernensis* of Croizet, has been found in the Pliocene strata of Auvergne; another supposed species, *S. provincialis* of Gervais, in the marine Pliocene sands of Montpellier; and species, as yet undetermined, of the same genus, occur in the Pliocene deposits of Italy. Is it certain that the "Red Crag" molars of *Sus* differ from all these?

The *Equus* of the Red Crag is stated by Professor Owen to resemble in the molar teeth his *Equus plicidens* of the Oreston Cavern, reconcileable with a Pliocene origin. The evidence respecting the teeth of the form considered by Prof. Owen "as probably of the subgenus *Hipparion*" has not been adduced. This subgenus had hitherto been regarded as strictly confined to Miocene strata, but Gervais‡ has attempted to distinguish several species from the marlbeds of Curcuron in the Vaucluse, the age of which, whether Miocene or Pliocene, he alleges, still remains to be determined.

As regards the two Cervine Ruminants from the Red Crag, the determination of the form which Prof. Owen refers to *Cervus dicranocerus* of Eppelsheim rests upon two shed antlers and two detached molars. The horns undoubtedly closely resemble those figured by Kaup of that species; but, as Prof. Owen states, a species presenting the rare character of a similar bifurcate form of antler, and named *Cervus australis* by Marcel de Serres§, has been discovered in the Pliocene marine sands of Montpellier; and it has not been shown that the Crag form differs specifically from it. The identification which is most at variance with the conclusions hitherto accepted is that of the shed antler, said to be from a Crag-pit at

* Pomel, Catal. Méthod. et Descript. p. 84.

† Gervais, Paléontol. Française, tom. ii. p. 4. pl. 5. figs. 4 & 5. Gervais doubts, with De Blainville, whether the materials are sufficient at present to prove that these Pliocene nominal species really differ from the *Tapirus priscus* of Eppelsheim.

‡ Paléontol. Française, tom. i. p. 177.

§ Gervais, Paléontol. Française, tom. i. p. 85. pl. 7. figs. 1-3.

Felixstow, which Professor Owen (in the reference to the figure) describes as the "base of the antler of the *Megaceros Hibernicus*;" inferred to occur in a formation where the majority of the mammalian species are regarded as Miocene. Any determination emanating from so distinguished a palæontologist as Professor Owen must be entertained with the respect which his great authority carries with it. But the specimen in question, although (like most of the fossils of the "Red Crag") highly impregnated with iron, and of corresponding gravity, is encrusted with fresh patches of *Lepralia Peachii*. Prof. Busk, to whom I am indebted for this identification, after a careful examination of the original, informs me that the pearly appearance and transparency of the walls of the cells indicate the modern origin of this marine Bryozoon. Other species of the same genus are found in abundance upon the fossil shells of the Red Crag, but they are invariably more or less tinged with an ochreous colour, and the walls of the cells are opaque. Instead, therefore, of having been found in a Crag-pit (the statement under which the specimen came before Professor Owen), it would seem most probable that it was dredged out of the present sea, from some locality off the coasts of Suffolk or Essex. Teeth and bones of Elephants and of other herbivorous mammalia, highly impregnated with iron, and encrusted with marine Bryozoa, are brought up by the dredge, or found upon the beach, at intervals all along the coast from Mundesley to Harwich. A large number of molars of *Elephas (Loxod.) meridionalis*, presenting a highly vitreous polish, heavy, and dark-coloured, exist in Mr. Fitch's collection at Norwich; and analogous remains are to be met with in various collections in Suffolk and Essex; yet it is not a little remarkable, considering the numerous descriptions of the coast-section which have been made by different English geologists, that the particular beds from which these remains have been derived, have not yet been determined with precision. No authentic case has as yet been made out of remains of the Irish Elk in strata of an older date than the period of the Mammoth, Siberian Rhinoceros, and *Ursus spelæus* of the Glacial fauna: and the palæontological evidence would require to be very conclusive before the range of this species could be extended so as to include the Pliocenes of the Subapennine period.

As regards the Carnivora of the "Red Crag" enumerated by Prof. Owen, the evidence, so far as it has been published, is of a very limited nature, being confined to detached teeth, and is adequate for little more than the identification of the respective genera. No Miocene species of *Ursus* has yet been met with in Europe. The tooth from a Red Crag pit at Newbourn, which Professor Owen guardedly describes as "somewhat smaller than the corresponding tooth of the *Ursus spelæus*," would correspond in size with that of the Pliocene *Ursus Arvernensis*, found abundantly in Italy and Auvergne. Professor Owen admits that the carnassial teeth specimens, from Newbourn and Woodridge, of his *Felis pardoides*, do not differ in size from the Pliocene *Felis pardinensis* of Croizet and Jobert, found in Auvergne, and it remains to be shown that the former is specifically

different from the latter form. The remarkable sectorial tooth from the Red Crag, which, according to Professor Owen, closely resembles one of the ancient Carnivora called *Hyænodon* and *Pterodon*, and which he suspects to be an indication of an extinct osculant genus, linking on the true Felines to the Hyæna or Musteline family, has not been generically determined; and it may have been washed in from strata of the Eocene age*.

If, on the other hand, a palæontologist, having satisfied himself that the Red Crag Mastodon is an undoubted Pliocene form, and finding the same species in the Fluvio-marine Crag, were to infer that they were both of the same geological age, and if he were then to take a group of some of the well-established species as a starting-point, he would experience little difficulty in reconciling many of the more doubtful mammalian species with a consistent Pliocene association. The species would run in the following order:—The Proboscidea, *M. (Tetralophodon) Arvernensis*, *E. (Loxodon) meridionalis*, and *E. (Euelephas) antiquus*; the Pachydermata, *Rhinoceros leptorhinus* or *Rhinoc.* —?, *Tapirus Arvernensis*, and *Equus plicidens*; the Carnivora, *Felis pardinensis*, *Ursus Arvernensis*, and probably a Pliocene species of *Canis*. With such an harmonious agreement in the great leading forms, he would naturally look to Pliocene forms for comparison when he met with scanty and indecisive remains of such a widely distributed and extensive genus as *Cervus*, unless the characters were so pronounced as to be decisive of species of an earlier age.

This is the manner in which I have been led to regard the fossil Mammalia of the Red and Fluvio-marine Crag; and it has appeared to me that (where remains obviously of an anterior epoch have not been adventitiously intermixed) they agree generally, so far as the species have been well determined, with the great Pliocene fauna of Italy, as exhibited along the valleys of the Po and of the Arno. But it must at the same time be freely admitted, that the materials upon which the determination of many of the species of the Red Crag Mammalia at present rests are so scanty and indecisive, that the identification, either way, whether as Miocene or Pliocene forms, must be regarded as little more than approximative.

There are other considerations which corroborate the Pliocene view of the Mammalian fauna of the Crag. The debateable species referred by Prof. Owen to a Miocene origin all belong to genera that are common to the Miocene and Pliocene periods—such as *Mastodon*, *Rhinoceros*, *Tapirus*, *Sus*, *Cervus*, and *Felis*. But of the more remarkable types which are limited to the Upper Miocene deposits, and which abound in them all over Europe, such as *Dinotherium*, *Chalicotherium*, *Aceratherium*, *Anchitherium*, *Amphicyon*, &c., not a single remain has ever been cited as having been found in the Crag-deposits. The question naturally arises, how does it happen,

* Quarterly Journal of the Geol. Soc. vol. xii. p. 237. fig. 20.

if the majority of the Red Crag Mammalia are Miocene, that there has been this selective admixture of species of long-termed "Miocene" genera in the Crag, and why the exclusion of the strictly characteristic genera?

Another view may be taken, that, as the Red Crag contains Fish and Crustacean remains which have been inferred to have been washed out of denuded Eocene deposits, so the Pliocene sea-bottom of the Red Crag may have had Miocene mammalian remains washed into it, thus causing an extraneous admixture among the Pliocene mammalian fossils. But it may be asked in reply, where are the Falunian deposits, in proximity with the Crag in England, from which such a washing-in could have taken place? And, if they were transported from a distance, they ought to show marks of abrasion from rolling, which, so far as my observation goes, are not seen in a great many of the Red Crag Mammalia to which a Miocene origin has been attributed. Many flattened pieces of bone, exhibiting a high vitreous polish, and bearing palpable marks of having been long rolled in the sea among shingle, have unquestionably been met with in the Crag; but it does not necessarily follow that they were all washed out of an older deposit. It is intelligible that the effect may have been produced by attrition caused by the waves of the Crag-sea upon bones of animals of the same geological period.

It now remains to consider how far the Cetacean fossils of the Crag are in accordance with the inferred Pliocene character of the Land Mammalia. Professor Owen has described "Cetotolithes" of five species of *Balaenida* from the Red Crag. He states (Brit. Foss. Mam. p. 527), that they "appear to have been dislodged from a subjacent Eocene deposit;" and the same opinion is repeated in the note appended to the "Conspectus" of British fossil species which I have already cited. They are there arranged under the head of Eocene, and excluded from the Miocene fossils. Cetacean remains have been met with in abundance in the Pliocene deposits of Italy, under circumstances which leave no doubt that they are of the same age as the land-quadrupeds found associated with them. I have already mentioned the case examined by myself, where the skeleton of *M. (Tetraloph.) Arvernensis*, covered with marine incrustations, was found in the "Panchina inferiore" of the lower Val d'Arno near Leghorn, associated with the entire skeleton of a whale referred by the Italian naturalists to *Physeter*, and with Dolphin-remains. A still more remarkable and conclusive instance is furnished by the rich and well-known deposit of Pliocene Mammalia investigated by Cortesi in the Subapennine deposits near Piacenza. Monte Pulgnasco is stated to attain an elevation of about 1700 feet above the level of the Adriatic*, and near it there are lower elevations, Monte Zago and Della Torazza. The upper beds in all three alike, to a great depth, consist of reddish calcareous sands full of marine shells; and below these there are beds of blue clay ("Marna cerulea"), also

* Cortesi, Saggio Geolog. 1819, p. 72.

loaded with similar shells, both being of the Subapennine Pliocene age. Cortesi discovered in the blue clay, at different points, nearly entire skeletons of extinct whales, referred by Cuvier to the Rorquals (*Balænoptera Cortesii* and *Balænoptera Cuvierii* *), and of Dolphins allied to *Phocæna Orca*, but differing in the form of the cranium (*Phocæna Cortesii*†, and other species unnamed). Near the summit of Monte Pulgnasco, in the overlying stratified sands, the greater part of a skeleton of the Val d'Arno Elephant, *E. (Loxod.) meridionalis*, was discovered; and upon Monte Zago the original skull, together with many other bones, of the individual Rhinoceros upon which Cuvier founded his *Rhinoc. leptorhinus* as distinct from *R. tichorhinus*. The Rhinoceros skeleton was found in the sandy strata, but resting immediately upon the blue clay, and with upwards of 200 feet of strata above it. I was enabled, by the kind permission of Dr. Emilio Cornalia, to examine the fine collection of these Monte Pulgnasco remains deposited in the Natural History Museum at Milan, including, among others, the palate specimen of the Elephant described by Cortesi‡, which I found to be identical with *E. (Loxodon) meridionalis* of the Val d'Arno and Fluvio-marine Crag.

Here are two cases of the association of Pliocene Cetacea with terrestrial Mammals, under circumstances where extraneous admixture is inadmissible. Cetacean remains were long ago described by Cuvier from the Crag of Antwerp§. Lyell found in the same formation numerous specimens of bones said to be of *Balænoptera* and *Ziphius*, which bore no marks of rolling as if washed out of older beds; and he inferred that the animals to which they belonged once co-existed in the same sea with the associated Crag Mollusca||. He considers the strata to be Older Pliocene, equivalents of the Red Crag and Coralline Crag.

Professor Owen, in his late memoir, enumerates some additions to the Cetacean remains from the Red Crag described in the 'British Fossil Mammalia.' Among these are portions of an upper jaw very closely resembling the *Dioplodon Becanii* of Gervais (*Ziphius* of Cuvier), and "water-worn teeth corresponding in size and form" with those of the *Hoplocetus crassidens*, an obscure and as yet imperfectly determined form, provisionally so named by Gervais¶, from the Miocene Faluns of La Drôme. Another supposed species of the genus, named *Hoplocetus curvidens* by the same palæontologist, is founded upon specimens procured from the Pliocene sands of Montpellier. The Crag "Cetotolites" (i. e. the same species) have nowhere as yet been described as occurring in Eocene beds in England; and the whole bearing of the evidence would seem to in-

* Diction. Univers. d'Histoire Natur. tom. ii. p. 443.

† *Op. cit.* tom. iv. p. 634.

‡ Cortesi, *op. cit.* p. 68. t. 6. f. 1, 2.

§ Oss. Foss. tom. v. p. 352.

|| Quart. Journ. Geol. Soc. vol. viii. p. 281; and Manual of Geology, 5th edit. p. 174.

¶ Paléont. Franç. tom. i. p. 161. Gervais throws out a suggestion, that his *Hoplocetus* may have a connexion with the *Balenodon* of Professor Owen; but does not enter into a detailed comparison.

dicate, that at least a considerable part, if not the whole, of the "Red Crag" Cetacea are of the same age as the associated terrestrial Herbivora.

[Since the preceding pages were in type, I have had an opportunity of examining specimens in some of the principal collections in Essex, Suffolk, and Norfolk, which throw light upon some of the points discussed above. In the Town Hall of Colchester there is a fine specimen, comprising both maxillary bones of a young *Elephas* (*Eueleph.*) *antiquus*, and presenting the last milk-molar (right side) in place. The matrix is very ferruginous, and the bones and tooth are of a dark-chocolate colour, with a vitreous polish. It was dredged up from off the "West Rocks" on the Essex coast; and it resembles in its mineral condition the large Cervine horn reputed to be from a Crag-pit at Felixstow, and referred by Professor Owen to *Megaceros* (see above, p. 354).

In the rich and valuable collection of Red Crag fossils belonging to William Whincopp, Esq., of Woodridge, there are two upper and three lower molars of a species of *Hippotherium* from the Red Crag pits at Sutton. They bear a close resemblance to the Miocene *H. gracile*, Kaup, from Eppelsheim. The same collection contains several molars, upper and lower, of the genus *Rhinoceros*, one of which (an upper antepenultimate milk-molar) agrees, in most of the characters, with an original specimen of a corresponding tooth of *Rhinoceros Schleiermacheri* from Eppelsheim, with which it was compared. Mr. Whincopp also possesses an upper maxillary bone containing a series of the molar teeth of *Hyracotherium leporinum*; also detached molars apparently of the smaller species, *Hyrac. cuniculus*, both said to have been procured from the Red Crag at Felixstow. Besides these, Mr. Whincopp possesses, first, several perfect Cetacean teeth, resembling those referred to *Hoplocetus* by Gervais; 2ndly, two remarkable molar teeth of a form which has not hitherto been described as a British fossil; and, 3rdly, numerous remains of Red Crag *Delpchinidæ*.

In the rich collection of Edward Acton, Esq., of Grundisburgh, there are specimens referable to both species of *Hyracotherium*, and reputed to be from Red Crag localities in Suffolk, besides molars of *Tapirus* and *Rhinoceros*. Mr. Acton also possesses a singularly perfect antepenultimate true molar from the lower jaw of *M. (Tetralophodon) Arvernensis*, showing the peculiar characters of the species strongly marked*.

In neither of these collections did I observe any specimen referable to *M. (Tetraloph.) longirostris* of Eppelsheim, nor to the peculiar mammalian genera of the Upper Miocene period, enumerated in a preceding paragraph as being usually associated with that species (p. 355). It is manifest that the Hyracotherian remains must have been derived from broken-up Eocene deposits; and the teeth of

* In Mr. Whincopp's collection there is a very beautiful specimen of an intact germ of an antepenultimate upper milk-molar, from the Red Crag, closely resembling the specimens figured by Croizet and Jobert.

Hippotherium indicate a similar inference of Miocene remains being mixed up with Pliocene forms in the reconstructed materials of the Red Crag deposit.—H. F., Oct. 20th, 1857.]

Conclusion.—On a review of the various facts and considerations discussed in the preceding pages, it seems clear that the Mammalian fauna of the Fluvio-marine Crag is of a Pliocene age. The undoubted association of *M. (Tetraloph.) Arvernensis* and of *E. (Loxodon) meridionalis* in this deposit admits of no other inference. The mixed contents of the Red Crag, including mammalian remains of different strata from the Eocene period upwards, are inferred to have been deposited in the reconstructed strata also within the Pliocene period; since *M. (Tetraloph.) Arvernensis*, which occurs so abundantly in the Red Crag, has not been met with anywhere on the Continent of Europe except in deposits of a Pliocene age. The Red Crag sea appears to have breached a previously established and populated Pliocene land, and to have buried the bones referable to various epochs in the same sea-bottom.

In the preceding remarks I have purposely excluded any reference to the *shell-evidence*, and confined the comparison strictly to the Mammalian Fauna. The Mollusca have unquestionably been wielded as a most powerful exponent of geological chronology, and of the successive physical changes which have taken place on the surface of the earth. But it will hardly be denied that the evidence presented by Mammalian remains, when obtained in sufficient variety and abundance, is of greater significance as a test of contemporaneous formation in geology, or the reverse:—1st, Because Mammalian genera and species are everywhere shown to be of more limited duration in time than the Mollusca; and, 2ndly, because from the vastly greater complexity of their relative functions, they are much more susceptible of being affected by the altered climatal conditions which are necessarily involved in every great physical change, and which conduce most to the extinction of species.

The conclusions to which the comparison has led are:—

1. That the Mastodon-remains which have been met with in the "Fluvio-marine Crag" and "Red Crag" belong to a Pliocene form, *Mastodon (Tetralophodon) Arvernensis*.
2. That the Mammalian Fauna of the Fluvio-marine Crag bears all the characters of a Pliocene age, and is identical with the Subapennine Pliocene Fauna of Italy.
3. That the Red and Fluvio-marine Crag, tested by their Mammalian Fauna, must be considered as beds of the same geological age.

[The sequel of this paper, Part 2, "On the species of ELEPHANT found fossil in England," with remarks upon the associated Mammalia, will be communicated at a future meeting of the Society.]

DESCRIPTIONS OF PLATES XI. & XII.

[The figures are all drawn on the scale of one-third of the natural size.]

PLATE XI.

Fig. 1. *Mastodon (Tetralophodon) longirostris*, Kaup, from Eppelsheim : plan-view of the penultimate true molar from the left side of the upper jaw. *a*, anterior talon ; *t*, posterior talon ; *b*, *c*, *d*, *e*, the four principal ridges which compose the crowns of the "intermediate molars" in the Tetralophodons. An irregular longitudinal cleft along the middle divides the crown into an inner and outer division.

Fig. 2. The same tooth, seen in profile.

[From a cast in the Society's Collection.]

Fig. 3. *Mastodon (Trilophodon) angustidens*, from the Dep. Gers, in the Subpyrenees : plan-view of the penultimate true molar from the left side of the upper jaw, showing the worn disks of the three principal ridges which compose the crowns of the "intermediate molars" in the Trilophodons. *a*, anterior talon ; *t*, posterior talon ; *b*, *c*, *d*, the three ridges. The longitudinal cleft is partially worn out.

Fig. 4. The same tooth, seen in profile.

[From a specimen in the Collection of M. Lartet, For. Mem. G. S., Seissan, Gers.]

PLATE XII.

[The letters to the figures refer to the same parts as in fig. 1, Pl. XI.]

Fig. 1. *Mastodon (Tetralophodon) Arvernensis*, from Ramsey, near Harwich : plan-view of the germ of the penultimate true molar from the right side of the upper jaw.

Fig. 2. The same tooth, seen in profile. A large flanking mammilla is seen to occupy the middle of each valley.

[This specimen is in the Collection of the Rev. J. R. Marsden, Great Oakley, Essex.]

Fig. 3. *Mastodon (Tetralophodon) Arvernensis*, from Suffolk : plan-view of the germ of the last true molar from the left side of the lower jaw.

b, *c*, *d*, *e*, *f*, the five ridges composing the crown, the mammillæ of which are disposed alternately.

Fig. 4. The same tooth, seen in profile.

[Figs. 3 & 4 are drawn from a cast in the Society's Museum ; the "bour-relet" being partly restored from a Crag molar of similar age, also in the Society's Collection.]

APRIL 22, 1857.

Thomas Alfred Yarrow, Esq., C.E., Gresham House, Old Broad Street, was elected a Fellow.

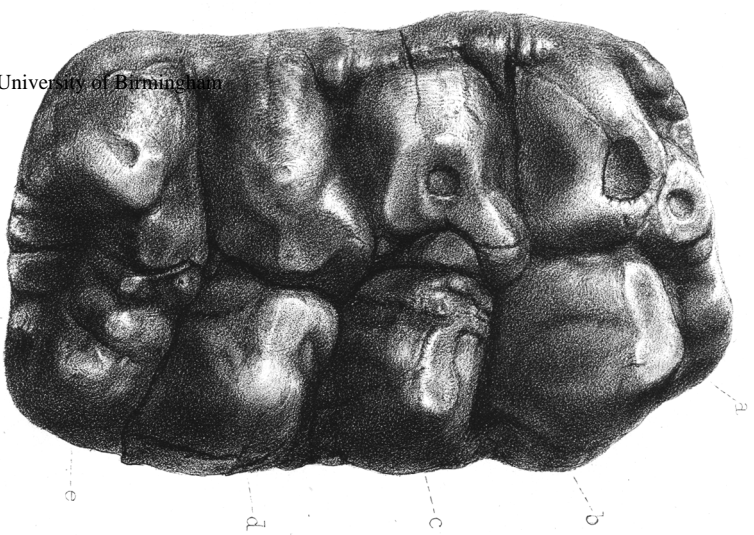
The following communications were read :—

1. *Description of a NEW FOSSIL CRUSTACEAN (Tropifer lævis, C. Gould) from the LIAS BONE-BED.* By CHARLES GOULD, Esq., B.A.

[Communicated by J. W. Salter, Esq., F.G.S.]

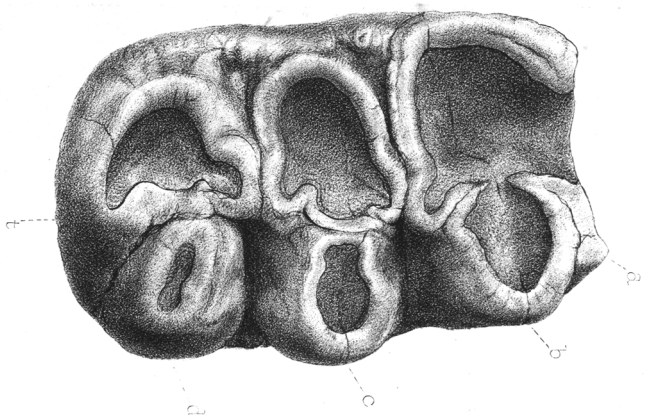
CRUSTACEAN remains from this Bone-bed, and indeed from the Lias itself, are so rare, that I feel no apology is necessary for introducing

Fig. 1.



M. (TETRALOPHODON) LONGIROSTRIS.

Fig. 3.



M. (TRILOPHODON) ANGUSTIDENS.

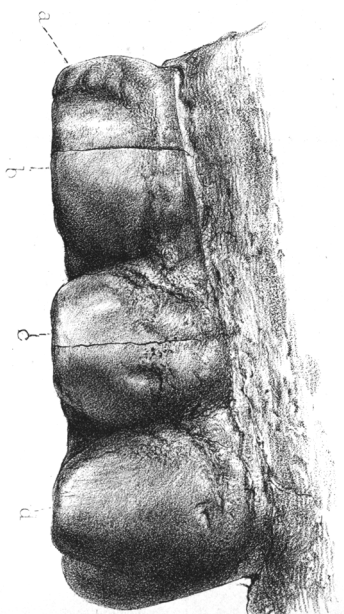
Fig. 2.



($\frac{1}{8}$ nat. size.)

MASTODON.

Fig. 4.



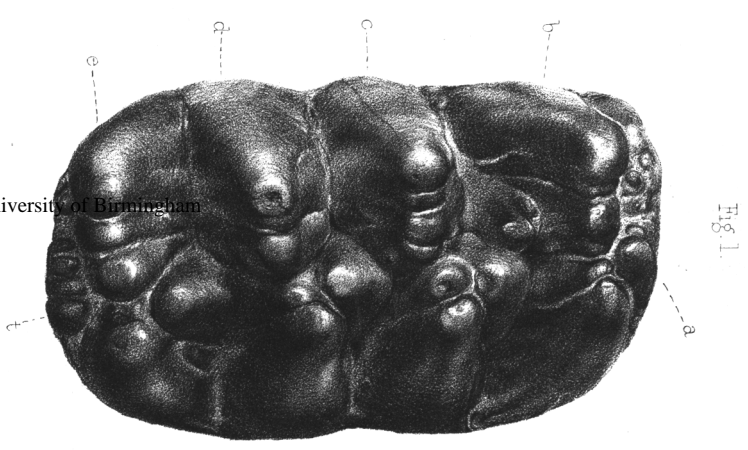
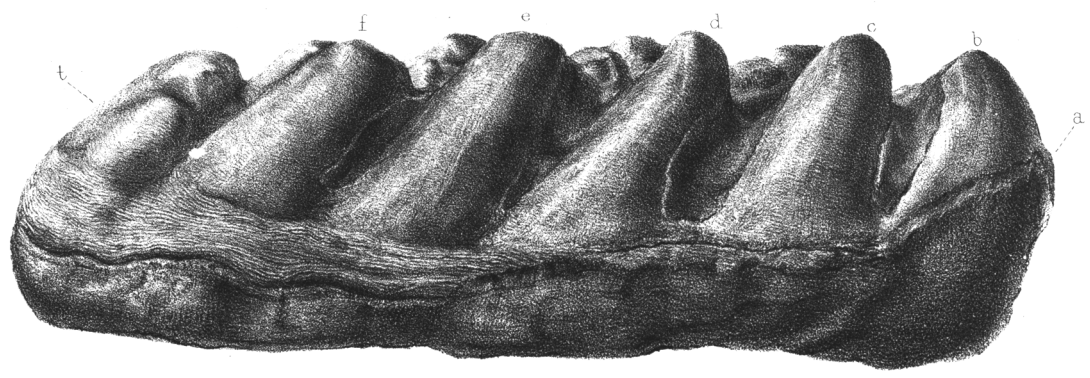
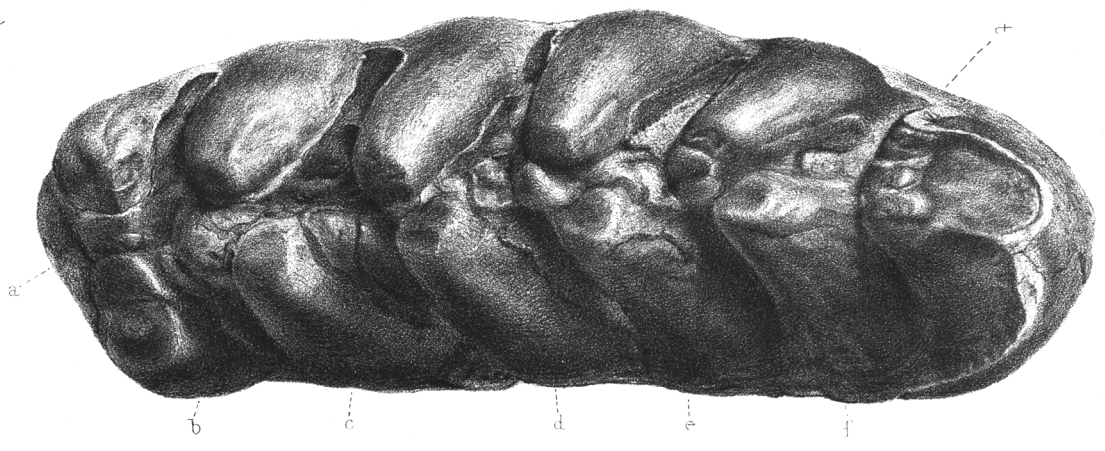


Fig. 1.



Fig. 2.

($\frac{1}{3}$ nat size)



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MASTODON (TETHALOPHODON) ARVERNENSIS. From the Craie.