ON THE EXTINCT ANIMALS OF NORTH AMERICA.

By Professor WILLIAM HENRY FLOWER, F.R.S.

[PLATE CXXXVIII.]

FEW branches of knowledge have received greater accessions during the last few years than that of the past history of the living creatures which have peopled the earth.

I propose in the present instance to call attention to some of the results that have been achieved, mostly within the last four or five years, by a small but energetic band of explorers upon a limited part of the earth's surface; results the greatness of which already is only equalled by the promise they give of future still more important extensions of knowledge.

It is mainly through the agency of the admirably conducted geological and geographical surveys of the Western Territories, made by the United States Government, under the direction of Dr. F. V. Hayden, that the subjects to which I shall refer have been brought to light; surveys which are giving to the world, in an excellent series of publications, rich funds of information upon the physical geography, mineralogy, geology, palæontology, zoology, and botany of that hitherto little known but most remarkable region of the earth embracing and bordering the great range of the Rocky Mountains. For the special knowledge which we in England possess of the vertebrate fossils which have been discovered by these surveys, we are greatly indebted to the excellent descriptions of Professor Joseph Leidy of Philadelphia, who in two large and beautifully illustrated volumes* has given the results of his investigations upon them. More recently two other naturalists, Professor E. D. Cope of

* "Extinct Mammalian Fauna of Dakota and Nebraska, with a Synopsis of the Mammalian Remains of North America," 'Journ. Acad. Nat. Science,' Philadelphia, 1869; and "Contributions to the Extinct Vertebrate Fauna of the Western Territories," 'Report of the U. S. Geological Survey of the Territories,' Washington, 1873.

Plate CXXXVIII.

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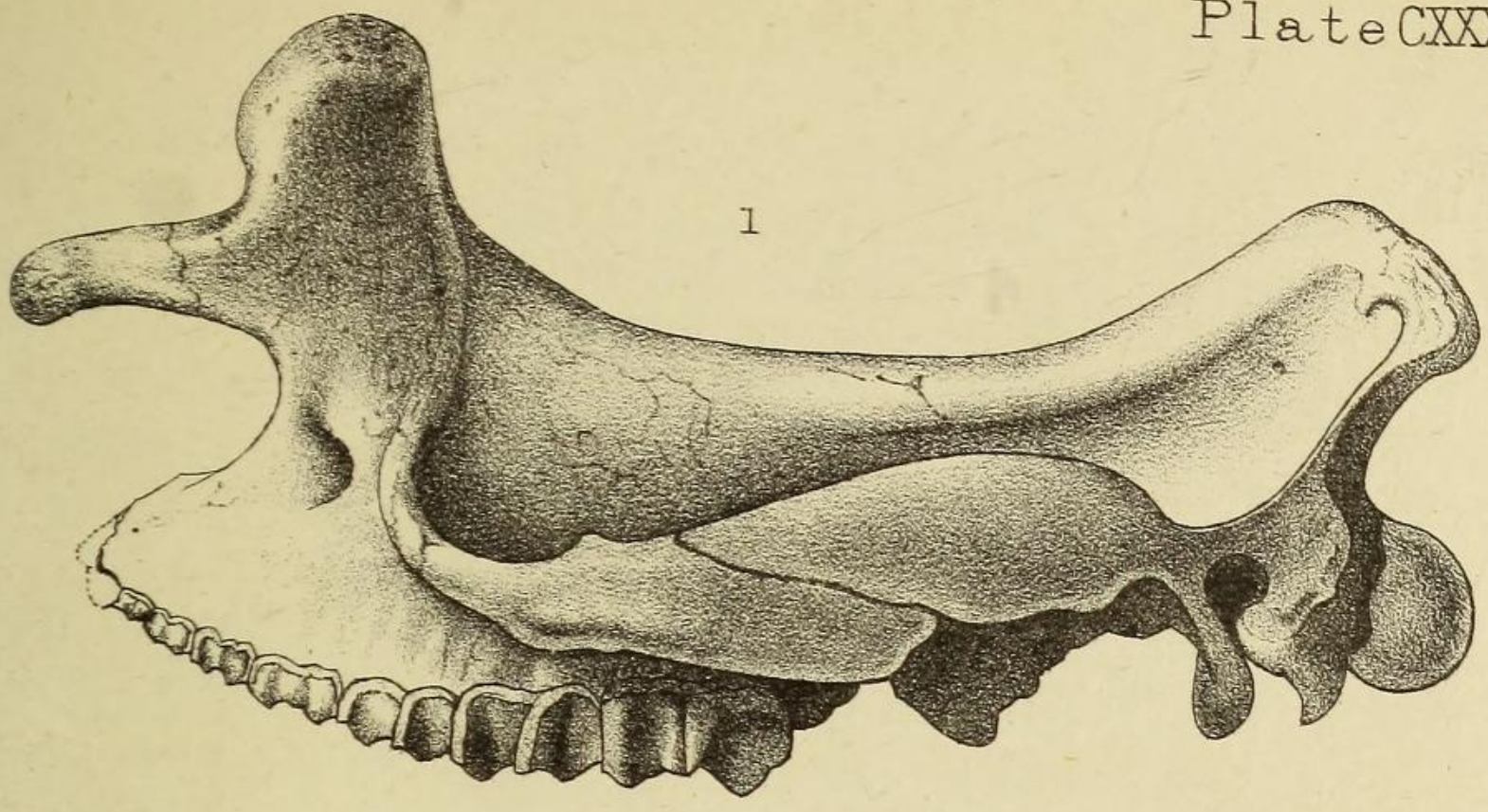

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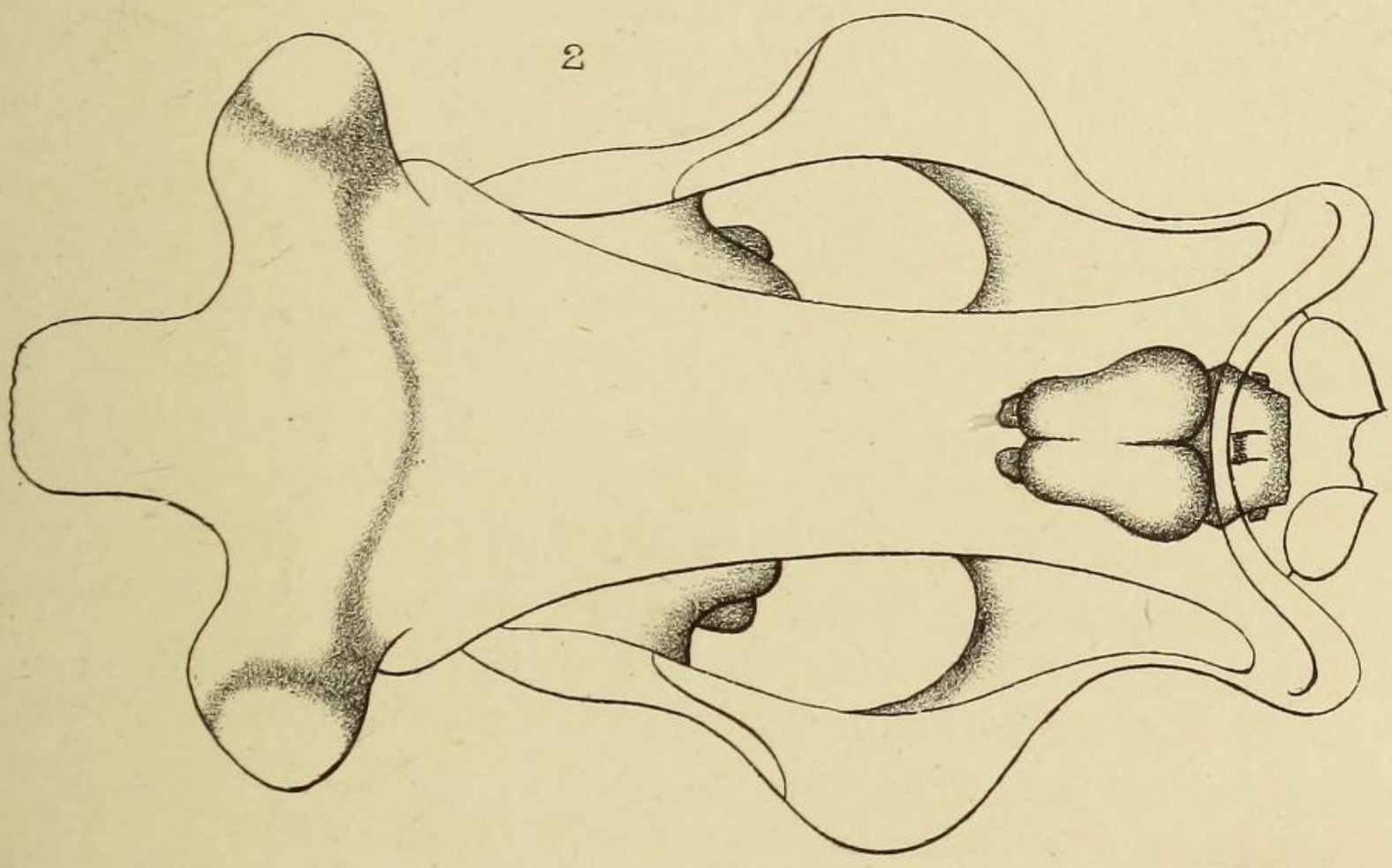

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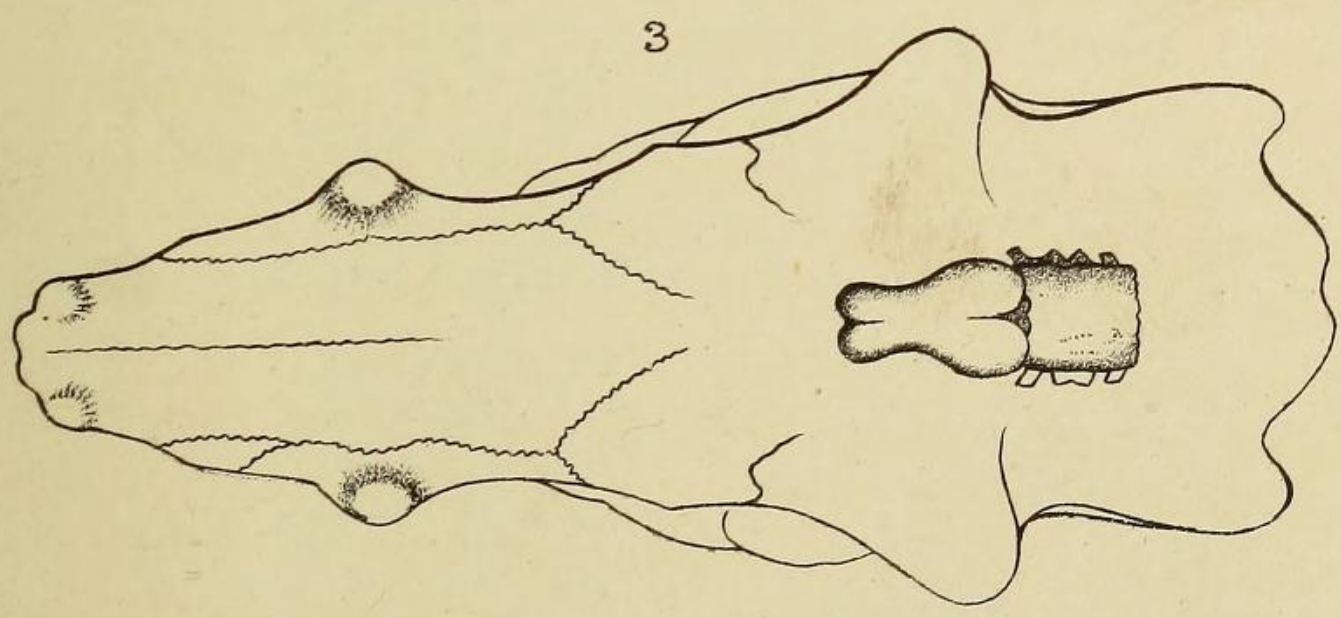

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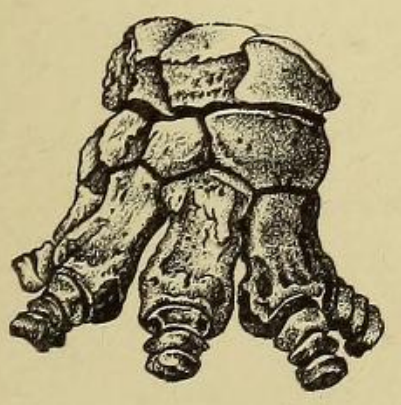

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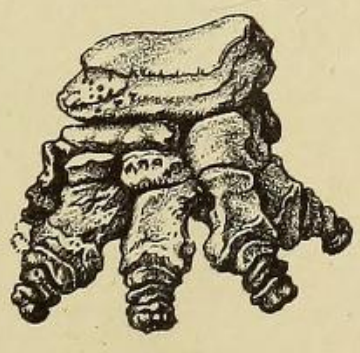


W. West & Co. lith.

American extinct Mammals.

Philadelphia, and Professor O. C. Marsh of Yale College, have taken the subject in hand, both as explorers and describers.*

It must be premised that the material has come to hand so rapidly during the last three or four years that most of the information which has hitherto been given to the world, especially by the two last-named palæontologists, is in a very provisional and fragmentary state; and that until the flood of new discovery begins to ebb, and the few labourers in this plentiful harvest-field have leisure to prepare careful, elaborate, and, above all, well-illustrated descriptions of the specimens, we shall remain in much uncertainty about the real nature and relations of many of the animals of that strange old fauna, which at present are to us little more than names.

I must presume that readers are familiar with the main epochs of time into which geologists have divided the earth's history. For the present purpose we shall only have to refer to the latest of these, the Tertiary, representing how many millions of years we cannot say; and which, for convenience, is generally subdivided into four sub-epochs, the Eocene, the Miocene, the Pliocene, and the Pleistocene, the end of which brings us to the period in which we now dwell. Of course it is not implied by this division that there was any sudden break or interruption of the steady course of the world's progress between these periods. They are merely artificial and arbitrary, though convenient stages, and pass insensibly one into the other; but without the use of some such terms we could not fix the epoch of any particular event or set of events. In geology we know nothing of centuries. We have no kings' reigns, as in political history, to mark the course of time, so we speak of "Miocene" much in the same vague kind of sense in which we speak of the "Middle Ages" in our chronology of the historical events in Europe.

