# TRANSACTIONS OF THE WAGNER FREE INSTITUTE OF SCIENCE

OF

PHILADELPHIA

VOL. IV.



JANUARY, 1896

WAGNER FREE INSTITUTE OF SCIENCE
MONTGOMERY AVE. AND SEVENTEENTH ST.
PHILADELPHIA

# FOSSIL VERTEBRATES

FROM THE

# ALACHUA CLAYS

OF

# FLORIDA

BY JOSEPH LEIDY, M.D., LL.D.

EDITED BY FREDERIC A. LUCAS

# INTRODUCTION

IN 1884 the then Secretary of the Smithsonian Institution, Professor S. F. Baird, submitted to the author for examination a small collection of fossil bones, which had been received from Dr. John C. Neal, of Archer, Alachua County, Florida, and had been discovered in his vicinity in the adjoining county. Correspondence on the subject was opened with Dr. Neal, who, with the desired information, sent to the author some additional specimens. The fossils proving to be of great interest, on directing the attention of the Director of the U. S. Geological Survey, Major J. W. Powell, to their discovery, he authorized an examination of the locality whence they were obtained. With this object in view Mr. William H. Dall and Mr. L. C. Johnson, officers of the Survey, in succession visited the place and procured considerable collections of fossils, which were directly sent to the author for investigation.

The fossils were obtained from clay-beds, mostly on the plantation of J. M. Mixon, in Levy County, ten miles south of Archer; while others were derived from Hallowell's place, ten miles north of Archer. Brief notices of the fossils have been given from time to time in the "Proceedings of the Academy of Natural Sciences of Philadelphia," 1884, 118; 1885, 32; 1886, 11; 1887, 309. Most recently Professor Marsh directed his ablest assistant, Mr. J. B. Hatcher, to visit the locality, where, at Mixon's plantation, he made an additional collection, which was likewise sent to the author for investigation.

The collection of fossils for the most part received on these occasions in 1885, 1887, and 1890, amounts in bulk to about the contents of half a dozen barrels. They consist of isolated bones and teeth, with numerous fragments of others indiscriminately mingled together. Mr. Dall remarks that the bones are found usually mixed without order, but adds that parts of one skeleton have several times been found in nearly their natural positions in relation to one another. In collecting the fossils at Mixon's plantation, Mr. Johnson states that trenches were cut in the bone-lead down to the bottom rock to a depth of from two and a half to six feet. The bones were found thickly distributed from the surface to the bottom, but without order. Mr. Hatcher says,

in a letter accompanying the last collection from the same locality, "the bones are very much broken up; there are ten thousand fragments to one good bone. They appear to have been transported by water, as no two were found in position."

The fossils are chiefly the bones and teeth of a species of Rhinoceros, and of a Mastodon different from the ordinary species whose remains are so frequently found throughout the country of the United States. Others pertain to three species of Llama, all larger than the living forms of South America, and one of them greatly exceeding the existing Camels. A few belong to another species of Rhinoceros, to two species of the equine genus Hippotherium, to a Tapir, a Mastodon, and a Megatherium. Among the remains are none of Carnivora; nor are there any of small animals, except the bones and teeth of a small Crocodile or Alligator, fragments of the shell of an Emys, and scales of a Gar-fish, with several bones of a Teleost. Among the bones those of the limbs greatly predominate, especially the smaller ones of the feet, which, with the crowns of teeth, are usually the best preserved specimens. Thus, as examples, independent of broken and young bones with separated epiphyses, of mature ones of the feet of the Rhinoceros, there are ninety-four entire metapodials, thirty astragali, thirteen carpal scaphoids, and seven cuboids, besides numerous specimens of the others. Of the largest species of Llama there are nine astragali and as many patellæ. There are no considerable portions of skulls preserved and only small fragments of mandibles. The fossils generally, fragments or entire specimens, of bones and teeth, usually the crowns alone of the latter, are well preserved, not fissured or mutilated, neither eroded nor water-worn or rolled. Further among the specimens there are none that appear gnawed or conspicuously exhibit the marks of the teeth of Carnivora.

Notwithstanding the confusion in which the fossils were found, the collocation of many bones and teeth, often from opposite sides of the body, and their condition of preservation, would indicate that the animals in many cases underwent dissolution on the spot. Certain specimens seem to indicate that the fossils while embedded were subjected to great pressure, for while the more compact and firmer specimens are well preserved, generally the pulp-cavity of the crowns of incompletely developed molar teeth of the Mastodon and Rhinoceros are filled with the finely crushed fangs mingled with clay. The enveloping matrix of the latter is usually free from such an admixture, while some skull fragments in like manner have their hollows filled with finely

crushed bone mingled with clay. Two specimens considerately collected by Mr. Hatcher illustrate the effect of pressure while they were embedded in their clay matrix. They consisted of those portions of the skulls of the Rhinoceros and the largest Llama, which contained all the molar teeth of both sides preserved in their proper relative position. The skull portions were somewhat distorted and were broken into innumerable fragments, retained in their natural position by the clay matrix. The fangs of the teeth were likewise crushed, but the crowns were beautifully preserved. The specimens, carefully removed from their resting-place, were enveloped in moss (Tillandsia), carefully packed, and in this condition sent to the author. On subsequent drying the skull portions actually fell into myriads of fragments, while the teeth are yet complete.

The texture of the fossils is variable, but mostly the bones and teeth have undergone little change other than the loss of a proportion of the ostein or bone-cartilage. Some are rather friable and chalk-like, but the greater number are hard and firm and brown in color, and permeated with iron oxide.

So far as relates to the geological relations of the fossils and other circumstances concerning them, the following account has been furnished by Mr. William H. Dall:

"Attention was first called to these remains in 1883, by Dr. J. C. Neal, of Archer, Alachua County, Florida, who communicated with Professor Baird, and subsequently with the officers of the U. S. Geological Survey, Dr. Leidy, and others.

"The localities observed by Dr. Neal were: (1) Mixon's farm, ten miles south and one and a half miles east of the railway station at Archer; (2) Hallowell's place, ten miles north and two miles west of the station; (3) pond, about a quarter of a mile from the station. Later Dr. Neal reports another, about two miles northwest of Mixon's, on a clay ridge in an old field. While in Gainesville I found some mastodon bones in the hands of a druggist in that town, evidently from a deposit of the same character, which were found on the banks of the Santa Fé River, to the westward of Gainesville, but the exact spot mentioned only as the point where the 'road crosses the river.' In conversation with others, I heard that similar bones had been found one mile north of Gainesville, in digging a ditch through stiff clay for the race of the 'old mill,' on the Newnansville road; and also near the town in digging another water-way known as 'Owen's ditch.' Clay Landing, on the Suwanee River, near Fort Griffin, is another probable locality.

"The bones are invariably found in a stiff and extremely tenacious clay, which occupies depressions on the higher knolls which rise here and there above the general level, and usually near a pond, sink, or other depression, still lower than the patch or strip of clay. Small and delicate bones are rare, and the remains are usually the parts best adapted to resist destruction. They are usually mixed without order, but parts of one skeleton have several times been found in nearly their natural positions with relation to one another.*

"The geological relations of the deposit in every case examined were the same. The country rock of most of Alachua County lies from two to six feet below the present surface. It is composed of a rather soft limestone, penetrated in every direction by cavities that represent fossil shells, which have been dissolved away, or, in rare instances, have been replaced by calc-spar or chalcedony. Nodules of the latter, resembling true flint and having the same conchoidal fracture, occur frequently, and often project from the surface where it has been weathered. These rocks represent the Vicksburg beds of Conrad, or the Oligocene of Heilprin, in which, however, two conformable series are recognizable. The true Vicksburg, according to local geologists, is the rock above described, over which is generally found another rock of similar constitution, but much softer, with fossils loosely aggregated and entire, and largely consisting of nummulites, orbitoides, and other foraminifera. This is locally known as the 'rotten limestone,' but is not the same as the 'rotten limestone' of Alabama and Mississippi, which is a much older rock. Heilprin describes this 'Orbitoitic rock' as Vicksburg, but does not discriminate between it and the first mentioned, though the latter has no nummulites in it where I observed, and is lithologically distinguishable. Both appear to be Oligocene. Above it he recognizes no marine deposits, nor have any been described by geologists, as far as I know. Another rock, however, covers the nummulitic rock in many places to a thickness of six or eight feet. This is locally known as the 'phosphatic rock.' It occurs in place at the 'Devil's Mill-hopper,' a remarkable sink about seven miles northwest from Gainesville, on the Newnansville road. Lumps and boulders of it occur on the higher knolls eastward of this, but my opportunities did not admit of any attempt to trace its limits. Information received from Mr. L. C. Johnson, of the Survey,

* See Wyman, Florida Shell Mounds, p. 81. Some of these bones were mixed with the material used by the Indians in building their mounds.

is to the effect that it is widely distributed westward of Gainesville, and is often separated from the 'rotten limestone,' or nummulitic rock, by thin beds of ferruginous sand, which sometimes come to the surface, and contain boulders or nodules of bog-iron ore.

"The 'phosphatic rock' contains but few fossils; an echinoderm was found in it by Mr. Johnson, and I found a shark's tooth of small size and uncertain genus, but belonging to the group of sharks with non-serrated cusps to the teeth. It also contains some silicified wood occasionally showing teredo-borings, and from its surface sometimes project heads of silicified corals belonging to the Astræidæ. These are called 'fossil stumps' by the people of Florida. It is unquestionably of marine origin, and consists of silicious grains, varying from very fine sand to small water-worn pebbles, probably derived from the silicious parts of the older Vicksburg rocks, all coated with a pure white form of limestone containing variable proportions of phosphoric acid. This serves also to cement the grains together, and when of moderate size the rock has a striking oölitic structure. From specimens obtained at Hawthorne, Alachua County, Dr. Hawes obtained a mean of sixteen per cent. of phosphoric acid. The rock is now manufactured into a fertilizer at this place. Specimens obtained loose on the surface near Archer showed, according to Professor F. W. Clark, of the Survey, considerably less phosphoric acid, and a beautifully oölitic specimen from Tampa had but a trace. A very similar-looking rock at Enterprise, on the east side of the St. John's River basin, also showed but little. This rock, however, seemed to have been of æolian origin, as it contains large numbers of land shells of recent species, and no other fossils. It occurs on the east side of the St. John's River in many places, covered with from two to six feet of sand and humus, and, notwithstanding its similarity of appearance and structure, cannot be synchronous with the phosphatic rock of the west side of the peninsula.* The latter wherever observed by me was the uppermost rock of the country, and may have been formed within salt-water lagoons, bordered by coral reefs; at least all the circumstances would fit into such an hypothesis. It is of upper Oligocene age, and should be distinguished from the lower Oligocene or Vicksburg series. A notable feature of the rock is, that where it is the substratum there are springs and running streams; as soon as one comes eastward from it, and

* It was in this rock that Pourtales found the human bones which gave rise to so much discussion and wide-spread error.

the nummulitic rock or Vicksburg shell rock is the substratum, there are nothing but sinks, natural wells, shallow ponds, and subterranean streams.

"The phosphatic rock resists fire well, is easily sawed or hewn when fresh, becomes hard by exposure, and is employed for the construction of chimneys. From a considerable area, between the localities where it has been found in place and the central depression, or relics of the great ancient central lake of Florida, it has been denuded. The same agency which wore it away made gullies, ravines, or channels in which clay was deposited. In this clay, which in its turn exists now only in patches, generally in depressions but occasionally as short ridges, the fossil bones have alone been found. There are no invertebrate remains with them. The aspect of the bones, etc., suggests that the animals might have been mired in the mud on the borders of lakes or ponds, and this would explain the association of the forms so far recognized.

"Ashes and burnt clay were found under some of the bones at Hallowell's, but there was—after a most careful inspection—no evidence to indicate any human agency in this. The fire was probably due to lightning, an every-day occurrence in Florida at the present time. The longitudinal splitting of the long bones, sometimes ascribed to human action, in mounds and recent bone-heaps, may often be the result of the penetration of roots into the interior of hollow bones, which split with the growth of the root, which may afterwards decay and leave no sign of its presence. I account for some split bones in the collection made at Hallowell's in this way."

# MASTODON

## *Mastodon floridanus*

AMONG the most abundant fossils of the Florida collection are the remains of a species of Mastodon different from the familiar one, distinguished as the American Mastodon, *M. americanus*, whose remains are so widely distributed throughout the region of the United States. The Florida species in the character of its dentition seems to have been more nearly related with the *Mastodon angustidens* of Europe than with our common American Mastodon.

The remains under investigation consist of many islolated molar teeth and bones, together with numerous fragments of others, mostly of very young or comparatively young animals, of half a dozen or more different individuals. Among thirty-five specimens of molar teeth and considerable fragments of many others, there are half a dozen last molars and the anterior portion of four others, none of which are worn except several slightly in the summit of one or two of the anterior lobes. In the collection there are several fragments of maxillæ with teeth, and there are four detached exoccipitals with their condyles of two young individuals. Of the larger bones of the limbs there are a number of fragments, mostly of young animals, and with detached epiphyses. Thus, in the collection there is the proximal extremity of a mature femur and five detached epiphysial heads of other femora. The most complete specimens preserved are a number of the bones of the feet, especially those of the carpus and tarsus, many of which are co-ordinate of several individuals.

The specimens of molar teeth in the collection illustrate nearly the complete series, and they present different conditions of age, some being unworn and others more or less worn.

The molar series of the genus Mastodon has been until recently commonly regarded as consisting of three milk or deciduous teeth, with a single premolar as a vertical successor to the second milk tooth, and behind these three adult, true or permanent molars.*

---

* Owen, Odontography, 1845, 615; Falconer, Palæontological Memoirs, 1868, vol. i, 98.

M. Lartet, in the Bulletin de la Société Geologique de France, 1859, 489, plate xiv., represents the molar dentition of *Mastodon angustidens* as consisting of three milk molars, of which the posterior two are succeeded vertically by two premolars, and which behind in the adult are succeeded by three

Commonly in the description of the molar teeth of Mastodon they seem to be viewed as rather being of a perissodactyl than an artiodactyl character, the constituent pairs of lobes of the crown being described as cross ridges or crests. Professor Owen speaks of the Mastodon as being at the Tapiroid or Dinotherian extremity of the Proboscidian series, manifested by modifications of the teeth most meriting to be held generically distinct from those of existing Elephants, the grinding surface of the molars instead of being cleft with numerous plates is divided into wedge-shaped transverse ridges, and the summits of these are divided into smaller cones, more or less resembling the teats of a cow, whence the generic name. The molars of Mastodon, in structure, bear more resemblance to those of a Hippopotamus than to those of a Tapir or Dinotherium. The crown exhibits a distinctly paired lobular constitution, as in the artiodactyla generally. According to the usual plan in the latter, the upper and lower teeth are similarly related.

The molars of the common American Mastodon, *M. americanus*, whose remains are so widely distributed through North America, exemplify among the many recognized species the simplest constitution. Selecting as types the intermediate molars of the series, the crown is composed of three successive pairs of pyramidal lobes, separated by deep angular valleys and embraced by a basal ridge. The lobes of each pair are extended and conjoined by a medial offset variably distinct, longer and wider in the outer lobes of the upper molars and inner lobes of the lower molars. Together at the summit they form an acute, tubercular ridge or crest, with a wide notch ending in a median vertical cleft, which defines the inner from the outer lobes. The inner lobes of the upper and the outer lobes of the lower molars are wider at base than the others, are more inclined laterally, and are proportionately narrower at the summit. Medially in front and behind they present a conspicuous ridge or buttress, extending from the summit to the base of the lobes. In the valleys the contiguous buttresses conjoin, producing a slight obstruction in their course, and at the front and back of the crown they end in or unite with the contiguous basal ridge. In the outer lobes of the upper and inner lobes of

true molars. The first and second milk molars and the later premolars have the crown composed of two pairs of lobes, while all the others except the last ones have three pairs of lobes.

H. von Meyer, in the Palæontographica, 1870, represents the molar dentition of the same species as consisting of the same kinds and number of teeth, but regards the later premolars as vertically succeeding the anterior two deciduous molars, to the first of which he ascribes two pairs of lobes to the crown, while to the second, as well as the third, he ascribes three pairs of lobes.

the lower teeth, the lateral surface is more defined from those fore and aft than in the others by variably prominent borders, which seem to correspond with the more medial buttresses of the latter. A similar but feebler ridge is not unfrequent in front and behind the medial offset of the same lobes.

Ordinarily the crown of the last molar of the American Mastodon is composed of four pairs of lobes like those of the molars in advance, with a fifth pair variably developed or more or less rudimental, and rarely absent. Commonly the anterior two or three pairs of lobes are nearly equal, while the others are successively reduced. In the various specimens observed the inner lobes of the upper and outer lobes of the lower molars have their buttresses variably produced; sometimes narrow and simple, at others thicker and rugose, and again they may be so stout as to approximate the condition in *Mastodon cordillerum*. The medial offsets of the lobes are variably distinct and tuberculate. The fifth pair of lobes, smaller than the preceding, are exceedingly variable. Usually they appear as a pair of large but unequal conical eminences, simple or subdivided transversely, or fore and aft; sometimes there is but a single one and rarely none.

The condition of the enamel in *M. americanus* is very variable. Mostly on the lateral surfaces of the crown it is comparatively even, but striated or finely wrinkled transversely. In the valleys usually it is less even, often is more or less rugose, and not unfrequently is more or less coarsely wrinkled longitudinally, and this condition in a variable degree may extend laterally. The chief differences observed in the teeth of *M. floridanus* from those of *M. americanus* consist in the rather more conical than pyramidal form of the constituent lobes of the crown, but especially in the great proportionate development of the fore and aft buttress-like ridges of the outer lobes of the lower teeth, and of the inner lobes of the upper teeth. In the valleys crossing the crown, in the former, the contiguous buttresses conjoin and obstruct their course for more than half their depth in the unworn teeth, whereas in *M. americanus* they scarcely interrupt them. The foremost buttress at the front of the crown, from the summit of the lobe to which it pertains, curves in advance of the contiguous lobe as a conspicuous tubercular ridge united with the basal ridge. At the back of the crown a buttress is undeveloped and is substituted in the first and second true molars by a conspicuous pyramidal and strongly tubercular production of the basal ridge. Further, the intermediate extensions in the pairs of lobes are in general more distinct as portions of these, and are more tubercular than in *M. americanus*. Ac-

cessory tubercles, more or less well marked, spring from the base of the non-buttressed lobes, contiguous to the buttresses of the other lobes, and to a variable degree contribute to obstruct the middle of the transverse valleys of the crown.

In the worn condition of the molar teeth of *M. floridanus*, the exposed dentinal areas of the specially buttressed lobes assume a more decidedly trilobate and quadrilobate form than in *M. americanus*, as seen in plate ii. figs. 1 and 2, and as is also the case in the South American Mastodons. In the opposite or non-buttressed lobes, the exposed enamel islets assume in general a transversely elongated elliptical form.

Professor Cope has described the molar tooth of a Mastodon from Texas, which he refers to a previously undescribed species with the name of *Tetrabelodon serridens*. In speaking of *M. floridanus* he remarks that its molars present the same tubercular crests of the *T. serridens*, and no important character appears to separate it from the latter. Though the tooth of *M. serridens* bears a general resemblance to the corresponding molars of *M. floridanus*, as do those of *M. angustidens* and some other species, it is sufficiently different to render it probable that it pertains to a distinct species. Professor Cope says it is peculiar among American species in its acute, elevated, entire crests, with tuberculo-serrate edges. If by entire crests is meant that they continue at a level across the crown, the condition will not apply to those of *M. floridanus*, in which the constituent lobes, together forming the crests, are separated by variably deep notches. In comparing the tooth with those of *M. turicensis*, Professor Cope says it differs in having well-developed longitudinal crests at the inner half of the external half of the crests, which consist of two tubercles on the posterior sides of the crest and one on the anterior sides of the next succeeding crests. In the molars of *M. floridanus* the corresponding longitudinal crests are usually divided into a greater number of tubercles. Further, in Professor Cope's illustration of the tooth, accompanying the description, the outer back lobe is represented with a conspicuous ridge, sweeping in a bold curve from its summit backward and inward behind the contiguous inner lobe. Such is not the case in any of the molars of *M. floridanus*, in which, generally, the posterior offset of the last outer lobe of the lower teeth, last inner lobe of the upper teeth, is not produced as in the lobes in advance, and is always isolated from the conspicuous tubercular process projecting from the basal ridge at the back of the crown.

The upper first and second true and the last deciduous molars of *M.*

*floridanus* are constructed on the same pattern. They possess three fangs; and the crown, which is nearly a third wider fore and aft than transversely, is composed of three pairs of transversely-united conical lobes, springing from a broad base and separated by deep angular valleys, which accommodate the summits of the lobes of the opposed teeth. The summits together of each pair of lobes form a crest, with a wide and variably deep notch terminating in a median vertical cleft which defines the inner from the outer lobe. The border of the crest is subdivided usually into five or six mammillary eminences. The inner and outer lobes conjoin by medial offsets, mostly distinct, and they are characteristically different.

The inner lobes have comparatively small medial offsets, sometimes scarcely developed or obsolete, and usually producing at the summit but a single eminence, contiguous to the main one. Fore and aft they expand in stout buttresses, of which those contiguous unite and divide the intermediate valleys across their middle for more than half their depth. Inwardly the buttresses are defined by deep furrows from the main body of the lobes. Their free border extends from the summit of the lobes in rows of mammillary eminences. The anterior buttress of the first inner lobe is extended by an equally stout ridge in advance of the position of the contiguous outer lobe. In the third inner lobe the posterior buttress is feebly produced or is altogether absent.

In the outer lobes the medial offsets, defined by variably strong furrows fore and aft, are nearly as large as the main portion of the lobes, and at the summit are usually divided into a pair of eminences, and not unfrequently more. Rudiments of buttresses, corresponding with those of the inner lobes, appear as variable tubercles in the intermediate valleys, springing from the medial offsets.

At the back of the crown is a wide, flattened, pyramidal talon, springing from or embraced by the adjacent basal ridge, and variably divided into a row of unequal nipple-shaped eminences, of which the larger are mostly inward.

A variable tubercular basal ridge embraces the crown. Thickest in front of the latter at its inner half, it is usually next best developed along the inner side of the crown, forming conspicuous eminences at the entrance of the valleys. Externally it is less marked and often obsolete, except as variably developed eminences at the entrance of the valleys. It sometimes also appears more or less distinct from the talon of the crown.

In the wear to which the upper molars are subjected, the inner lobes suc-

cessively precede the contiguous outer lobes. As the summits of the inner lobes are worn, the abrasion proceeds from the main eminence to those of the medial offset and buttresses. When much worn, the exposed dentinal surfaces, considerably hollowed, assume a broad, shield-shaped, and mostly a more or less quadrilobate outline. As the summits of the outer lobes are worn, usually two or three islets of dentine first appear, and subsequently, in enlarging, run together, forming a tranversely, in general, elliptical area.

The lower first and second true and the third deciduous molars are like the corresponding upper teeth, composed on the same pattern. They possess two fangs and have a narrower crown, which is likewise composed of three pairs of similar lobes, but the corresponding ones are reversed in position; that is to say, the inner lobes are homologous with the outer ones of the upper molars and *vice versa*.

The crown of the lower molars is also of less uniform width than in the upper ones, being more narrowed forward. The greater narrowing of the crown seems due to a flattening laterally in the inner lobes and to a less degree of development of their medial offsets than in their homologues, the outer lobes of the upper teeth. The offsets usually form but a single eminence adjacent to the main one at the summit of the inner lobes.

The talon of the crown is considerably thicker than in the upper molars, and usually supports an unequal pair of conspicuous conical eminences which look like reduced lobes.

The basal ridge is commonly best developed at the front and along the outer side of the crown.

Among the most interesting and important remains discovered of *M. floridanus* are two specimens obtained by Mr. Hatcher in 1890. These consist of portions of the opposite sides of the upper jaw of a young animal, both of which contain the third milk molars and the successional premolars. The third milk molar occupies its functional position, and is considerably worn across all the constituent lobes of the crown. The first true molar was partially protruded, and is only slightly abraded from use on the summit of the anterior lobes of the crown. The first successional premolar has protruded in advance of the third milk molar, but has barely reached its functional position. Within the jaw, contained in its appropriate cavity, is the completely developed enamel-cap of the crown of the second successional premolar, situated above and internal to the position of the third milk molar. The teeth appear to have protruded a little irregularly in time on the two sides of the

jaw. Thus, the third milk molar of the right side is rather more worn than that of the left side; the first right premolar is worn at the summit of the largest or first outer lobe, while the left slightly larger tooth is entirely unworn; and the left first true molar is most abraded at the summit of the first outer lobe and slightly on the contiguous inner lobe, while in the left tooth less abrasion appears only on the first outer lobe.

Plate iv. fig. 10 represents the first premolar and the succeeding third milk molar of the left side; plate ii. fig. 2 represents the first true molar of the right side, better preserved than the other; and plate iv. figs. 9 and 11 represents the second premolar from the same specimen.

The first premolar tooth has an ovoid crown, widest behind, and is situated obliquely in its position in relation with the line of the teeth behind. The fore and aft diameter inclines inward and forward from that of the succeeding second milk molar with which it is in contact. The tooth of the left side is slightly the larger, and as before indicated, is entirely unworn; which seems the more remarkable from the apparent greater completeness of its investion, for the right tooth yet occupies a larger excavation, left by its predecessor, the first milk tooth.

In the third milk molar, plate iv. fig. 10, the summits of all the constituent lobes of the crown are worn away so as to expose conspicuous dentinal tracts. The inner lobes are most worn and exhibit broad shield-shaped dentinal excavations, which are variably trilobate medially, according to the extent of the offsets of the lobes in this position. The dentinal tracts of the outer lobes are much smaller and are most extended transversely. Their shape conforms to the wear of a double eminence. On the first outer lobe are islets side by side; on the second the tract is transversely elliptical and constricted at the middle, and on the third lobe it is transverse elliptical and bent. In the opposite tooth all three outer tracts are more worn, are transversely elliptical and constricted at the middle. The tooth has a strong basal ridge internally but somewhat interrupted at the middle of the corresponding lobes.

The first true molar, plate ii. fig. 2, is typical of the usual form and construction of all the molars of the species from the first to the last, except the premolars. The inner constituent lobes of the crown are all medially extended both fore and aft in stout tubercular buttresses, of which those contiguous unite in the intermediate transverse valleys, while that in front of the crown is the most robust and is continued in advance of the contiguous outer lobe, and that at the back of the crown is more isolated than the rest. The outer lobes,

with stronger medial offsets directed to the inner lobes, display but little disposition comparatively to form tubercular offsets in front and behind.

Of several other specimens of teeth associated with those just described, I feel more uncertain as to their exact relative position.

Plate iv. fig. 3 represents the crown of what I suspect to be an upper second milk molar of the right side. It appears to have been composed of two pairs of lobes and an additional third inner lobe. It is partially worn so as to display exposed dentinal areas on the paired lobes, and is imperfect at the fore inner part. It is fore and aft quadrate oval, and appears to have been inserted by a pair of fangs.

In comparison with the other teeth above described, this one is somewhat peculiar in the proportionately more distinctly tubercular condition of the crown and in the strongly longitudinal wrinkled state of the constituent lobes. The lateral surfaces of the lobes are prominently convex and comparatively even, but those in front and behind are ridged longitudinally.

The first inner lobe is continuous with the remains of a stout process, similar to that in the back molar teeth, extending in advance of the contiguous inner lobe, and at its back part with another stout process, which appears as a development of the basal ridge at the outer part of the crown, extending to the third inner lobe. Its summit is worn away so as to display a broad dentinal area, which appears to have extended on both processes just indicated. The second inner lobe, also considerably worn away at the summit, is devoid of a posterior buttress, except as a tubercle at the bottom of the corresponding valley. The third inner lobe, more prominent than the former, is unworn, conical, with a nipple-like summit, and is provided with three conspicuous offsets, as anterior, medial, and posterior buttresses. The outer lobes, partially divided, each into a pair of sublobes, are strongly marked in front and behind with buttress-like ridges or tubercular offsets. The summit of the first outer lobe is worn so as to display a considerable reniform dentinal area, that of the second displays a pair of small dentinal islets. Back of the second outer lobe the crown is occupied by a group of conspicuous tubercles, springing from the basal ridge and apparently representing a third outer lobe. A conspicuous process of the basal ridge also occupies the interval externally between the outer lobes of the crown, to the fore part of which descends a strong ridge from the first outer lobe. The transverse diameter of the tooth behind is 40 mm., the height of the crown at the third inner lobe 27 mm.

The imperfect second left lower milk molar, shown in plate iv. fig. 4,

appears to have consisted of two pairs of lobes and a single posterior lobe, or talon. There are several irregularly placed tubercles on the outer side between the first and second pairs of lobes, and the cingulum is raised into a conical, crescentic eminence on the inner side, opposite the valley dividing the lobes. The tooth is well worn, and exhibits irregular areas of dentine. This tooth was implanted by two very long roots.

Its measurements are as follows:

| | |
|---|---|
| Width across posterior lobes | 27 mm. |
| Height of crown on outer side | 13 " |
| Depth of remaining portion of root | 37 " |

The third right lower milk molar, plate iv. fig. 5, consists of three pairs of lobes and a posterior pair of cones. The cingulum, which everywhere shows a tendency to rise into little cones, is well developed on the outer side, and in front sends up a considerable prominence. The outer lobes are connected by the usual fore and aft buttresses, while much smaller buttresses are developed on the first and second outer lobes. The posterior lobes are very little abraded; the anterior end of the crown shows considerable wear from the impact of the preceding tooth.

Subjoined are measurements of this tooth:

| | |
|---|---|
| Length | 73 mm. |
| Width across anterior pair of lobes | 32 " |
| Width across posterior pair of lobes | 45 " |
| Height of inner anterior lobe | 26 " |
| Height of inner posterior lobe | 32 " |

Plate iv. fig. 12 represents the crown, imperfect at the fore part, of what I suspect to be an upper third milk molar of the left side. It nearly resembles in constitution the complete specimen of the last upper premolar, but is considerably smaller. All the lobes are worn at their summits in the usual proportion, most in the anterior pair and least in the third inner one.

The inner lobes are divided by furrows, each into a pair of sublobes, and these exhibit in front and behind variable buttress-like ridges. The outer lobes have the usual three offsets appearing as anterior, posterior, and medial buttresses. The summits of the second and third outer lobes exhibit broad elliptical dentinal areas with three small medial processes. The second inner lobe exhibits a transverse figure-of-eight dentinal area, while the succeeding inner lobe is only sufficiently worn to exhibit minute dentinal islets on its sublobes. At the back of the crown a thick pyramidal process of the basal ridge

extends from the outer lobe to the base of the inner one, resembling the extension of the anterior buttress of the first outer lobe in the lower back molars. Tubercular processes, elements of the basal ridge, occupy the entrance of the valleys of the crown.

The transverse diameter of the crown at the middle pair of lobes is 48 mm.

Plate iv. figs. 1, 2, 6, and 7 represents the first lower premolars of both sides, and though apparently from the same individual present some differences.

The left tooth, imperfect at the fore part and in the figure restored from the other specimen, has a fore and aft irregular ovoidal crown, slightly constricted at the middle and narrower in front. It is composed of four lobes, of which the anterior, nearly equal, are the higher and of greater fore and aft breadth, while the posterior are unequal, and together of greater width transversely. The anterior lobes appear as laterally compressed cones, separated by a deep groove behind, but scarcely distinct in front. Of the posterior lobes, which are conical, the outer is nearly twice the size of the other, and in the specimen its summit is worn so as to exhibit an exposed dentinal tract in the form of the figure 8. At the back of the crown is a tritubercular heel in which the inner tubercle is double the size of the outer ones.

In the right tooth, at the base of the anterior lobes in front of the crown is a ledge, an element of a basal ridge, which was apparently absent in the former tooth. The postero-external lobe is much more worn, exhibiting a broad dentinal area. The contiguous inner lobe of the left tooth in this one, in which the part is imperfect, appears to have been substituted by a thick, somewhat tubercular ridge, extending from the antero-internal lobe to the back of the crown. The teeth have a pair of fore and aft connate fangs.

Their measurements are as follows:

| | Right tooth. | Left tooth. |
|---|---|---|
| Fore and aft diameter of the crown . . | 28 mm. | 28 mm. |
| Transverse diameter of the crown in front . | 15 " | 14.3 " |
| Transverse diameter of the crown behind . | 16.3 " | 17 " |

The first lower premolars described resemble the corresponding teeth of *Mastodon angustidens*, but are considerably smaller and exhibit slight details of difference.

The crown of the first premolar has a prominent convex base, from which project four unequal conical lobes, closely united, and together enclosing a central pit. The constituent lobes may be viewed as having an arrangement in transverse pairs, but from their less proportionate development the condition

appears not so distinct as in the other teeth. The lobes of each transverse pair conjoin through a medial tubercular offset springing from each lobe, and though the offset to the second inner lobe is not evident in the left tooth figured, it is distinct in the right tooth. The first outer lobe of the tooth is the largest, and independent of its medial tubercular offset is simply conical. The contiguous inner lobe is more extended fore and aft, and independent of its medial offset is divided into a row of four eminences, which decline forward and are thence continued in a tuberculated ridge curving in advance of the outer lobe. Of the posterior pair of lobes the outer is the larger and the simpler, while the inner, the smallest of the crown, independent of its medial offset, is divided into three eminences, and is continued behind by a tuberculated ridge to the base of the contiguous outer lobe.

In the right tooth the inner lobes are less developed, less distinct from each other, and together appear more as a strongly tuberculated ridge embracing the inner semicircumference of the crown.

The measurements of the first premolar are as follows:

| | Right tooth. | Left tooth. |
|---|---|---|
| Fore and aft diameter of the crown . . | 36 mm. | 37 mm. |
| Greatest width transversely . . . | 30.5 " | 32 " |
| Depth at the first outer lobe . . . | | 24.5" |

The crown of the second upper premolar, plate vi. figs. 3 and 4, is quadrate, fore and aft widest outwardly, and transversely widest opposite the anterior lobes. The constituent lobes partake of the character of those of the back molar teeth. As in the first premolar, the anterior lobes are the largest and the postero-internal lobe is the smallest. Deep notches separate the anterior from the posterior lobes, and a less deep notch separates the anterior pair. The antero-internal lobe forms a tubercular ridge, extending from the lobe behind and curving outwardly in advance of the position of the antero-external lobe. The summits of the anterior lobes are divided into three and four eminences. The posterior lobes together form a transverse ridge, subdivided into half a dozen eminences. They are conjoined behind by a ridge, and together enclose a considerable pit. The deep transverse valley of the crown exhibits a conspicuous central tubercle.

The measurements of the tooth are as follows:

| | |
|---|---|
| Fore and aft diameter of the crown . . . . . | 45 mm. |
| Transverse diameter at base of the anterior lobes . . | 41 " |
| Transverse diameter at base of the posterior lobes . . | 35 " |

Plate iv. fig. 8 represents a first upper premolar of the left side, scarcely worn. The crown is fore and aft oval in outline, and is of much greater transverse width than that of the lower tooth. It also exhibits four constituent lobes, with a strong basal ridge. Of the anterior pair, the outer lobe is much the larger and most prominent, is conical, and is partially divided in front, but more behind, and feebly at the summit into two sublobes. At the base, in front of the lateral sublobe, is a strong tubercle springing from the basal ridge. The contiguous inner lobe is continous in front, with a stout tubercular ridge curving outward to the tubercle at the base of the outer lobe. The posterior pair of lobes, smaller than anterior, are nearly equal, and widely separated, but conjoined by a small tubercular offset from each. A stout tubercular heel occupies the back of the crown intermediate to the adjacent lobes. A tubercular process of the basal ridge also occupies the outer part of the crown, both in front and behind the first outer lobe, or principal one of the tooth. Another tubercle, at the inner side of the crown, is placed in advance of the posterior lobe, and by an offset joins the anterior lobe.

The tooth appears to have been invested by a pair of fore and aft connate fangs, of which the posterior was much the stouter.

The measurements of the tooth are as follows:

| | |
|---|---|
| Fore and aft diameter of the crown . . . . . | 33 mm. |
| Transverse diameter of the crown . . . . . | 27 " |
| Depth at the principal or first outer lobe . . . . | 19 " |

Plate iii. fig. 2 represents the triturating surface of a lower first true molar of the left side, and plate iii. fig. 1 represents an outer view of the corresponding tooth of the right side in a fragment of the jaw, both from the same individual. These teeth nearly accord in character with the back molars, the crown being composed of three pairs of lobes of the same kind, with a strong basal ridge. The crown is a little worn, so as to expose small dentinal areas on the summits of the anterior pair of lobes and on the median outer lobe. A minute islet is also exposed on the anterior abutment or sublobe of the first outer lobe. The enamel is worn in an inclined plane on the anterior buttress of the third outer lobe, but not on its summit nor that of the contiguous inner lobe. In this tooth the offsets of the lobes are mostly distinctly marked as sublobes. The basal ridge is well produced at the outer part of the crown, and behind it is produced into a medial pair of conspicuous conical

tubercles or sublobes. Internally considerable tubercles, as isolated elements of the basal ridge, occupy the entrance of the valleys. The fore part of the basal ridge appears remarkably worn from pressure of the tooth in advance. A small quantity of cementum occupies the bottom of the valleys and the deeper depressions of the surface of the tooth.

The measurements of the teeth are as follows:

| | |
|---|---|
| Fore and aft diameter of the crown | 91 mm. |
| Transverse diameter of the crown in front | 45 " |
| Transverse diameter of the crown behind | 52 " |
| Height of crown obliquely at the third outer lobe | 51 " |
| Height of crown obliquely at the third inner lobe | 44 " |

Plate ii. fig. 1 represents the triturating surface of the crown of a much worn lower first true molar of the left side. The tooth nearly accords in constitution with the former, but is somewhat wider transversely, and elements of the basal ridge are not so conspicuous internally. The distinction between the anterior lobes has been destroyed by wear, and the enamelled structure at the front of the crown has entirely disappeared. On the second pair of lobes the dentinal tracts are united by a small isthmus, but on the posterior pair they are still separated by a double boundary of enamel. Dentinal islets have also appeared on the basal tubercles at the back of the crown.

The measurements of the tooth are as follows:

| | |
|---|---|
| Fore and aft diameter of the crown | 80 mm. |
| Transverse diameter of the crown behind | 57 " |

Two specimens from the bone-bed of Mixon's plantation in the collection of 1890 consist of the front and back portions of the crowns of the last lower molars, apparently from the same individual, but different from the former. Represented in plate iii. fig. 4 and plate v. fig. 1, they serve to give the character of the entire tooth. Like the other specimens of last molars described, the present one had nearly assumed its functional position, as from use at the fore part the summits of the anterior two pairs of lobes are but slightly abraded. The tooth is most like the corresponding ones last described, but is still narrower in its proportions. The medial offsets of the outer lobes are less developed, while those of the inner lobes are better developed and more distinct. The basal ridge is completely absent, both externally and internally. A considerable quantity of cementum occupies the recesses of the crown.

The measurements of the tooth are as follows:

| | |
|---|---|
| Estimated diameter fore and aft of the crown . . . | 190 mm. |
| Transverse diameter at base of first pair of lobes . . | 69 " |
| Transverse diameter at base of second pair of lobes . . | 73 " |
| Transverse diameter at base of third pair of lobes . . | 72 " |
| Transverse diameter at base of fourth pair of lobes . . | 66 " |
| Height of first outer lobe . . . . . | 66 " |
| Height of third outer lobe . . . . . | 70 " |
| Height of fourth outer lobe . . . . . | 67 " |
| Height of fifth outer lobe . . . . . | 57 " |

Among the characteristic specimens of the Mastodon from Mixon's plantation are three, two of which, the isolated crown of a right upper molar tooth and a fragment of the left maxilla, with another molar, were received in the earlier collection, while the third specimen, a larger fragment of the opposite maxilla, with the corresponding tooth to that of the former one, was received in the collection of 1890. The three specimens appear to have belonged to the same animal, an individual of medium age and comparatively of small size. The isolated molar I at first viewed as a first true molar, but its correlation with the specimen last observed leads me to regard it as the second of the series, and those in the jaw fragments as the first in the same series.

Plate ii. fig. 6 represents the crown of the upper second true molar. It is complete, and is only a little worn on the summit and anterior extension of the first internal lobe. It may be regarded as typical of the intermediate molars of the series in the species.

The crown is composed of three pairs of lobes, embraced by a basal ridge and separated by transverse valleys, which are divided along the middle of the tooth by strong tubercular offsets of the inner lobes. In each transverse pair of lobes they are separated by an angular notch, which becomes successively deeper from the first to the last. The inner lobes are the larger, and are conical, with the lateral surface continuous fore and aft and prominently convex, and medially expanding in front and behind in strong buttress-like ridges. These extend from the summit, are divided into tubercular eminences, and in the valleys conjoin so as to obstruct their course, but leave angular notches between the summits of the lobes. A tubercular offset, variably produced from the medial surface of the inner lobe, is directed to the contiguous outer lobe. It is best marked in the first inner lobe and least in the last one. In the last inner lobe also the posterior buttress-like ridge is but

feebly developed. The outer lobes are conical and are medially extended by an offset, which is variably prominent and divided into tubercular eminences, and is separated by a notch from the contiguous inner lobe.

At the front of the crown a stout tubercular process springs from the basal ridge and appears like an extension of the anterior buttress of the inner lobe in advance of the position of the outer lobe. At the back of the crown is a similar process divided into tubercular eminences, more medial in position and disconnected from the inner lobe. The basal ridge is well developed internally, and is thickest where it embraces the first inner lobe, continuous forward and outward. Internally it is thin, interrupted at the base of the middle lobe, and produced into conspicuous eminences at the entrance of the valleys. A considerable quantity of irregular cementum occupies the bottom of the principal valleys and other recesses of the crown.

The measurements of the tooth are as follows:

| | |
|---|---|
| Fore and aft diameter of the crown | 122 mm. |
| Transverse diameter at fore part | 75 " |
| Transverse diameter at back part | 78 " |
| Height at anterior-internal lobe, obliquely | 52 " |
| Height at posterior-internal lobe, obliquely | 58 " |

Plate ii. fig. 4 represents the first true molar contained in the right jaw fragment. The tooth is entire, but worn to such an extent that all the constituent lobes display considerable dentinal areas. The crown conforms in structure with that of the second molar above described. The exposed dentinal areas are concave, while their enamel borders are convex. Those of the first and second inner lobes are the broadest, and are quadrilobate, with the inner division much the larger. That of the third inner lobe has nearly half the outline of the former. The dentinal areas of the outer lobes, much the smaller, are transversely elliptical.

The basal ridge is well produced internally, but only in slight eminences at the entrances of the valleys externally. In front of the crown it exhibits the same conspicuous eminence as in the posterior molars, continuous with the anterior buttress of the inner lobe, and extending in advance of the contiguous outer lobe. At the back of the crown is a conspicuous pyramidal eminence springing from the basal ridge, and most prominent opposite the middle of the inner lobe.

The measurements of the tooth are as follows:

| | |
|---|---|
| Fore and aft diameter of the crown | 97 mm. |
| Transverse diameter of the crown at fore part | 60 " |
| Transverse diameter of the crown at back part | 67 " |

The tooth of the left side, also preserved entire, essentially accords with that just described. The jaw fragment retains the alveoli of the premolar in advance, which thence would appear to have been a two-fanged tooth. It also retains the fore part of the alveoli of the succeeding true molar, which co-ordinates with the isolated tooth above described.

In the collection from Mixon's plantation of 1890 are five isolated specimens, the crowns of molar teeth, which appear to have belonged to the same animal,—a young one, from the jaws of which the teeth had not yet protruded. They are entirely unabraded from wear, and are nearly destitute of cementum. They consist of the fourth upper molar of both sides, the corresponding lower left molar incomplete, and both lower third molars, of which the right one is imperfect.

The upper first true molar, that of the left side being represented in plate ii. fig. 1, nearly accords in form and construction with that of plate ii. fig. 6, previously described. It is smaller, and the lobes of each transverse pair are less deeply separated by angular notches from the greater proportionate development of their medial offsets.

The first lower molar, of the same side, represented in plate ii. fig. 3, resembles the former, narrowed transversely and with its homologous lobes reversed in position, and with its posterior talon proportionately more developed and appearing as a conspicuous pair of unequal conical eminences.

The fourth lower molar, incomplete in its anterior two outer lobes, is an enlarged representative of the tooth preceding it, just described.

The measurements of the teeth are as follows:

| | |
|---|---|
| Fore and aft length of the crown of the upper fourth molar | 106 mm. |
| Transverse breadth at base of the anterior lobes | 65 " |
| Transverse breadth at base of the posterior lobes | 68 " |
| Height of middle external lobe | 53 " |
| Fore and aft length of the crown of the lower third molar | 97 " |
| Transverse breadth at base of the anterior lobes | 46 " |
| Transverse breadth at base of the posterior lobes | 56 " |
| Height of middle internal lobe | 44 " |

Among the characteristic specimens of the Florida Mastodon under examination from Mixon's plantation are five isolated molar teeth, which,

from their general appearance of age and other conditions, are so correlated as to render it probable that they belonged to the same animal, an individual of adult age. The teeth consist of the series of upper true molars of the right side, and those of the left side except the last one. The crown of the right second true molar is broken away at its back part, but that of the corresponding left tooth is complete. The crown of the last molar is also complete, and those of the first molars nearly so. The latter are well worn, but the last molars had just commenced to protrude, and in the specimen preserved is only slightly abraded from use on the summit of the first outer lobe.

The first molars, represented in plate ii. figs. 1 and 2, differ a little in size and the condition of wear, the left being slightly the larger. The constituent lobes of the crown are worn away nearly to their bases, the inner ones to the greatest extent. The exposed dentinal areas are strongly depressed, the broader ones of the inner lobes even to a greater depth than the bottom of the valleys of the tooth.

In the right tooth the dentinal areas of the anterior pair of lobes conjoin by a narrow isthmus, in the middle lobes are separated by a little neck, but in the posterior lobes are still separated by a double wall of enamel. In the left tooth the worn condition in a manner seems reversed; in the anterior lobes the dentinal areas being separated as in the posterior lobes of the former tooth; in the middle lobes they are united by a narrow isthmus, and in the posterior lobes are completely united, leaving only an enamel islet as a remnant of the original separation. Contrary to the usual course of wear of the teeth of the Mastodon, these look more worn behind than in front.

The measurements of the two teeth are as follows:

| | Right tooth. | Left tooth. |
|---|---|---|
| Fore and aft diameter of the crown . . | 107 mm. | 113 mm. |
| Transverse diameter at base of anterior lobes . | 75 " | 73 " |
| Transverse diameter at base of posterior lobes . | 70 " | 70 " |

The second true molars, of which the left one is represented in plate i. fig. 2, are typical of the molar teeth in general of the species. Conforming to the first molars, their crown is composed of three pairs of lobes springing from an expanded base and embraced by a tubercular basal ridge. The inner lobes are closely united through their contiguous buttresses, which completely divided the transverse valleys of the crown. The anterior buttress of the first inner lobe is prolonged in the usual manner by an equally stout ridge extending in advance of the contiguous outer lobe. There is no buttress to

the last inner lobe. The intermediate buttresses exhibit more or less disposition to extension in the valleys as tubercular ridges between the outer lobes. The disposition is really more strongly marked in the right tooth. At the back of the crown is a broad pyramidal talon springing from the basal ridge, and divided into a row of mammillary eminences. The basal ridge is well developed internally, and is continuous with the thicker portions in front and behind the crown. The first and second outer lobes are subdivided into two, and the outer portion of the second is again divided at its summit. The third outer lobe towards the summit divides into three eminences.

In these teeth all the lobes are worn except the last outer one. The right tooth is more worn than the left one. The pairs of lobes are worn across in inclined planes nearly to a level, sloping in front and behind on the anterior two pairs of lobes, but in front only on the posterior pair. Shield-shaped areas of dentine are displayed on the anterior two inner lobes. In the left tooth, as seen in fig. 2, elliptical areas of dentine are displayed on the inner subdivisions of the anterior two outer lobes. In the right tooth the first outer lobe displays a pair of elliptical dentinal areas, and the second outer lobe a transverse row of three smaller areas. An elliptical islet of dentine occupies the extension of the anterior buttress of the crown in both teeth. The enamel of the summit of the last inner lobe is worn in an inclined plane forward, but the dentine is not exposed. The contiguous outer lobe exhibits no trace of wear. A moderate layer of cementum, pretty evenly deposited, occupies the deeper recesses of these teeth.

The measurements of the teeth are as follows:

| | Right tooth. | Left tooth. |
|---|---|---|
| Fore and aft diameter of the crown . . | | 148 mm. |
| Transverse diameter at base of anterior lobes . | 95 mm. | 92 " |
| Transverse diameter at base of middle lobes . | 88 " | 89 " |
| Transverse diameter at base of posterior lobes | | 88 " |
| