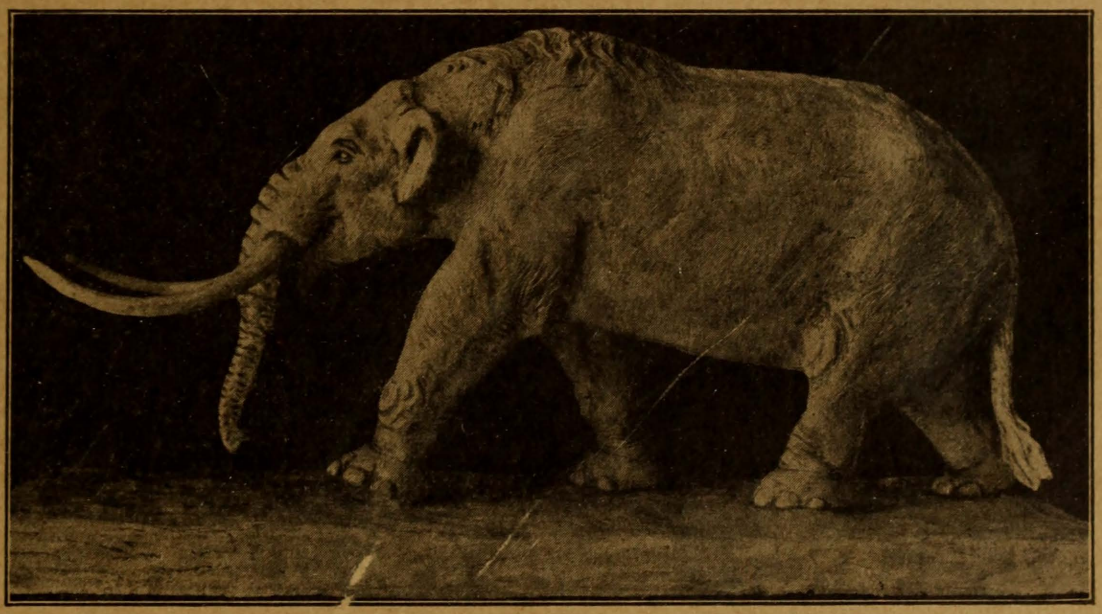
AMERICAN MUSEUM OF NATURAL HISTORY

Mammoths and Mastodons

By

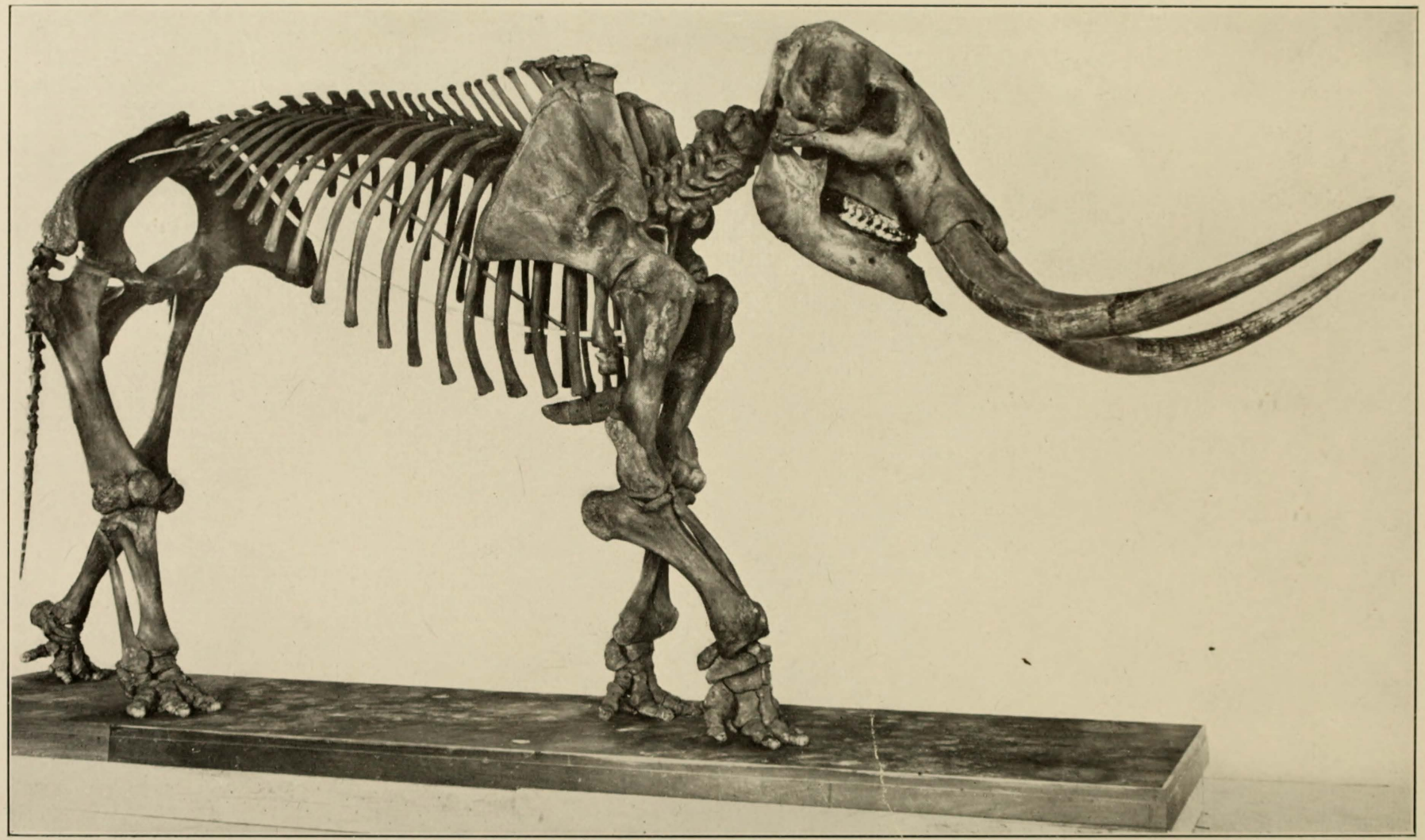
W. D. MATTHEW



THE AMERICAN MASTODON

Model by Charles R. Knight, based upon The Warren Mastodon skeleton in the American Museum of Natural History

No. 43 OF THE GUIDE LEAFLET SERIES.—NOVEMBER, 1915.



After Osborn

THE WARREN MASTODON SKELETON IN THE AMERICAN MUSEUM.

Mammoths and Mastodons

A guide to the collections of fossil proboscideans in the American Museum of Natural History

By W. D. MATTHEW

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I. INTRODUCTORY.

ELEPHANTS now inhabit only the warmer regions of the Old World. The Indian Elephant is native to southeastern Asia, the African Elephant to central Africa. Both are forest and jungle dwellers, avoiding the plains and deserts and unknown in cold or temperate regions.

Mammoths and mastodons, extinct relatives or ancestors of the existing elephants have been found in nearly all parts of the habitable world, except in Australia. During the Pleistocene or Glacial epoch they ranged in the Old World from the Arctic Ocean to South Africa, from Japan in the east to England in the west, and in the New World from Alaska to Patagonia. They were of many different species; some nearly related to the living Indian or African elephant, others more distant cousins. In the Tertiary formations of the Age of Mammals, which preceded the great Ice Age, remains are found in the Old World and in North America of more ancient and primitive kinds, and their evolutionary history has been traced back step by step to an ancestry of primitive mammals of comparatively small size with no trunk and very unlike a modern elephant in both teeth and tusks.

Fossil teeth, tusks and bones of the skeleton are very commonly found in the surface soils, clays and gravels, and especially in peat-bogs or drained lands and in river valleys. On account of their size they have always attracted attention. In olden days they were often attributed to giants,* and it is not unlikely that many of the circumstantial stories and myths of mediæval giants were suggested by discoveries of this sort.

Early in the eighteenth century the discoveries of fossil teeth and bones recognized as belonging to elephants, in France, Italy, Germany and England were currently explained as relics of those brought by Pyrrhus or Hannibal or Julius Cæsar. About the end of the century, however, Cuvier demonstrated to the world not only that these relics were found in many regions never invaded by these warriors of antiquity, but that they belonged to distinct species from those now living. He was not indeed the first to make this discovery; various learned men of his time or earlier had come to the same conclusion, but its general acceptance was largely due to the great influence of Cuvier.

Besides the true elephants of extinct species Cuvier distinguished the mastodons (μαστός=nipple, ὀδούς=tooth) with grinding teeth very different from those of elephants, although much like them in skull and skeleton.

In this country early discoveries of mastodon or elephant bones were also thought to be the remains of giants. Doctor Warren in his memoir

*This is not so absurd as it might seem, for most of the bones of an elephant skeleton are more like human bones, except as to size and massive proportions, than they are to most other large quadrupeds.

on the mastodon quotes an interesting correspondence between the learned Cotton Mather and Governor Dudley of New York, concerning the discovery of such bones on the banks of the Hudson near Newburgh. French explorers on the Ohio discovered great quantities of teeth and bones of mastodons and mammoths at the Great Salt Lick in Kentucky, and elsewhere along the river, and some of these were sent to France and studied by Cuvier and other scientists.

During the last century many fossil skeletons and skulls and innumerable teeth and bones have been found in all parts of the United States, in Alaska, Canada and Mexico and are preserved in various museums throughout the country.

Scientific notices of the fossil remains in America begin about 1750. They are mentioned by Thomas Jefferson in his Notes on Virginia, 1782, and noticed at more or less length by many other less distinguished authors, usually under the name of mammoth or elephant bones. Numerous descriptions and figures of the mastodon appear during the first half of the last century, culminating in the great memoir of John C. Warren 1852. Descriptions and notices of mammoths or other fossil elephants are hardly less numerous in American scientific literature of the last century, but no adequate treatise dealing with them has yet been published, nor is there any general treatise on the fossil proboscideans of the world. The literature is scattered and the subject much confused.

II. THE EXTINCT ELEPHANTS.

Genera, Elephas, Loxodon, Stegodon.

THERE are at least ten or twelve species of extinct elephants known in different parts of the world. Some are nearest to the modern Indian elephant (*Elephas*), others to the African species (*Loxodon*), while others (*Stegodon*) are intermediate between these and the older mastodons. Three species are found in North America, three or more in Europe and northern Asia, the remainder are chiefly known from India and the Mediterranean region. Probably there will be more when the world has been more thoroughly explored.

The Mammoth. The best known of all the extinct proboscideans is the mammoth, *Elephas primigenius*. It was a near relative of the Indian elephant, but adapted to live in cold climates, and covered with a heavy coat of long coarse black hair with thick brown underwool. The most abundant and perfect remains of this animal have been found in Siberia, and it is often called the Siberian mammoth, but it ranged through all the countries of the north—in Europe as far south as Spain and Italy, in North America as far south as North Carolina and California. It was able to endure the most severe cold, for its remains are found in greatest abundance

on the shores of the Arctic Ocean and buried in the frozen tundra of northern Siberia and the gold-bearing gravels of Alaska and northern Canada. Entire carcasses, with flesh and hide preserved more or less completely, have been discovered in Siberia. One such specimen, found by the explorer Adams in 1799 on the banks of the Lena, and another discovered on the Beresofka in 1901, are mounted in the Petrograd museum. Similar remains, only less complete, were found by Quackenbush on Kotzebue Sound, Alaska, and are in this museum. The contents of the stomach show that these animals fed upon the same vegetation, grasses and sedges, birches, alders, poplars, etc., that prevails today in the far north. The deeply frozen soils and gravels in which their remains occur were accumulated by the overflow

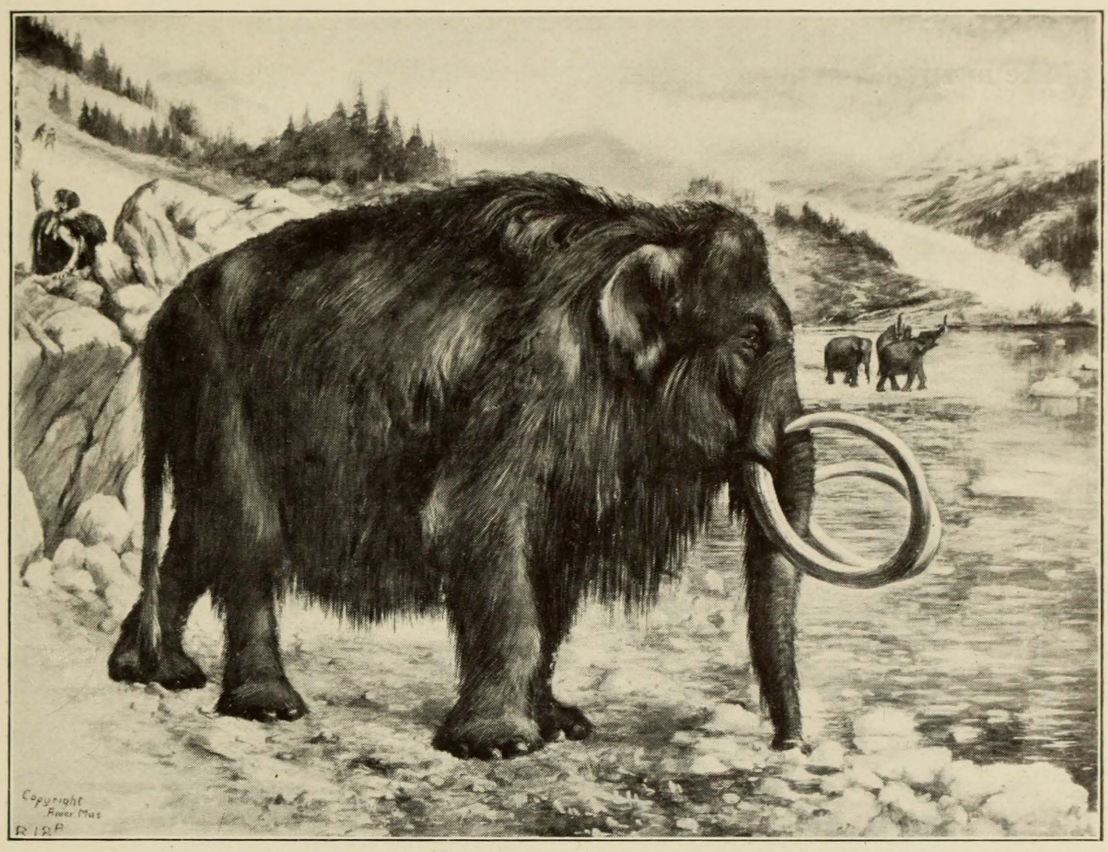

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Fig. 1. Restoration of the Mammoth, *Elephas primigenius*, by Charles R. Knight.

and freezing of river sediments during a long and bitter winter, which the short summer season was not sufficient to melt except on the surface. There is no doubt therefore that the mammoths of Siberia and Alaska lived in an arctic climate. The range of the species southward as far as southern Europe and the United States is directly associated with the advance of the great ice sheets which extended southward from Labrador, Keewatin and the northern Cordilleras, as far as New York and the irregular line of

the great terminal moraine that crosses the northern states. In Europe similar ice sheets extended southward from Scandinavia across Great Britain and Germany and radiated outwards from the Alps, Carpathians and Pyrenees. The mammoths and other northern animals followed the ice sheets southward and ranged beyond their limits in the cooler temperatures that accompanied them.

With the mammoths came also the hardy huntsmen of the north—tall, active and intelligent races of men, whose pursuit was no doubt an important factor in their extinction. In compensation they have left us sketches and rude paintings of the great prehistoric beast, preserved on bone or ivory and on the walls of caverns in southern France and Spain. These sketches, crude and impressionistic as they are, have been of no small assistance in completing and rendering more lifelike the reconstructions of the mammoth made by Mr. Knight under Professor Osborn's direction.

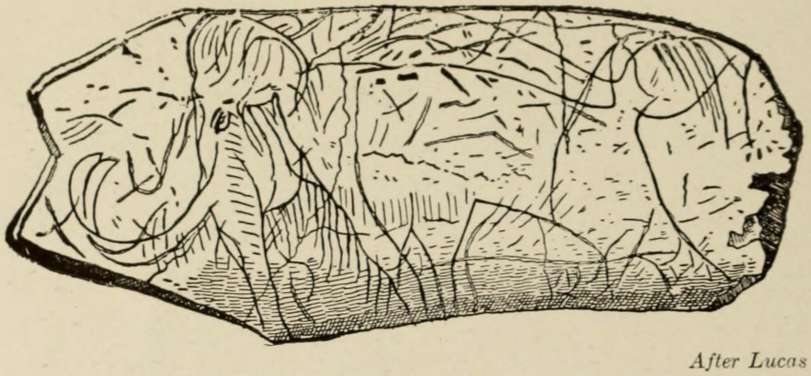

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Fig. 2. Drawing of the mammoth on ivory, by a prehistoric French artist.

A characteristic feature seen in all these drawings is the great boss of wool or hair on top of the head. This was not preserved in either of the two Siberian carcasses, and would not be suspected from the form of the skull. It gives the animal a noticeably different aspect from any previous restoration.

Alaskan mammoths. Gold mining in Alaska and the Klondyke has resulted in the discovery of numerous teeth and bones of the mammoth and a few skulls, but no complete skeleton has yet been recovered. In 1908 Mr. L. S. Quackenbush secured for the Museum considerable parts of a mammoth carcass from the margin of the frozen tundra at Elephant Point, Eschscholtz Bay. There had been much more of the specimen, but most of it had been destroyed and the remainder badly disorganized by erosion and sliding of the face of the bluff in which it was exposed. The tusks and lower jaws, pelvis and hind limb, several vertebrae and numerous fragmentary bones and pieces of skin, masses of hair and wool, flesh and fat were preserved. The principal parts are in the museum's

exhibit.[1] The remarkable freshness of these remains is due to their burial in soil permanently frozen ever since their entombment. They are probably many thousand years old. There is no reason to believe that the mammoth is still living in Alaska or has become extinct within the last few centuries. Various stories have appeared in the magazines and news-

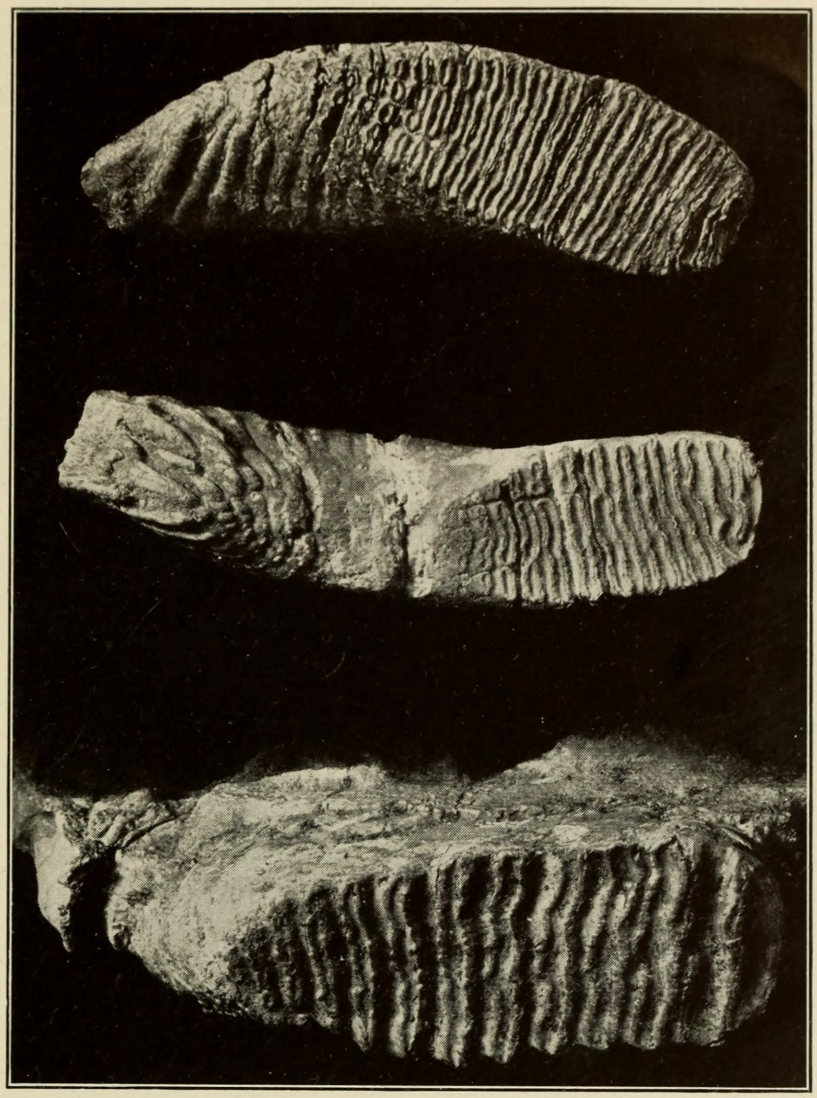

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Fig. 3. Molar teeth of extinct American elephants. Above, the mammoth, *E. primigenius;* middle, Columbian elephant, *E. columbi;* below, Imperial elephant, *E. imperator.* All x ¼.

papers of the survival of the animal in the more remote parts of the territory, and its being seen or even captured by white men. All of them may be set down as purely mythical, and the alleged tradition among

[1]Quackenbush, L. S., 1909, Bull. Amer. Mus. Nat. Hist., vol. xxvi, pp 87-130, pll. xvii-xxv.

the Eskimo of such an animal still existing is probably the result of inquiries by white explorers who provided the natives with the evidence as to appearance and habits of the animal. There is nothing impossible about these stories, but investigation has failed to show any valid evidence for them.

Skeleton of the Mammoth from Indiana. This fine skeleton was discovered on the farm of Dora S. Gift near Jonesboro, Ind., and purchased for the Museum in 1904. The feet and some of the limb bones were missing, otherwise it was fairly complete. The tusks were complete and in position when first found, crossing each other as in the mounted skeleton. This was demonstrated by sounding with an iron rod in the muck in which the skeleton lay buried. Unfortunately they were badly damaged by the finder in an unskilful attempt to get them out. After purchase by the Museum the tusks were repaired and the missing bones modelled in plaster mainly from casts of the fine skeleton of an allied species in the Paris museum, and the skeleton was mounted in 1906. The pose is based upon careful studies of the Indian elephant. The skeleton was at first thought to represent the Columbian elephant, but recent studies by Dr. O. P. Hay led him to conclude that it should be referred to the true mammoth. The restored limb and foot bones are probably somewhat too large and robust.[1]

Size of the Mammoth. It would be natural to suppose that this animal was so called on account of its gigantic size. In fact, however, the derivation of the word is the other way about—the name of the extinct monster has passed into a synonym for hugeness and massive proportions. It is derived originally from the old Tartar designation, *mama 'ntu*, by which the remains found in Central Asia were called when first brought to the knowledge of western nations. The name is said to signify "earth-mouse" and to be connected with Chinese legends concerning the animal which lived underground and perished when it came to the light of day.

The northern mammoth was not in fact any larger than the modern Indian elephant, despite exaggerated notions as to its proportions. It was not as tall nor as bulky as the largest African elephants, nor was it as large as some of the other extinct species of more southerly range. The skeleton mounted in this museum probably represents the maximum size; the Siberian mammoths and those from Alaska are considerably smaller.

The Columbian Elephant, *Elephas columbi* Falconer, is a near relative of the mammoth and the Indian elephant, distinguished by the coarser plates of the teeth, and attaining a somewhat larger size. It inhabited most of the United States and Mexico, its range overlapping on the mammoth to the north and the Imperial elephant to the southwest. It is

[1]Osborn, 1907, Bull. Am. Mus. Nat. Hist., vol xxvii, pp. 255-257.
Hay, 1912, Ann. Rep. Dept. Geol. Nat. Res. Indiana for 1911, pp. 719-722.

finely represented in the American Museum by the large male skull from Whitman Co., Washington, and female skull from Dallas, Texas.

The Imperial Elephant, *Elephas imperator* Leidy, is a still larger species, with decidedly coarser enamel plates in the grinding teeth, and gigantic

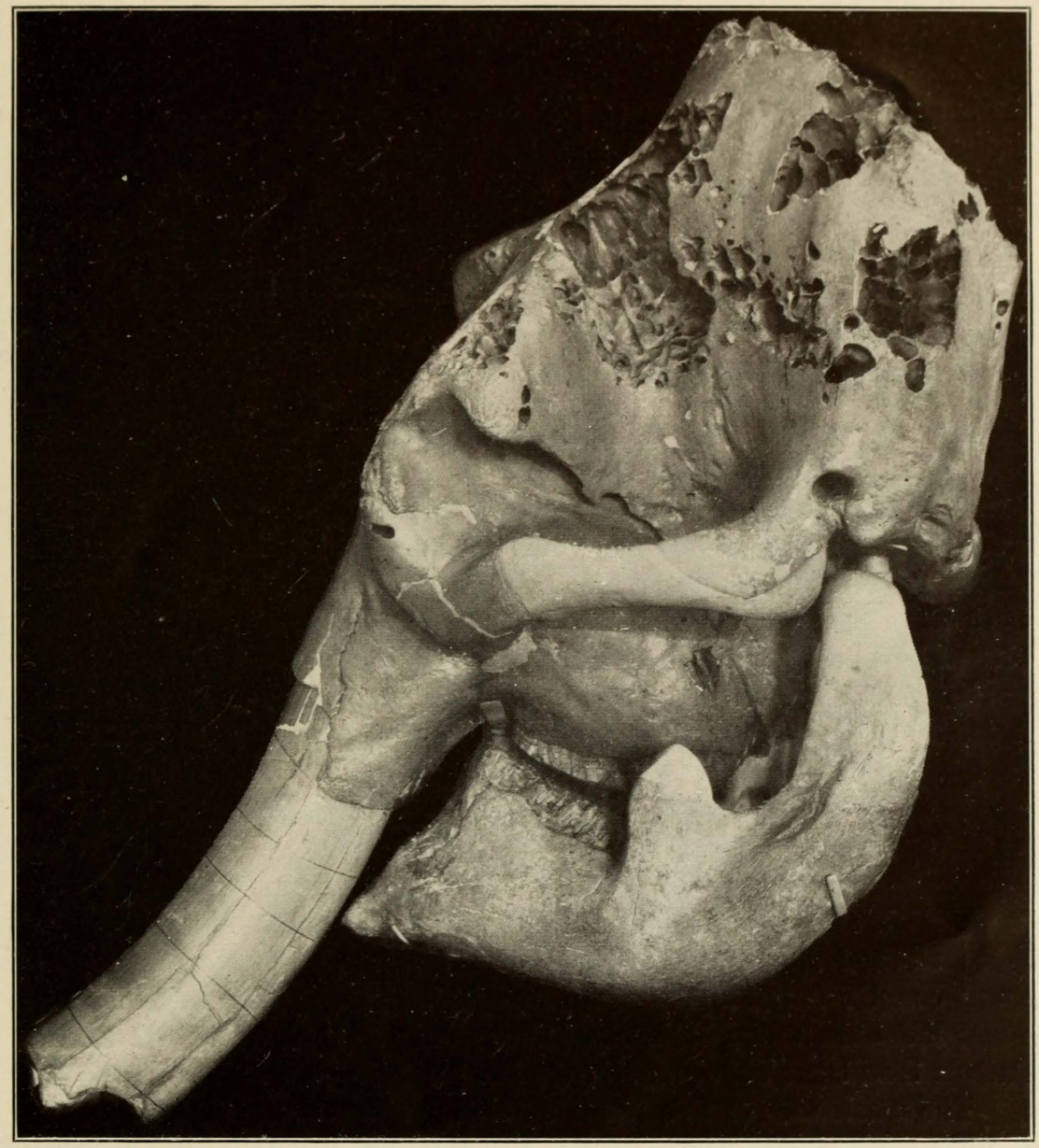

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Fig. 4. Skull and jaws of Columbian elephant (male) from Whitman Co., Washington. About one-tenth natural size.

tusks. It attained a size equal to the largest living African elephants, the height at the back between twelve and thirteen feet, the tusks ten inches in diameter and measuring 13 ft. 6 inches along the outer side of the curve

in a specimen from Victoria, Texas, in the American Museum. This elephant inhabited Mexico and the southwestern portion of the United States in the early Pleistocene, followed apparently by *E. columbi* during the later glacial stages. Jaws and teeth from various localities from Oregon to Guatemala are shown in the wall cases.

Extinct Old World Elephants. In the older Pleistocene of Europe, especially the Mediterranean coasts, two very large elephants are found—the Southern Elephant, *E. meridionalis*, corresponding to the Columbian elephant in this country, and also nearly related to the Indian, and the Ancient Elephant, *E. antiquus*, with affinities to the modern African species. These species ranged over large portions of Europe, southern Asia and Africa. In the islands of the Mediterranean have been found remains of pigmy elephants, dwarfed probably as a result of being isolated on the islands after they were separated from the mainland. Distinct pigmy forms have been described from Malta, Crete and Cyprus.

Pliocene and Pleistocene Elephants of India. *Evolution of Elephants from Mastodons.* Numerous skulls and teeth of fossil elephants have been found in the Siwalik and later formations of India. Besides the more typical species there are several which are intermediate in tooth structure between the elephant and the more ancient mastodons of the Tertiary formations, and are placed in the genus *Stegodon*—*S. latidens*, *S. clifti*, *S. insignis*, with tremendously long tusks little curved, and others. These intermediate stages, found only in southern Asia, indicate that it was in this region of the world that the elephants evolved out of the ancestral mastodon groups.

III. THE AMERICAN MASTODON.

Genus **Mastodon** (=*Mammut*)

NEXT to the mammoth this is the most familiar and best known of all the fossil proboscideans. Indeed, it is much more common in this country than the mammoth, and it has been stated that there are many more mastodon skeletons in museums of the United States and Canada than there are of modern elephants.

The mastodons of this genus were contemporaries of the mammoth, and like them ranged widely over the northerly parts of the world. They equalled or exceeded the largest mammoths in bulk, but were not so tall, the limbs being shorter while the body is broader and more massive.

Teeth of the Mastodon. The tusks are similar to those of the mammoth but the skull and jaws are of different proportions, not nearly so deep and short as those of elephants, and the teeth are of quite different type. They are much smaller and shorter crowned, and instead of the successive

plates of enamel alternating with dentine and cement, the grinding surface shows two, three or four cross crests with intervening valleys and no cement. These teeth are adapted for chopping the food, like those of the tapir. The elephants on the other hand grind the food as does the horse. The teeth of the mastodon are but little different from those of his Tertiary ancestors —Cuvier included them both under the same genus—but what difference there is is a perfecting of the chopping tapir-like type. As in the elephant they are gradually pushed forward in the jaw during wear, and break off at the front of the grinding row when worn down to the base. But there are usually two or three on each side of the jaw in use at one time instead of one or parts of two as in the elephants. A young adult will have three teeth on each side of each jaw—twelve grinders in all; in an old animal these are reduced to two, rarely to one in extreme age.

Habits and Environment. The wide differences in grinding teeth are doubtless correlated with differences in the food and range. The mastodons seem to have been especially abundant in the heavily forested regions

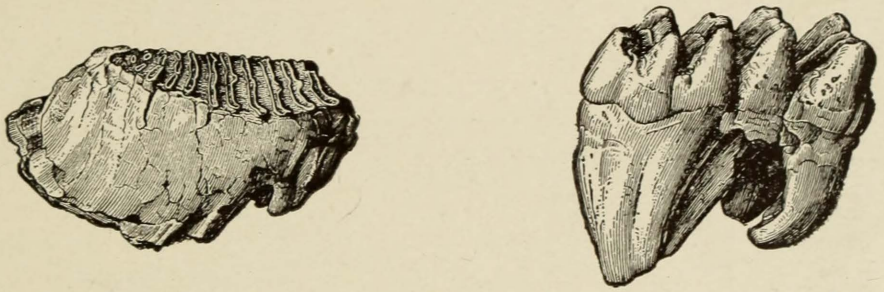

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Fig. 5. Grinding teeth of mastodon and mammoth.

of the north. They are rare in the open tundra regions of Alaska and Siberia and in the plains and deserts of the western states and are most abundant in the heavily wooded sections of the eastern states, as far west as Michigan and Iowa and as far south as the Carolinas.

Their remains have been chiefly found in the course of drainage canals and ditches in the swamps and boggy lands in this part of the country, where no doubt they were mired and so preserved from decay. The boggy valleys southwest from Newburgh, N. Y., and swampy districts in central Indiana, Ohio, Illinois, Michigan and Iowa have yielded many skeletons, skulls and other parts. Nearly all these remains are of post-glacial age, showing that the animal was abundant in this country after the glaciers had retreated. It has not been found in any of the formations older than the Pleistocene. The contents of the stomach have been preserved in two or three skeletons and show that they fed on the twigs of hemlock, spruce and other evergreen trees, but probably they were not restricted to this diet. Remains of the hair of dark golden brown color, long, dense and shaggy, are recorded as preserved with a skeleton found in Ulster Co., N. Y.