The first evidence of mammalian remains in strata of Miocene age in Western America was that made known in 1846 by Dr. Hiram A. Prout, of teeth then supposed to belong to a gigantic species of *Palæotherium*, and subsequently described by Leidy under the name of *Titanotherium*. This was the commencement of that interesting series of discoveries, which have now made the "Mauvaises Terres," or "Bad Lands," of the White River of Dacota, classical ground to the palæontologist. But it was not until 1869 that the older beds on the western side of the Rocky Mountains were explored, and the more ancient Eocene land fauna of North America brought to light. In that

* I am glad to take the opportunity of thanking Professors Hayden, Leidy, Marsh, and Cope, for their kindness in sending me copies of all their numerous memoirs bearing upon the subject of this article.

year commenced the explorations in the vicinity of Fort Bridger, a military post situated in the south-west corner of Wyoming Territory, which have yielded such an abundant harvest, and the locality of which is thus graphically described by Professor Leidy:—

"Fort Bridger occupies a situation in the midst of a wide plain, at the base of the Uintah Mountains, and at an altitude of nearly seven thousand feet above the ocean level. The neighbouring country, extending from the Uintah and Wahsatch Mountains on the south and west to the Wind River Range on the north-east, at the close of the Cretaceous epoch, appears to have been occupied by a vast fresh-water lake. Abundance of evidence is found to prove that the region was then inhabited by animals as numerous and varied as those of any other fauna, recent or extinct, in other parts of the world. Then, too, a rich tropical vegetation covered the country, in strange contrast to its present almost lifeless and desert condition.

"The country appears to have undergone slow and gradual elevation; and the great Uintah Lake, as we may designate it, was emptied, apparently in successive portions, and after long intervals, until finally it was drained to the bottom. The ancient lake-deposits now form the basis of the country, and appear as extensive plains, which have been subjected to a great amount of erosion, resulting in the production of deep valleys and wide basins, traversed by Green River and its tributaries, which have their sources in the mountain boundaries. From the valley of the Green River the flat-topped hills rise in succession, as a series of broad table-lands or terraces, extending to the flanks of the surrounding mountains.

"The fossils which form the subjects of our communication for the most part were derived from the more superficial deposits of the great Uintah basin, which Professor Hayden has distinguished as the Bridger group of beds. These compose the terraces or table-lands in the neighbourhood of Fort Bridger, and consist of nearly horizontal strata of variously-coloured indurated clays and sandstones. As the beds wear, through atmospheric agencies, on the naked declivities of the flat-topped hills, the fossils become exposed to view, and tumble down to the base of the hills among the crumbling *débris* of the beds."

The immense length of time that this ancient lake has existed may be inferred from the fact that the mud or sand deposited in it has accumulated to more than a mile of vertical thickness.

It is from this and from neighbouring localities systematically explored only during the last four or five years, both by the Government surveys and by expeditions organised for the purpose from Yale College, that most of the remarkable animals

attributed to the Eocene epoch have been obtained; although still more recently fossiliferous beds of the same age have been discovered both in Colorado and New Mexico, so rich as to give hopes that we are still only on the threshold of our knowledge of the wonderful fauna of the ancient American continent. Besides the extensive and older known Miocene and Pliocene beds between the Rocky Mountains and the Missouri, others of corresponding age have been discovered west of the Blue Mountains in Eastern Oregon.

I must now pass in successive review some of the principal groups into which animals have been divided by naturalists, and show what is known of their past history on the great North American continent. I am aware that the summary I am about to give will be exceedingly imperfect, partly on account of the limited time allowed in one discourse, and partly on account of the difficulty of extracting a connected account of these discoveries from the exceedingly numerous notices in which they are described—often fragmentary and disconnected, and even contradictory, and scattered through a variety of periodicals and reports. As most of these descriptions are put forth by their authors as "preliminary," to be superseded by more elaborate and detailed work hereafter, so must this notice of them be regarded. It will at least serve the purpose of calling attention to the importance and interest of this comparatively new field of research.

The first group to which I will direct attention, as it is that of the ancient history of which we have more complete knowledge than of any other, is the large order of *Ungulata*, or hoofed animals; and first among them I will consider those characterised, among many other distinctive peculiarities, by the uneven or *perissodactyle* structure of the foot, represented in the actual fauna of the world only by the three families of Horses, Tapirs, and Rhinoceroses—animals differing very considerably from each other in general outward appearance, and yet having many important common characteristics.

It is well known that in the Old World, species of this group, very intermediate in characters to those now existing, flourished in the Eocene age. Cuvier's grand researches in the Paris gypsum beds, which laid the foundation of the study of mammalian palæontology, reconstructed the form, now almost as well known as that of the existing tapir, of the *Palæotherium*; and numerous allied species have since been found, not only in France, Switzerland, and Germany, but in the corresponding beds in our own country. But in America, before 1869, not a single Eocene Perissodactyle had been discovered. In fact, as just mentioned, no Eocene beds containing the remains of terrestrial animals had been explored. Since that date, how-

ever, it has been ascertained that the region in which the stupendous mountain ranges of western North America have since been elevated were tenanted by animals of similar form and characters, and quite as varied in species and as numerous in individuals as those which at a corresponding period of time ranged through the marshes and forests of the Paris and London basins.

None of these appear to be identical specifically with the European forms; and even the generic indications, being often founded on very limited portions of the organisation only, as a few teeth, must be regarded as provisional. Many were undoubtedly quite distinct from any which we know from the Eastern world. It would be useless here to give a catalogue of the generic and specific names which have been given to the animals of this group already discovered. A brief mention of the most important and interesting will suffice. The two best known genera are those named by Leidy *Hyrachyus* and *Palæosyops*; the former is allied to the Lophiodons and Tapirs, the latter to the Palæotheriums. They both embrace animals in size varying from that of a small rhinoceros down to a peccary. The numerous modifications and combinations of characters found in forms apparently allied to them, which are little known to us at present except by the names given to them by their discoverer, will doubtless afford for a long time to come materials for the minutest scrutiny. Some appear to be allied to the European *Lophiodon* and *Hyracotherium*, one of which *Orohippus* (Marsh), seems to connect these forms through *Miohippus* and *Mesohippus* with the horse-like *Anchitherium*, and thus fill a link wanting in European formations in the pedigree of the Equine family. This animal, like so many other of the Eocene Perissodactyles, resembles the modern tapirs in retaining the fifth digit on the fore-foot, though, as in all known members of the group, the first was wanting, and both first and fifth were wanting to the hind-foot. Several species are described, but none larger than a common fox. One form only, *Diceratherium* (Marsh), is rhinocerotic. It is found in the uppermost Eocene strata of Utah, and gives the earliest indication of this group yet known. It seems, according to Marsh, to be connected with the lower Eocene *Hyrachyus* on the one hand, and the Miocene *Hyracodon* on the other.

In the Miocene period in North America the Perissodactyles attained a great development of form, variety, and size, the groups became more distinctly separated from each other, and some of them possessed remarkably specialised characters. True tapirs have not yet been met with in this period, which is rather remarkable, taken in conjunction with the present geographical distribution of that group. The Palæotheroid

and Lophiodont forms had nearly, if not quite, died out, but the more horse-like *Mesohippus*, *Miohippus*, and *Anchitherium* were abundant, and appear to continue the line from the Eocene *Orohippus* to the true horses of the Pliocene period.

Rhinocerotic forms now became ascendent, being represented by *Diceratherium* (Marsh), differing from all existing animals of the group, by having a pair of horns placed side by side on the nasal bones; and a very interesting genus, *Hyracodon* (Leidy), an animal with molar teeth and many other of the characters of rhinoceros, but having no nasal horn, and having a complete set of incisor and canine teeth, as in all the older Perissodactyles, which are lost in the more modern rhinoceros. It is therefore quite a connecting link between the Palæotheroid animals of the Eocene, and the true rhinoceros of the Pliocene, and occupies exactly the right geological horizon that such a form ought to do if the one has been genetically derived from the other.

Hyracodon, therefore, has a high place of interest among many of similar nature which have been revealed by our newly-acquired knowledge of the ancient American fauna. If, however, as is stated, the fifth digit of the fore-foot is only rudimentary, it could scarcely have been, as remarked by Marsh, on the direct line of descent from the four-toed Eocene to the equally four-toed Miocene rhinoceros, though certainly in such a case we know not what ought to be allowed for reversion.

The same period (generally speaking) also produced several species of a more perfect rhinoceros, still hornless, however, and resembling the contemporaneous European *Aceratherium*.

But the most remarkable of the Miocene Perissodactyles, and in some respects the most remarkable of all the animals which the recent explorations have brought to light, are a number of species of gigantic size, to the first known of which Leidy gave the name of *Titanotherium*, and of which other forms have been named by Marsh *Brontotherium*, and by Cope *Symborodon*.

They must, by their great size and strength, grotesque appearance, and general mode of life, have taken the place in the Miocene times of the then extinct *Uintatherium* of the Eocene, and were in their turn replaced by the Mastodons and Elephants of later ages. The rhinoceros of the present day will serve to give the best general idea of the appearance of these creatures, but some of them (for they seem to have been numerous both in species and individuals) approached nearer to the elephant in size and length of limb. The skull (Pl. CXXXVIII. figs. 1 and 2) in its general characters was quite rhinocerotic; but the nasal bones supported a pair of large, laterally divergent, rugged prominences, apparently for

the attachment of horns. The limbs were intermediate in proportions between those of the elephant and rhinoceros; but, as in the latter, the femur has a third trochanter, and a deep pit for the round ligament. The feet were short and stout, but in essential characters agree with the true Perissodactyles, and have four toes in front and three behind.

Numerous species have been described, both by Cope and Marsh, founded chiefly upon the form and direction of the horn cores on the nasal bones: they are all from the Miocene beds east of the Rocky Mountains, in Dakota, Nebraska, Wyoming, and Colorado; and there is no evidence of any of the *Titanotheridæ*, as the family should be called, after the first-characterised genus of the group, having survived to a later geological epoch.

FIG. 1.

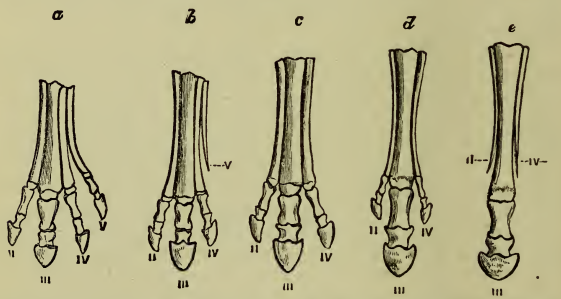


Diagram of several stages of modification of the feet of extinct forms of American horse-like animals (chiefly from Marsh), showing gradual reduction of the outer, and enlargement of the middle toe (III).

a, *Orohippus* (Eocene); *b*, *Mesohippus* (Miocene); *c*, *Miohippus* (Miocene); *d*, *Hipparion* or *Protohippus* (Pliocene); *e*, *Equus* (Pleistocene).

When we pass to the Pliocene and Pleistocene times, the Perissodactyles met with can all be referred to one or other of the three existing families; all the intermediate forms, and all those which have attained a different type of specialisation, as those last named, have completely disappeared.

Remains of several species of *Rhinocerotidæ* were very abundant during the Pliocene period in western North America; they all appear to belong to the hornless type, and from causes unknown became entirely extinct before the Pleistocene age. No rhinoceros exists now on the American continent, nor is there evidence that it ever supported animals belonging to the minor groups of the family to which the existing Indian, Sumatran, or African rhinoceros pertain.

During this period an immense development took place in the various forms of three-toed horses, *Anchippus*, *Protohippus*, *Parahippus*, *Hipparion*, &c., which replaced the *Anchitherium* of the Miocene. These in their turn, through many well-marked gradational forms (a full knowledge of which is among the many interesting results of these explorations), gave way to the true horses, of which remains of several species have been found in Pleistocene deposits, scattered throughout almost every region of the continent from Escholtz Bay in the north to Patagonia in the south. These also became entirely extinct before the discovery of America by the Spaniards—a most remarkable circumstance, considering the fitness of the country for their maintenance, as proved by the facility with which the descendants of horses introduced by European invaders have multiplied in a feral state.

On the other hand, of tapirs, fossil remains have been found most sparingly, though sufficient to show that they had a much wider geographical range northwards in the Pleistocene period than now, and yet several species of this genus still linger in the highlands of Central and South America, the sole direct representatives of the vast and varied Perissodactyle fauna of the continent in ages long gone by.

We may now pass to the remaining great group of hoofed animals, the even-toed or Artiodactyles, represented at present by the pigs, hippotami, camels, chevrotains, deer, antelopes, sheep, and oxen.

The remains of this group in the hitherto explored American Eocenes are very scanty and unsatisfactory as affording indications of its early history and development. Not a single specimen has yet been described which was found in a sufficiently perfect state of preservation to give a tolerably correct idea of its structure and affinities, and no forms corresponding to the well-established European *Anoplotherium*, *Dichodon*, *Xiphodon*, or *Cœnotherium* have been found. Towards the close of the period only (if the age of the Tertiary beds of Utah are rightly determined) do we find indications of well-defined crescentic-toothed or Selenodont species (*Agriochœrus*, Leidy), and also of tubercular-toothed or Bunodont forms (*Elotherium* and *Platygonus*). During the Miocene period, however, Artiodactyles of both these two main divisions abounded. It will be as well to take each group separately, and follow its history throughout, from the Miocene to the present day.

1. The Bunodonts, or those which inclined most to the pigs in dental structure. These were in North America, as in Europe, chiefly represented by animals of the genus *Elotherium*, huge swine-like creatures, some of whom approached the hippopotamus in size, and also by an allied four-toed form, *Pelonax*

(Cope), remarkable for its horn-like bony tubercles projecting out on each side from near the front end of the lower jaw. These became extinct, as in the Old World, before the close of the Miocene epoch.

Animals more like true pigs also existed, but all of the peccary type, the only one which now survives on the American continent. If the evidence of teeth alone can be trusted, this form, like the tapir (and the African *Hyomoschus*), is an unmodified remnant of the old Miocene fauna. But both at that period and in the Pleistocene, peccary-like animals existed in greater variety (as in the genus *Platygonus*), and in wider geographical distribution than at present. It is interesting to note that no remains of true *Sus* or any of its Old World modifications, as the wart hog (*Phacochœrus*), and babirussa, or of any species of hippopotamus, have hitherto been met with on the American continent. And thus the American Bunodont Artiodactyles, instead of undergoing great and diverse modifications, as did the corresponding animals of the Old World, have been gradually dwindling and contracting to the two closely-allied species of peccary (*Dicotyles tajacu* and *D. labiatus*), among the smallest and most insignificant of the whole group.

2. Of the Selenodont or crescentic-toothed Artiodactyles, the former existence in America of the long-extinct Old World genus *Hyopotamus* has been recognised by the discovery of a few teeth in the lowest Miocene of Dakota; and this is remarkable as the only recorded instance of an American form with three cusps on one of the lobes of the upper molars, a very common character among the European Miocene Artiodactyles.

Remains have also been found recently of various small ruminant-like animals, some not larger than a squirrel in size, to which the names *Leptomeryx*, *Hypisodus*, *Hypertragulus*, &c., have been applied. Whether these belonged to the family of Chevrotains or *Tragulidæ* (improperly called pigmy musk-deer), or whether, as appears more probable, they were not rather generalised or ancestral forms of the true Pecora or Ruminants, is difficult to determine from the present evidence.

Perhaps the most interesting of the American Miocene Artiodactyles, on account of their great abundance both in species and individuals, the full information which has been collected as to their structure, and their distinctness from any known forms from any other part of the world, is a family to which Professor Leidy applied the term *Oreodontidæ*. They played the part in the North American Miocene fauna which the deer do now in the same country, the antelopes in Africa, and the sheep in Central Asia. They were in nearly all points of structure intermediate between the ruminants and pigs, and

(with many other Old World forms, however) completely break down the line of demarcation which our knowledge, when limited only to the existing fauna of the world, caused zoologists to draw between those two groups.

They appear to have survived throughout the whole of the Miocene period, commencing in the genus called *Agriochœrus* in the uppermost Eocene, and ending in the *Merychyus* of the early Pliocene; and it is of great interest to know that a gradual modification can be traced in the characters of the animals of the group, corresponding with their chronological position, from the earlier more generalised to the latest comparatively specialised forms, thus affording one of the most complete pieces of evidence that is known in favour of a progressive alteration of form, not only specific, but even of generic importance, through advancing ages.

Another group of great interest made its appearance in the Miocene of North America, and which, if the evidence of fragments can be trusted, did not become extinct, like the last, but, continuing to exist through the Pliocene and Pleistocene ages, is still represented on two distant parts of the earth by the three or four species of llama of South America, and the two species of camel of the Old World. The discovery of the early Miocene *Pöebrotherium* and of the Pliocene *Procamelus* and *Pliauchenia*—remains of which, and of Pleistocene *Auchenia* of great size, though not generically distinguishable from the modern llamas, are abundantly distributed over the North American continent—seem to show that that country was the original home of the singular family of *Camelidæ*, which was probably introduced by emigration in its perfect condition into the Old World, where none of the transitional forms from the more generalised ruminants, like those above mentioned, have been met with.

On the other hand, of the gigantic four-horned *Sivatherium* of the Himalayas, the equally large but hornless *Helladotherium* of the Grecian Miocene, or of the giraffes, no representatives have hitherto been found in America. And very little light has been shed upon the origin and distribution of the true ruminants by these researches, except in a negative manner. No deer have been found in the Miocene (at which epoch they were abundant in Europe); in the Pliocene but a single and poorly developed species; while in the Pleistocene, with the exception of one large species, called *Cervus Americanus*, they scarcely differ from those of the actual fauna. Of the hollow-horned ruminants, several species of bison, of *Ovibos* or musk ox, and a single *Ovis*, have been described, all from the Pleistocene, but not a single species of antelope. From these facts it may safely be inferred that the few existing and Pleistocene

hollow-horned ruminants are immigrants of recent date from other lands; and it is probable that the deer have been similarly derived, though at a somewhat older period, which will account for their being more varied and wider spread in surface distribution, extending down almost to the southern extremity of the continent, while the hollow-horned ruminants are entirely confined to the north.

Scarcely any group to which the term "Order" is applied is so limited in the number of its existing species as that called, from one of the most striking external characteristics of the animals composing it, "*Proboscidea*." The two species of elephant, that of Asia and Africa, the largest and in some respects the strangest of all land animals, are its sole representatives. Between these two animals and all others now existing there is a wide gap in numerous essential structural characters, so that really, in the world as we now see it, they have no near relatives.

But this was not always so. Leaving the existing condition of the earth's surface, and passing back to the last well-marked stage before our own, the Pleistocene period, we find abundant remains of elephants, imbedded in alluvial gravels, or secreted in the recesses of caves, into which they have been washed by streams or floods, or where, in many cases, they have been dragged in as food by hyænas or other predacious inhabitants of these subterranean dens.

We find these remains of elephantine animals extensively distributed over regions of the earth where no such creatures have existed within the memory of man. We find, moreover, that the elephants of the Pleistocene period, judging from their bones, and especially their teeth, do not in most cases exactly correspond in form or size to either of the existing kinds. We certainly find remains undistinguishable from those of the existing African elephant, in the north of Africa and southern parts of Europe; but the majority of these remains not only differ among themselves, but differ more or less from either the African or Indian species, and hence have had many different appellations bestowed upon them, as belonging to what are considered to be different species.

But not only in the Pleistocene period did elephants abound. Animals which must come within any definition which will include both *Elephas Indicus* and *Elephas Africanus* are also found in the European Pliocenes; and even earlier in Asia, the deposits of the Sivalik Hills, belonging to a transition between the Pliocene and Miocene age, are rich with the remains of elephants of varied form, in some cases presenting a considerable departure from our better-known types. Further back in time, however, we search in vain for true elephants. In the Miocene

period, it is true, many kinds of huge Proboscideans roamed over the surface of the earth; but these differ so much from what we now call "elephants," that it becomes necessary to distinguish them by another name; and that of *Mastodon*, first applied by Cuvier, is generally adopted.

Mastodons however were, after all, very like elephants, only being distinguished by some peculiarities of the teeth; and by means of intermediate species the two forms pass so gradually into one another, that it is difficult to say, in the case of some species, with which group they ought most properly to be classed. One other form of animal, which can be referred to the order *Proboscidea*, is known in the Old World—the *Dinotherium*, a huge beast, the nature of which for a long time was very doubtful, having been grouped by some naturalists with the Manatees, by others even with the Marsupials. Its remains have been found, though comparatively rarely, in Miocene deposits in Germany, France, Greece, Asia Minor, and India.

Here our knowledge of the history of the order *Proboscidea*, as derived from palæontological researches in the Old World, ends. The *Dinotherium*, being in its teeth and some other respects slightly less specialised than the other forms, constitutes some kind of an approximation to the Ungulate animals. especially the tapirs; but the gap to be bridged over is very wide; and no remains referable to animals of the order, or any intermediate forms between this and other orders, have been found in Old World Eocene deposits.

Let us now turn to America. Neither at the present time nor within the memory of man have any Proboscidean animals existed within the length and breadth of the whole continent. But at one time—and that, geologically speaking, a very recent one—both true elephants and true mastodons abounded in North America, and the last-mentioned genus extended far into the southern portion of the continent. The elephant, the remains of which are most abundant throughout what are now the United States, differed but very slightly, if at all, from that which at the same period ranged throughout the northern portion of the Old World from the British Isles to Alaska. The commonest species of mastodon (*M. Americanus*, or *Ohioticus*, or *giganteus*) seems to have survived to a much later period than any of its European congeners, and even to have been the last extinct of all the American Proboscideans. Remains of other elephants and mastodons, though not differing in any remarkable degree from well-known European forms, have been found in Pleistocene and (at all events with respect to the last-named genus) in Pliocene deposits; but, as far as the evidence is at present before us, nowhere earlier.

So far, then, we find that elephants and mastodons, of types

quite resembling those found in the Old World, but in less specific variety, appeared on the American continent at a later period than in the Old World (none having been found of undoubted Miocene age), and ultimately became completely extinct before the historic period. No animal corresponding to the *Dinotherium* has been found. We shall hardly, then, be prepared to look for primitive types of the race in earlier American formations.

Among the most remarkable discoveries of the Eocene formations of Wyoming, has been that of a group of animals of huge size, approaching, if not equalling, that of the largest existing elephants, and presenting a combination of characters quite unlike those known among either recent or extinct creatures, and of which there were evidently several species living contemporaneously. Bones of some of these animals were discovered by Professor Marsh and Lieutenant Wann, of the Yale College exploring party, near Sage Creek, Western Wyoming, in September 1870, and described by the former in the following year, though provisionally referred to the genus *Titanotherium*. Other remains were discovered and described by Leidy in 1872, under the generic name of *Uintatherium* (from the Uintah Mountains, near which they were found). Very shortly afterwards other portions of bones and teeth of either the same or closely allied forms were described by Marsh as *Dinoceras*, and by Cope as *Loxolophodon* and *Eobasileus*. Whether these names will ultimately be retained for separate generic modifications, or whether they will have to be merged into the first, it would be premature to attempt to decide upon the evidence before us. Until satisfactory grounds have been shown for considering them to be distinct, it will be best to speak of them all under the name which has the priority.

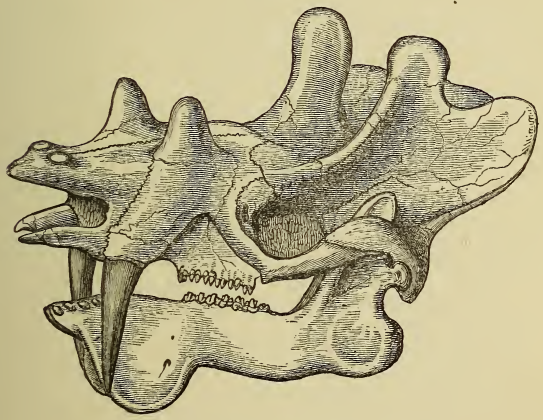
To form some idea of the general appearance of one of these animals, we must imagine a creature very elephant-like in its general proportions, elevated on massive pillar-like limbs, not quite so long, certainly, as those of elephants, but with the femur vertically placed, without third trochanter, and without pit for the round ligament as in those animals, the radius and ulna complete, and crossing, and the feet short, broad, massive, and with five toes on each. At first sight the skeletons of these feet (as figured by Marsh) show an extraordinary resemblance to those of the elephant, and to no other animal (see Pl. CXXXVIII. figs. 4 and 5), especially in the form of the astragalus; but on closer inspection it is seen that in the mode of articulation between the different bones of the carpus and tarsus they really come nearer to the rhinoceros and other Perissodactyles. For example, the upper end of the third metacarpal, instead of joining almost alone to the magnum, as in elephants, is united

by two nearly equal facets to the magnum and unciform, and the astragalus articulates largely with the cuboid, which it does not in the elephants. The presence, however, of five complete and distinct toes to the fore foot, and probably also to the hind foot, is a definite distinguishing character from any known Perissodactyle.

The vertebræ, in their main characters, resemble those of the Proboscideans; though the neck was somewhat longer in proportion. The tail was long and slender.

The head was long and narrow, and in its essential features more resembling that of the rhinoceros than the elephant. It

Fig. 2.



Restored skull of Uintatherium (*Dinoceras*, Marsh).

was elevated behind into a great occipital crest, as in the former, but, unlike that of any other unknown animal, it had developed from its upper surface three pairs of conspicuous laterally diverging protuberances, one pair (the largest) from the parietal region, one on the maxillaries in front of the orbit, and one much smaller than the others, near the fore part of the elongated nasal bones. Whether these were merely covered by bosses of callous skin, as the rounded form and ruggedness of their extremities would seem to indicate, or whether they formed the basis of attachment for horns of still greater extent, either like those of the rhinoceros or the buffalo, must still be a matter of conjecture. Whichever may have been the case, they would have given a very strange aspect to the creature

which possessed them, and have been formidable weapons in encounters either with animals of its own kind, or with the carnivorous beasts whose remains have been found associated with it.

The teeth were no less remarkable than the general formation of the skull. The dental formula was $i\ \frac{0}{3}$, $c\ \frac{1}{1}$, $p\ \frac{3}{3}$, $m\ \frac{3}{3} = 34$. The front teeth, or incisors, were, as in modern ruminants, absent above, and in the lower jaw rather small, directed forwards, and forming a continuous series with the still smaller canine. A large, trenchant, enamel-covered tusk, not unlike that of the musk-deer, or Chinese water-deer (*Hydopotes*), descended from each side of the upper jaw, and lay against a singular flattened expansion of the lower border of the ramus of the lower jaw, which has been conjectured to be for the purpose of protecting them from injury, though no such processes are found necessary in the animals above mentioned with similar tusks; and they recall a like conformation of the *Megatherium*, which can have no such function. They must have effectually prevented any stabbing or penetrating action of these weapons. There is some evidence that the tusks were smaller in the females. The molar teeth were six on each side, above and below, placed in continuous series, and separated from the canines by a considerable interval. They were small for the size of the animal, and of simple structure, each having two more or less transverse crests, though those of the upper jaw diverge externally, and meet at the inner border of the tooth in a V-shaped manner.

The brain (as indicated by the size and form of the cerebral cavity, of which a cast has been made and figured by Professor Marsh) was proportionately smaller than in any other known mammal, recent or fossil, and was almost reptilian in its character. (See Pl. CXXXVIII. fig. 3.) It was actually so diminutive (in Marsh's *Dinoceras mirabile*) that the entire brain could apparently have been drawn through the neural canal of all the presacral vertebræ, certainly through the cervicals and lumbars. It was therefore exceedingly unlike that of modern Proboscideans.

These animals, taking the totality of their organisation into consideration, appear to belong to the great Ungulated group, and to hold a position somewhat intermediate to the Perissodactyles and the Proboscidea, though nearer to the former than was at first supposed. This affinity is still further shown by the discovery of other forms, constituting the genera *Bathmodon* and *Metalophodon* of Cope, from an earlier geological horizon, which, with the general structure of the *Uintatheridæ*, retain, in an extremely interesting manner, many primitive

characters, common to all early Ungulates, especially the complete number of incisor and premolar teeth. These are forms for fuller information upon which we anxiously wait.*

It should be mentioned that Professor Marsh has made of *Uintatherium* and its immediate allies a peculiar order of mammals, to which he has given the name of *Dinocerata*, while Cope, who formerly included them in the Proboscidea, and placed *Bathmodon* with the Perissodactyla, has now ("Syst. Cat. of Vertebrata of the Eocene of New Mexico," 1875) formed an order called *Amblypoda*, of which the *Dinocerata*, containing the genera *Uintatherium* and *Loxolophodon*, is one sub-order, and the *Pantodonta*, containing *Bathmodon* and *Metalopholodon*, the other. Both, however, admit that they hold a position somewhat intermediate between the modern orders of Proboscidea and Perissodactyle Ungulates, and so stand out, as it were, as broken piers of the bridge by which the gulf which now so completely divides these orders might have been passed over.

The negative evidence (which of course must be received with the greatest caution in palæontology) of the absence of the remains of any of these animals in the Miocene or Pliocene deposits of North America, indicates that the race became extinct, at least in that land, though it possibly may have migrated elsewhere, and perhaps in Asia may have laid the foundation of that family, which first appears in the Old World under the more familiar form of the typical Proboscideans.

While, however, it would be the rashest possible assertion to say that these were derived directly from the Eocene Bathmodons and Uintatheriums, it is not too much to look upon the latter as affording us some indications of the steps by which the process might have taken place, and as such their discovery is one of the most interesting that has been revealed by modern palæontological research.

The history of the North American *Carnivora* may next engage our attention. In the actual condition of affairs, this order is tolerably well represented on that continent. The *Procyonidæ*, or raccoon-like animals, are almost peculiar to it; the bears, and their allies the otters, martens, and skunks are numerous. The dogs also are widely distributed and variously modified. The Felidæ, though tolerably abundant, do not attain the same size and strength as in the Old World, and the *Hyænidæ*, *Protelidæ*, *Cryptoproctidæ*, and the great family of *Viverridæ*, the civets and genettes, are entirely wanting.

As the modern tapirs and peccaries, which pursue their peace-

* It has been shown quite recently that *Bathmodon* is the same as *Coryphodon* (Owen) of the European Eocenes.

ful existence in the deep shades of the tropical American forests, frequently become the victims of the ferocious jaguars and pumas, which prowl in search of prey through the rank vegetation of the river banks, or lie in wait concealed amid the luxuriant foliage of the branches overhead, it is only natural to suppose that the countless herds of tapir and swine-like herbivorous animals which lived in a similar manner amid the ancient Eocene swamps and forests of Wyoming and Colorado, were also destined to furnish subsistence to a tribe of rapacious beasts of form and fashion long passed away. Palæontological research amply shows that this was the case. Side by side with the remains of *Hyrachyus*, *Palæosyops*, and the rest, are found bones and teeth of animals of various size and structure, but of undoubted carnivorous habits. Unfortunately at present most of these are known only by fragments, and not a few of the numerous genera recently described are founded on the evidence of a single tooth!

There are some, however, about which our knowledge has, within the last two or three years, been greatly extended, and which have proved to be of very special interest.

Among these are two genera, called by their describer, Professor Cope, *Synoplotherium* and *Mesonyx*, each represented by a single species, *S. lanius* and *M. obtusidens*; the latter the size of a large wolf, the former somewhat larger, both from the Eocene of Wyoming. These, like so many of the animals of the same period of the world's history, present such a combination of characters, that it is impossible to place them in either of the existing families of the order to which they belong, being in some respects bear-like, in others dog-like, and in some being more generalised than are any existing members of the order. For instance, their claws had not that narrow, compressed, curved, and sharp-pointed form seen more or less in all modern carnivores, and in the highest degree in the most typical or specialised members of the group, the cats; but they were nearly flat, straight, and blunt (from whence it has been conjectured that they were adapted for an aquatic life), and two bones of the carpus, the scaphoid and lunar, which in all existing carnivora (even including the seals) are united to form a single bone, were distinct from each other, as in the majority of mammalia. The lower canine teeth were placed very close to the fore part of the jaw, which appears to Professor Cope "a special modification for peculiar habits, which," he says, "I suspect to have been the devouring of the turtles, which so abounded on the land and in the waters of the same period. The slender symphysis could most readily be introduced into the shell, while the lateral pressure of the upper canines with the lower would be well adapted for breaking the bony covering of those reptiles."

In the character of the molar teeth, of which there were a considerable number resembling one another in form, these animals, and many others less perfectly known, resemble the well-known *Hyænodon* of Europe, a lost type of carnivorous animal first found in the Upper Eocenes of Europe, but abundant also in America at an apparently later age. The members of this group of carnivores are all characterised by long and somewhat slender jaws, containing a series of teeth one behind the other, each being in its form a repetition of the one before it, as in many of the existing predaceous marsupial animals. The greater differentiation of the characters of the teeth and the shortening of the jaws, with corresponding increase of the force with which they can be closed, seen in the highest forms of modern carnivores, is one among many examples of progressive adaptations conducing to more complete efficiency in performing the functions of life. These Eocene carnivores also (according to Cope) show a primitive character in the tibio-astragalar articulation, or "ankle-joint." "The astragalus is flat, and the applied surfaces are nearly a plane, and without the pulley-shaped character seen in existing carnivora, as dogs, cats, and, in a less degree, in the bears and in other mammalia with specialised extremities, as *Perissodactyla*, *Artiodactyla*, &c. The simplicity of structure resembles, on the other hand, that found in the opossum and various *Insectivora*, *Rodentia*, and *Quadrumana*, and in the *Proboscidia*, most of which have the generalized type of feet. The structure indicates that the carnivorous genera named were plantigrade—a conclusion which is in conformity with the belief already expressed, that the mammalia of the Eocene exhibit much less marked ordinal distinction than do those of the Miocene or the recent periods. It is, indeed, questionable whether some of the genera here included in the carnivora are not gigantic *Insectivora*, since the tibio-tarsal articulation in many, the separation of the scaphoid and lunar bones in *Synoplotherium*, the form of the molars, and the absence of incisor teeth in some, are all characteristic of the latter rather than the former order."

The Miocene carnivorous animals found associated with the herbivorous Oreodons of Dakota are more perfectly known, many of them having been well worked out and figured some years ago by Leidy. The most remarkable are several species of *Hyænodon*, a genus already mentioned as found in the Upper Eocenes and Lower Miocenes of France, and also of the south of England; but one of the American species (*H. horridus*, Leidy) is larger than any of its European congeners, its skull (which, as Leidy remarks, is not like that of any existing carnivores, but something intermediate between that of a wolf and an opossum) fully equalling that of the largest individual

of the black bear (*Ursus Americanus*); other species were not larger than a fox. These were the last survivors of a group notably different from any now existing.

The remaining American carnivores of the Miocene and more recent ages can be, as far as they are known, referred to one or other of the groups into which the order is now divided. The dog-like forms were abundant throughout the Miocene and Pliocene ages. But in the earliest period more generalised types were met with, assigned to the well-known European genus *Amphicyon*, which differs from the true dogs in the more tuberculated character of its molars, and the presence of the last upper tooth of this class, which is missing in the modern *Canidæ*, and also in the more bear-like structure of its limbs. Various modifications of *Felidæ* were also abundant, the most remarkable in the Miocene period belonging to that group (*Machœrodus* or *Depranodon*), with immensely developed sabre-like upper canine teeth, which flourished throughout such an extensive period of time and in so many parts of the world: in the sub-Himalayan region; in Miocene and Pliocene epochs in various parts of Europe, and almost down to recent times in England, as we know by the teeth found in Kent's Hole; in South America, where remains of its largest and most powerful form (*M. neogœus*) have been found in the caves of Brazil and in the alluvial plains of Buenos Ayres; and again in the Miocene of the North American territories. Why this form, so highly specialised for its mode of life, once apparently the dominating type of the whole order throughout the world, should have entirely disappeared, and given way to the more modestly armed modern tigers and leopards, is not very easy to explain.

From the time of the extinction of the sabre-toothed cats in North America, to the present period, other forms more like those now existing continue to prevail, none, however, equalling in size those of the Old World lion or tiger; but of the other families of the carnivora little has hitherto been found. *Ursidæ* and *Mustelidæ*, except in Pleistocene deposits, are very rare; and, what is more remarkable, remains that can with certainty be referred to the *Procyonidæ*, a group whose head-quarters are in America, have not been met with. The families which were previously mentioned as not now existent in that continent are equally unknown in its extinct fauna.

Perhaps the most conspicuous, both on account of their colossal size and their singular conformation and habits, of the animals inhabiting the American continent in the period immediately preceding the one in which we now live, were the great ground sloths, known to us familiarly by the names of *Megatherium*, *Mylodon*, *Megalonyx*, &c. As these animals are

peculiarly American, it might have been expected that when the earlier formations of the continent on which they flourished were explored, the remains of similar or at least allied forms would have been brought to light. But hitherto this has not been the case.

Two species of a genus (*Morotherium*, Marsh) allied to *Megalonyx* and *Mylodon*, from Pliocene strata in Central California and Idaho, have been described; but it is a most remarkable fact that not a fragment attributed with certainty to an Edentate animal has been found in any Miocene or Eocene deposit on the North American continent, and therefore (if this negative evidence can be trusted) we shall have to look elsewhere (probably to the Southern American continent) for the region which gave birth to these mighty creatures, and to look upon them as but temporary excursionists into the northern portion of the continent during the Pleistocene epoch.

On the other hand, numerous species of the orders *Rodentia*, *Insectivora*, and even *Chiroptera*, and some attributed to the *Marsupialia*, have been found in almost all the hitherto explored fossiliferous deposits down to the Eocenes. Of these time will not suffice to give an account, and this is less important as it is difficult to draw any general conclusions from the fragmentary descriptions of them which we possess at present. I must, however, not omit to call attention to two recently announced discoveries, which, when fully worked out, promise results of considerable interest.

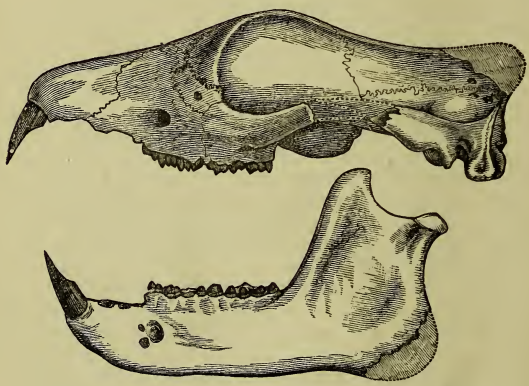
Professor Leidy, in 1868, described a single lower molar tooth from a Tertiary formation, supposed to be Miocene, of Shark River, Monmouth County, New Jersey, apparently of Ungulate affinities, and to which he gave the name of *Anchippodus riparius*. Subsequently a lower jaw of a very anomalous character, from the Bridger Eocene, with large rodent-like perpetually growing incisors, no canines, and bilobed molars, something like those of Palæotherium, was described by the same author under the name of *Trogosus castoridens*; but comparison with the single molar from New Jersey showed so close a resemblance, that the latter name was withdrawn, and both specimens referred to the first described, or *Anchippodus*.

Other similar forms found in a more perfect condition have been described by Professor Marsh, who at a meeting of the Connecticut Academy, Feb. 17, 1875, suggested that as they could be included in no known order of mammals, they should be placed in a new one, for which he proposed the name *Tillodontia*.

"These animals," Professor Marsh observes, "are among the most remarkable yet discovered in American strata, and seem to combine characters of several distinct groups, viz. Carnivores,

Ungulates, and Rodents. In *Tillotherium* (Marsh), the type of the order, the skull has the same general form as in the bears; but in its structure resembles that of the Ungulates. The molar teeth are of the Ungulate type, the canines are small, and in each jaw there is a pair of large scalpriform incisors faced with enamel, and growing from persistent pulps, as in the Rodents. The adult dentition is as follows: incisors, $\frac{2}{2}$; canines, $\frac{1}{1}$; premolars, $\frac{3}{2}$; molars, $\frac{3}{3}$. The articulation of the lower jaw with the skull corresponds to that in Ungulates. The posterior nares open behind the last upper molars. The brain was

Fig. 3.



Skull of Anchippodus (*Tillotherium fodiens*, Marsh), ¼, from Marsh, "Am. Journ. Sci. and Art," 1876, Plate VIII.

small, and somewhat convoluted. The skeleton most resembles that of carnivores, especially the *Ursidæ:* but the scaphoid and lunar bones are not united, and there is a third trochanter on the fermur. The radius and ulna, and the tibia and fibula, are distinct. The feet are plantigrade, and each had five digits, all terminated with long, compressed, and pointed ungual phalanges, somewhat similar to those of the bears. The other genera of this order are less known, but all apparently had the same general characters. There are two distinct families, *Tillotheridæ* (perhaps identical with *Anchippodentidæ*), in which the large incisors grow from persistent pulps, while the molars have roots; and the *Stylinodontidæ*, in which all the teeth are rootless. Some of the animals of this group were as large as a

tapir. With *Hyrax* or the *Toxodontia* they appear to have no near affinities."

The second recently announced discovery to which I alluded is, that a considerable number of fragments of teeth, jaws, and bones from the American Eocenes, the nature of which for some time was an exceedingly difficult problem, really belong to a low form of the great and important order *Primates*, an order embracing the lemurs, various species of monkeys, and culminating in man himself, and which hitherto has not been known with any certainty (except at least by some equally recent discoveries in France) to have existed in the Eocene period. The evidence, however, on which this announcement, made almost simultaneously by Professors Marsh and Cope, rests, is not very fully before the world. Already more than fifteen genera have been named and described, which are assigned to this group, and their characters are said to be those of a low or generalised form of lemur; while some are compared with the true monkeys. Far more rigid comparisons and carefully balanced deductions are required before we can assign their various species to their correct position, and appreciate their bearings upon the generic history of the Primates. In some of the descriptions at present before us lemur and monkey are used as convertible terms, and yet those who have studied these groups most closely are far from being able to pronounce upon the true relationship even of the existing species, and some even doubt whether they ought properly to be associated in the same order. But this is far too large a subject to discuss in all its bearings at the close of a discourse. I can only indicate it as one which may have much light thrown upon it by the researches of American palæontologists.

I can say nothing now of what is being done by the same persons, in the same regions of the world, with regard to other classes of animals than the one I have hitherto been speaking of. But the great and important discoveries of new forms and new links between old forms have not been confined to the mammalia alone. The knowledge of the past history of birds, reptiles, and of fishes, has likewise been greatly enlarged. The very remarkable discovery of Odontornithes, or birds with true teeth and other reptilian characters, has been made. Numbers of new invertebrates, and a whole world of new fossil plants, have been brought to light.

Apart from the special interest of the individual results, some few only of which I have been able to bring under notice on this occasion, the contemplation of what has been done in American palæontology in the last few years teaches us—First, that the living world around us at the present moment bears but an exceedingly small proportion to the whole series of

animal and vegetable forms which have existed in past ages. Secondly, that, notwithstanding all that has been said, and most justly said, of the necessary imperfection of the geological record, we may hope that there is still so much preserved that the study of the course of events which have led up to the present condition of life on the globe, may have a great future before it.—*A Lecture delivered before the Royal Institution, March* 10, 1876.

EXPLANATION OF PLATE CXXXVIII.

FIG. 1. Side view of the cranium of Titanotherium (*Brontotherium ingens*, Marsh).

FIG. 2. Upper view of the same, showing the size and form of the brain.

FIG. 3. Upper view of the cranium of Uintatherium (*Dinoceras*, Marsh), showing the size and form of the brain.

FIG. 4. Fore foot of Uintatherium (*Dinoceras*, Marsh).

FIG. 5. Hind foot of Uintatherium (*Dinoceras*, Marsh).

(All $\frac{1}{10}$ the size of nature. From Marsh's figures.)