The Warren Mastodon. This skeleton is the most perfect one ever discovered; it is a male of very large size. It was found at Newburgh in 1845, on the farm of Nathaniel Brewster, and purchased by Professor John C. Warren of the Harvard Medical School for his private museum. Doctor Warren published a memoir in 1852[1] describing it fully and discussing its habits and affinities, a classic treatise which is still the principal source of scientific knowledge of the American Mastodon. In it he also describes the Shawangunk Head—a finely preserved skull and

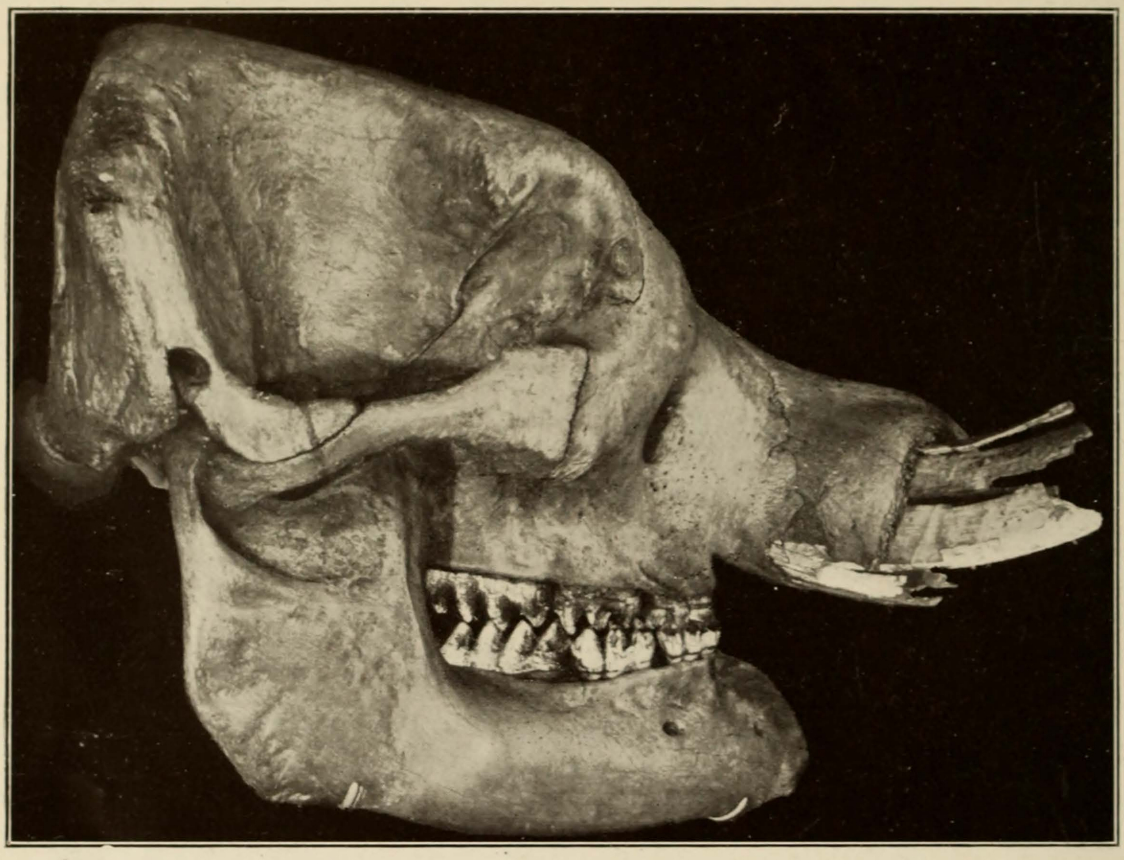

Fig. 6. Skull of the American Mastodon, one-eleventh natural size. This is the well known "Shawangunk skull" found at Scotchtown, Orange Co., N. Y., and figured by Warren in his memoir.

jaws of the largest size found at Scotchtown, Orange County, N. Y. Both these specimens along with the rest of the Warren Collection were purchased for the American Museum by Mr. J. P. Morgan in 1906. The skeleton has been remounted, the original tusks being repaired and set in position in place of the papier-maché models used by Dr. Warren for his mount.

Male and Female Mastodon Skulls. Two skulls from Indiana illustrate the very marked differences between male and female of this species. The male has a much larger skull, the crests at the back higher,

[1]Warren, 1852, The Mastodon Giganteus of North America, pp. i-viii, 1-219, and 28 plates.

the tusk sockets much heavier and longer. The tusks in the male are six to eight inches in diameter and six to eight feet or more in length. The tusks of the female are only three or four inches in diameter and four to six feet in length. The grinding teeth are much alike. There are no tusks in the lower jaw of the female mastodon, but in the adult male there is frequently a pair of small peg-like vestigial tusks, sometimes only one. These fall out in old individuals and the socket closes up; sometimes they are not present in young adult males. Various specimens in the wall case illustrate the presence or absence of lower tusks in the two sexes. Of the two skulls in separate case the larger is the *Ashley skull* found near Ashley, Indiana, in 1909; the smaller is the *Fulton skull* found near Fulton, Indiana, in 1915. A fine palate with tusks, two pair of lower jaws, separate tusks and parts of skeleton were found with the Fulton skull and are shown in the wall case. All belong to females of different ages, the complete skull being the oldest.

Distribution of the Mastodon. The American mastodon ranged all over the United States and Canada, and has been found in Alaska, Siberia and as far east as central Russia (Podolsk). In the wall case are shown specimens from Florida, Georgia and South Carolina illustrating its southern distribution, from Kansas, Texas and southern California, illustrating its western and southwestern occurrence, from Point Barrow, Alaska (collected by Vilhjalmar Stefansson), showing its northern range, casts of teeth from Russia to show its occurrence in the Old World. The closely allied species, *M. borsoni* is recorded from numerous localities in eastern Europe and Siberia.

IV. THE LATER TERTIARY MASTODONS.

Genera **Dibelodon, Rhyncotherium, Tetralophodon, Trilophodon.**

MIOCENE and Pliocene with some survivors in the Pleistocene (Glacial) epoch.

These proboscideans preceded the elephants and great mastodons of the age of man. They are of smaller size and include quite a variety of different types, some of which, in the Old World, are believed to be ancestral to the elephants (through *Stegodon*, see p. 24), while others probably gave rise to the American Mastodon. Most of the Tertiary mastodons, however, are more or less clearly off the direct line of descent, and their exact phylogeny is not yet certainly known. We will point out here only the general relations and distribution of the different types, so far as known.

The Two-tusked Mastodon.

Genus Dibelodon (=*Stegomastodon*). Pliocene of North America,

with a few survivors in the Pleistocene. Chiefly Pleistocene in South America, with a few precursors in late Pliocene.

Upper tusks large, up-curved or straight, with or without enamel band. Lower tusks vestigial or absent (usually absent). Cheek teeth short-crowned, the anterior molars falling out early in life, so that the young adult retains two and old individuals only one molar. The second molar has three cross crests, the last five to eight. The crests are not clearly defined as in the American Mastodon, but composed of a pair of conical cusps with a number of smaller cusps interposed, arranged in a trefoil pattern, so that the valleys between the crests are blocked in the middle instead of running clear across as in the later form. This is the primitive form among the mastodons, and appears in most of the Tertiary types with variations in the number and arrangement of the minor cusps, grouped customarily into the "single trefoil" and "double trefoil" type.

This genus therefore is a derivative of the primitive mastodon type (*Trilophodon*) of the Miocene, paralleling the elephant phylum in (1) loss of lower tusks and shortening of the jaw, (2) increase in size of the upper tusks with tendency to upward curvature and loss of enamel band, (3) reduction in the number of functional teeth, the last molar becoming the principal grinder.

The typical form is *D. mirificus* Leidy, the characteristic species of the Pliocene of North America, well represented by the fine skull and jaws and several other specimens from the Blanco formation of Texas, showing different stages of wear in the teeth. All the South American mastodons belong to this genus. They are chiefly from the Pleistocene formations ranging from Columbia to Argentina, but some may be as old as the late Pliocene.

The Long-jawed Mastodon Tetralophodon. This group of Tertiary mastodons is notable for the great elongation of the jaws in some species. The powerful upper and lower tusks are but little curved and directed forward. The enamel bands are preserved on both. The species are readily distinguished by the second molar which has four crests instead of three; otherwise the grinding teeth are much like those of *Dibelodon* but the anterior molars retained longer in use. It is characteristic of the Upper Miocene and early Pliocene of Europe, Asia and North America. The typical forms are *T. longirostris* and *arvernensis*, of Europe, and in this country *T. campester*, of which the type is shown in the wall case. In *T. arvernensis* the jaw is comparatively short with small lower tusks. Casts of jaws of the European species are exhibited in the wall case.

The Beaked Mastodon Rhyncotherium. In this genus the upper tusks are also stout, little curved and with enamel bands, but the

jaw is rather short, and the lower tusks and their sockets turned down at a sharp angle to the plane of the grinding teeth. It is a rare form, and the only representatives that we have found are from the Pliocene of Texas and Pleistocene of Mexico.

The Primitive Four-tusked Mastodons. Genus **Trilophodon** (= *Gomphotherium*). This group includes a large number of species from the Miocene of Europe, Asia, Africa and North America, representing the ancestral stock of the various later types of mastodons and probably of elephants. The typical form is *T. angustidens* Cuvier of Europe, a species with exceptionally long lower jaws and tusks. In this country it is admir-

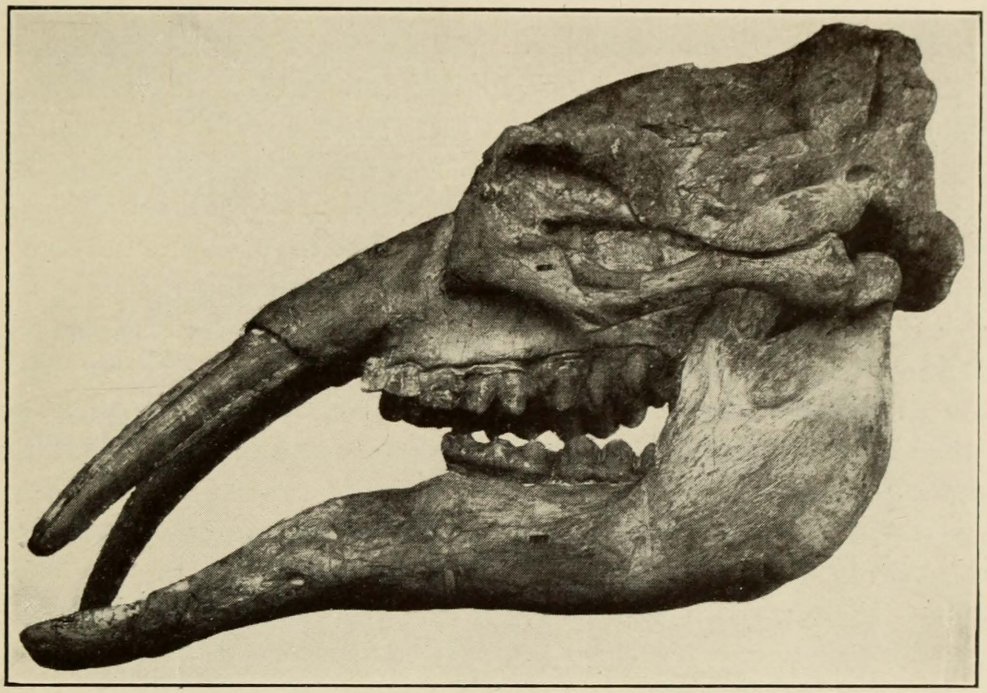

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Fig. 7. Skull of Primitive Mastodon, *Trilophodon productus* from Miocene of Texas. One-tenth natural size.

ably represented by *T. productus* Cope. The upper tusks are straight or slightly down-curved, the lower tusks well-developed, and both carry a strip of enamel. Two or three grinders are normally in use at once, and the second true molars have three cross crests. In one group (*Bunolophodon*) the cross crests are strongly trefoiled; in another (*Zygolophodon*) they are more ridged, the valleys less obstructed, approaching the American Mastodon in type. Different species in the first group approach more or less to *Dibelodon*, *Tetralophodon* and *Rhyncotherium* in the characters of the grinding teeth.

Although chiefly from the Miocene, there are several imperfectly known Pliocene or even Pleistocene species referred to it. These represent

survivals. The perfect skull and jaws of *T. productus* in the end case illustrates the primitive features of these Miocene mastodons.

The oldest mastodons from this country are from the Middle Miocene (*Merychippus zone*), and are too fragmentary to base any important conclusions upon their characters. They are shown in the wall case. *T. euhypodon* of the Upper Miocene and early Pliocene is well illustrated by the type specimen. *T. serridens* (very close to *T. turicensis* of Europe) of the Upper Miocene and *T. brevidens* of the Middle Miocene represent the *Zygolophodont* group, approaching the American Mastodon.

Dinotherium. This extinct proboscidean is found only in the Miocene and Pliocene of the Old World, and is very different from the contemporary mastodons. The cheek teeth have but two cross crests, except for the first molar which has three. The tooth row in the adult has five or six teeth, the premolars being retained while the true molars come into use. There are no upper tusks, and the *lower tusks* are large, stout, and *curve downward* to a right angle with the tooth-row. The skull has the general form of the later mastodons, and the animal undoubtedly had a long and heavy trunk. The body and limbs were proportioned much as in the American Mastodon. *Dinotherium* is chiefly found in the Miocene formations of Europe. A gigantic skeleton discovered in the Pliocene of Roumania exceeds the largest American mastodons in size. Smaller species are also found in Algeria and Tunis, in British East Africa, and in India. It is unknown in the New World.

Casts of palate, jaws, teeth and forefoot of different species of *Dinotherium*, chiefly from the Warren Collection, are shown in the Museum exhibit.

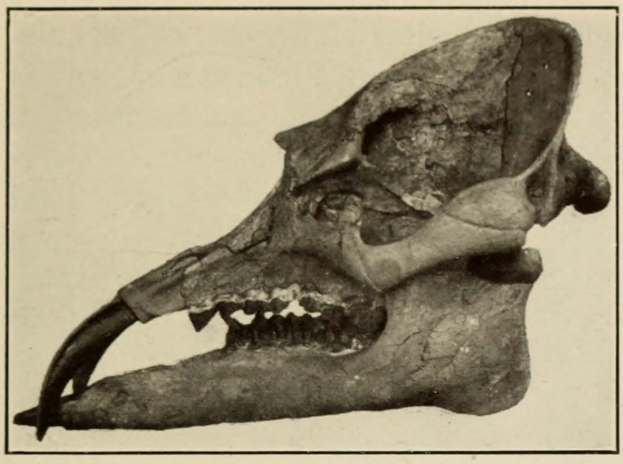
V. THE EARLY TERTIARY ANCESTORS OF THE MASTODONS.

Genera Palæomastodon, Mœritherium.

PALÆOMASTODON is chiefly known from the Lower Oligocene of the Fayûm district in Egypt but fragmentary remains have been recently found in the Gaj horizon of northern India, the lowest fossiliferous level of the great series of the Siwalik Hills. Its discovery and description are due to C. W. Andrews of the British Museum. It is unquestionably a primitive proboscidean, much smaller and more generalized than the earliest mastodons but showing clearly the especial characteristics of the order.

The upper tusks are small, down-curved, with enamel over the whole outer surface. The lower tusks are small, spatulate, and both upper and lower tusks have definite roots instead of growing from persistent pulps as do those of all later proboscideans.

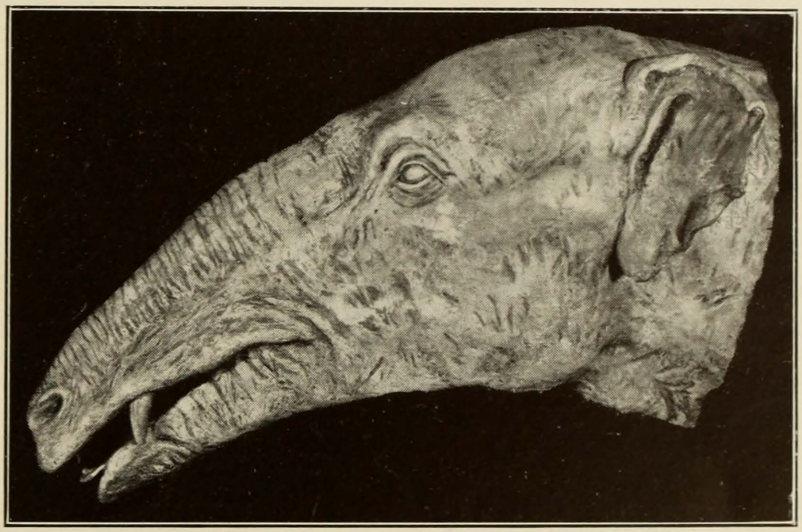
There are five or six grinding teeth on each side of the jaw, twenty to twenty-four in all. The anterior premolars are simple crested teeth of a type very much like those of other primitive ungulates. The molars and last premolar have three cross crests; the third molar has also a crested heel.



After Osborn

Fig. 8. Skull of Palæomastodon, Lower Oligocene ancestor of the mastodons and elephants. One-tenth natural size. Fayûm district, Egypt.

The skull although primitive has the characters of proboscideans in the depression of the grinding series much below the level of the base of the cranium, the position of the openings for the nostril (anterior nares), set far backward and but little in front of the eye-orbits, the nasal bones much reduced and the entire construction of the face adapted for the accommodation of a trunk which, while evidently much less developed than in the modern elephants or the mastodons, must have reached a considerable length. The cranium is built out above the brain-case with cellular bony tissue to a considerable extent, but much less than in the later proboscideans.

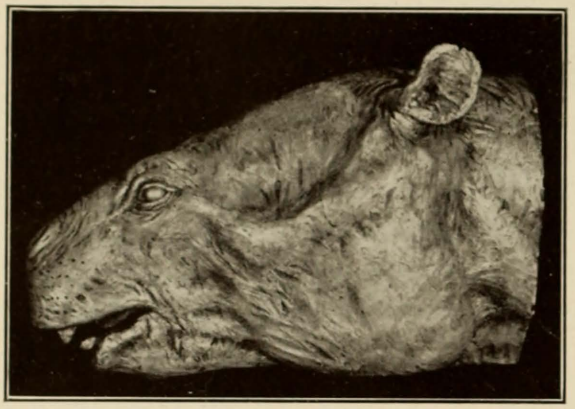


After Osborn

Fig. 9. Head of Palæomastodon modelled by E. Christman under direction of Professor Osborn. One-tenth natural size.

Skulls of *Palæomastodon*, and also of the more problematic genus *Mœritherium* are shown in the end case. Below them are palatal views of the jaws and teeth of the same genera, and above are the carefully studied life-size reconstructions of the heads of the two genera, modelled directly upon the fossil skulls by Mr. Erwin Christman under direction of Professor Osborn.

Mœritherium is likewise from the Fayûm district, where it accompanies *Palæomastodon* in the Lower Oligocene, but is also found in the older beds of late Eocene age beneath this horizon. It has therefore been regarded as representing the later Eocene ancestor of the proboscideans. Its proboscidean characters, however, are by no means so clearly shown, and its ancestral position is open to serious question.



After Osborn

Fig. 10. Head of *Mœritherium*, modelled by E. Christman under direction of Professor Osborn. One-tenth natural size.

The skull is quite unlike any proboscidean type, having a long middle region and rather short face, with no suggestion of any trunk. There is a full set of upper incisors and two pair of lower incisors, but the second upper and lower incisor are enlarged into stout short tusks, the upper projecting downward, the lower forward and upward. The cheek teeth are six in each jaw, the three premolars of a simple primitive-ungulate type, the true molars each with two pair of rounded cusps, imperfectly united into cross crests, the third lower molar with a distinct heel.

Dr. Andrews cites[1] the following characters in support of the proboscidean affinities of *Mœritherium*.

1. The large size of the nasal opening, its somewhat backward situation and the small size of the nasal bones.

2. The commencement of the development of air-cells in the bones of the back of the skull.

3. The enlargement of the second incisors in both jaws to form tusks.

4. The transversely ridged character of the molars.

5. The spout-like anterior portion of the lower jaw.

[1] Andrews, 1908, Guide to the Elephants Recent and Fossil. British Museum, London.

Against this view it has been pointed out[2] that none of these specializations are carried in *Mœritherium* to a degree that would serve to place it conclusively or definitely as proboscidean. All of them may readily be matched in various other living or extinct mammals which certainly have no proboscidean affinities. *Mœritherium*, although supposed to be the immediate ancestor of *Palæomastodon*, differs from it more widely than it does from the Miocene mastodons, separated by a much wider gap in time. And some of the differences appear to be not primitive characters but divergent specializations from the primitive ungulate type.

VI. THE EVOLUTION OF THE PROBOSCIDEA.

IN the preceding sections we have sketched briefly what is known about fossil elephants and mastodons, and their ancestors in the Tertiary period. The principal types are shown in the American Museum exhibit.

These fossil skulls and skeletons carry the ancestry of the proboscideans as far back in geological history as the Eocene. Although we do not regard *Mœritherium* as a direct ancestor of *Palæomastodon*, it represents in many respects the primitive type of ungulate from which the proboscideans were derived.

Mœritherium is an animal of quite moderate size; it has no indications of a trunk; the head is long and low, the brain-case small with little or nothing of the cellular bony cover that builds up the later proboscidean skull into so remarkable a bulk. The teeth have departed relatively little from the primitive type common to all early mammals, of three incisors, a canine, four premolars and three molars in each jaw—44 teeth altogether. A pair of upper and lower incisors have been enlarged, the third lower incisor lost, and each molar has two pairs of cusps on the crown, not yet fully united into cross crests. The posterior premolars have taken on in part the character of the molars. Little is known of the skeleton save that the limbs were of moderate length, the knee much more bent than in the later proboscideans.

Palæomastodon is clearly of proboscidean type, and there is a wide structural gap between it and *Mœritherium*. The enlarged pair of incisors are much elongated and the enamel confined to the outer face. The long forward reach and moderate downward curvature of the upper incisors, the great length of the front of the jaw and close set lower incisors, pro-

[2] Osborn, 1909, Nature, Vol. lxxxi, p. 139. The problem of the affinities of Mœritherum is here discussed at some length.

Professor Osborn concludes that: "It would not be far from the truth to say, from our present knowledge of the animal, that Mœritherium is an offshoot of the Proboscideo-Sirenian stock, with *slightly* nearer kinship to the elephants than to the Sirenians." See also Dr. Andrews' reply to the above (ibid., p. 305), concluding as follows: "On the whole it seems that the weight of evidence is in favor of regarding Mœritherium as a proboscidean, though perhaps not on the direct line of ancestry of Palæomastodon, and retaining some characters of the original Proboscideo-Sirenian stock."

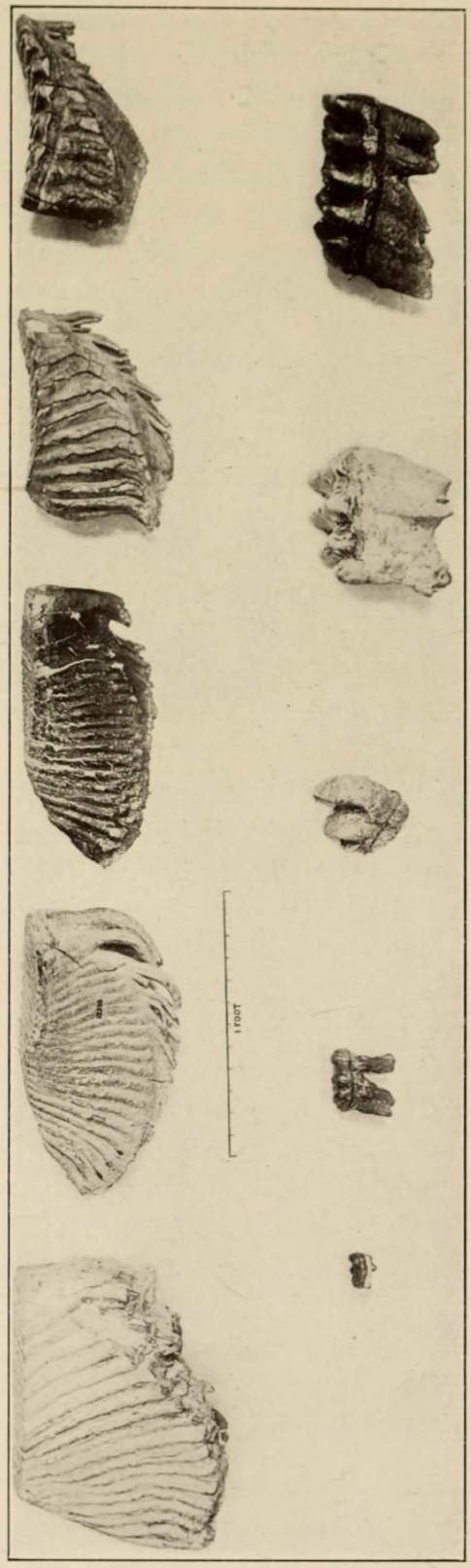


Fig. 11. Molar Teeth of Proboscidea. Above, elephants, living and extinct:—from left to right Imperial and Columbian elephants, Mammoth, Indian and African elephants. Below, mastodons and primitive types:—from left to right *Mæritherium*, *Palæomastodon*, *Dinotherium*, *Trilophodon*, *Mastodon*.

jecting forward and slightly downward are characteristically like the most primitive of the Miocene mastodons (compare *M. productus*). Three of the four premolars are still retained in the adult, but the construction of the molars, with their three cross crests, is unmistakably a near approach to the early mastodons. The skull is no less clearly that of a primitive proboscidean, in the depression of the palate and grinding teeth far below the level of the base of the cranium, the withdrawal of the anterior nares (opening for the nostril) to accommodate a flexible upper lip lengthened out undoubtedly into a trunk of considerable length, and various other particulars. It is obviously widely different from *Mœritherium*. The skeleton is only partly known, but is more clearly of proboscidean type, with short rounded five-toed feet, rather long and nearly straight limbs, short neck and deep compact body. The heavy foot-pads seem to have been much less developed than in the elephant, the heel much more primitive and resting nearly on the ground.

Dinotherium of the European Miocene, a contemporary of the Mastodons is an aberrant side branch of obscure ancestry. It can hardly be a descendant of *Palæomastodon*, since the molars (except $m\frac{1}{1}$) are decidedly simpler having only two crests, and the premolars are likewise of simpler construction. The grinding teeth indeed are more readily derived from those of *Mœritherium*. The skull, however, is highly specialized for a large and long trunk, no upper tusks are known, while the lower tusks are very large, long and stout, curving downwards to a right angle with the grinding teeth. The skeleton is thoroughly proboscidean in type, with long limbs and elephantine feet and the latest species *D. gigantissimum* reached a size fully equal to the largest of the elephants. Remains of *Dinotherium* have been found in the Miocene of India and Baluchistan and of central Africa, as well as in Europe and northern Africa, but its exact affinities and place of origin remain as yet unknown.

Trilophodon. The next stage in the ancestry of the mastodons and elephants is well shown in the fine *Trilophodon productus* skull. Although of a somewhat later age this species retains little changed the characters of the earliest known mastodons of the Lower Miocene of Europe, Asia and northern Africa. There is a very considerable gap between them and *Palæomastodon*, representing the evolution of the race during the whole of the Oligocene epoch. They are very much larger animals. The tusks are greatly lengthened, and rootless, growing from persistent pulps. The enamel is reduced to a rather narrow strip. The posterior grinding teeth are progressively enlarged, the anterior ones lost, falling out early in life. The cranium is built up into a great bulk by the cellular bony covering over the brain-case.

Tetralophodon, Dibelodon, etc. The numerous remains of mastodons in the Miocene and Pliocene of Europe, Asia and North America show a progressive divergence into several distinct types. In one series the elongation of the jaw, already great in *Palæomastodon*, is carried to an extreme, culminating in such types as *Tetralophodon campester* and *longirostris*. The intermediate molars have four crests, the last molar up to eight, but the cresting remains imperfect and the cross valleys are blocked. This is the *Tetralophodon* group of the late Miocene and early Pliocene of Europe, Asia and North America. In a second group, chiefly found in the New World, the upper tusks are enlarged and often curve upward; the band of enamel on their outer surface is sometimes retained but more often disappears completely. The lower tusks are lost, the jaw shortened, the posterior grinding teeth progressively enlarged, while the anterior ones are early lost. The teeth remain short-crowned although a small amount of cement is often present in the valleys. This is *Dibelodon*, common in the North American Pliocene and South American Pleistocene. All the Mastodons of South America belong in this group. In a third group *Rhyncotherium* the front of the lower jaw is bent downward at a sharp angle, the lower tusks large and straight. Little is known of this group, found only in Mexico and Texas.

Mastodon. A fourth group leads up into the great American Mastodon. In it the jaw is shortened, the lower tusks become vestigial, the cross crests of the molar teeth are perfected into a chopping tapir-like type. The upper tusks are large, curve upward with a spiral twist as in the elephants and have no enamel. Early stages are seen in *Trilophodon turicensis* of Europe, *T. brevidens* of Montana and *T. serridens* of Texas, of Miocene age; *M. borsoni* of the Pliocene and Pleistocene of Europe and *M. americanus* of the northern Pleistocene represent its culmination.

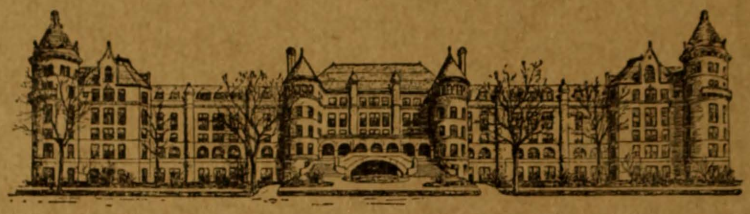
Stegodon, Elephas. The fifth and most important group leads up through the various species of *Stegodon* of the Pliocene of India into the elephants. In this group the jaw is greatly shortened, the lower tusks completely disappear and the upper tusks as in the American Mastodon are enlarged and curve upward. The posterior grinding teeth are progressively enlarged while the anterior ones are early lost. The crests of the molar crowns become progressively higher, narrower and more numerous, while the valleys are filled with cement, so that during wear the grinding surface presents cross ridges of enamel alternating with softer dentine and cement. The skull is greatly shortened, the trunk lengthened, the cranium built out with cellular bone, reaching finally the extreme specialization seen in the Pleistocene and modern elephants. The length of the limbs is also much increased, coördinately with the length of trunk.

The maximum of size is reached in the early Pleistocene elephants of Europe and North America—*E. antiquus*, *E. meridionalis*, *E. imperator*. But the mammoth shows the extreme of specialization in the grinding teeth, the enamel crests more numerous and closer set than any other species.

Origin and Dispersal of the Proboscidea. The fact that the oldest and most primitive remains of ancestral proboscideans have been found in Egypt has been commonly taken as proof that the original home of the order was in Africa. This may or may not be true. The absence of any ancestral proboscideans from the early Tertiary faunas of Europe and of the New World affords indeed reasonably conclusive evidence that they did not originate in those regions, and more indirect but fairly good evidence that they did not originate in the intervening regions of northern and central Asia from which a large part of their Tertiary faunas seems to have been derived. But of the early Tertiary faunas of southern Asia and of Africa we know nothing at all, save for the Fayûm faunas of northern Egypt, an area which is today transitional in its fauna between the two great regions, and decidedly more Asiatic than African in its affinities. While it is wholly probable that certain elements of the Fayûm fauna represent groups of early African origin, others are clearly of Asiatic affinities. It is not yet clear whether the Proboscidea are a group of Ethiopian or of Oriental origin. The choice is practically limited to these two regions.

The later evolution of the mastodons into the elephants appears to have taken place in the Oriental region, since intermediate stages are absent from the later Tertiary faunas of all the other regions, and a full series is found in India. But with the oncoming of the Glacial cold, the dispersal centre seems to have shifted to the north, for we find both in Europe and North America the highly specialized mammoth and mastodon spreading outwards from the north, and replacing other species more gigantic in size but less specialized in teeth. Today we find the African elephant, huge but somewhat primitive, surviving in a somewhat isolated tropical continent, and the Indian elephant, more progressive in its teeth but less so than the mammoth, surviving in tropical Asia, while the last step in specialization, the northern mammoth, after overrunning three continents in the later Pleistocene, has been completely swept away, following his predecessors in the northern countries to extinction. That the same fate awaits the African and Indian elephant, save as they may be preserved artificially in parks or by domestication, can hardly be doubted. Man has witnessed or aided in the extinction, during the short time that he has occupied the globe, of many magnificent types of the larger quadrupeds—but none so gigantic in size or so remarkable for peculiarities of structure and habits as are the great Proboscidea. That we have been able through the researches of science to preserve and reconstruct the

remains and restore the form and habitat not only of those extinct species known to our prehistoric ancestors, but of their ancestors and predecessors of older geologic epochs, and to trace the history and evolution of the race, may be some palliation for the widespread destruction and extinction of the greater quadrupeds that has accompanied the development of civilization.



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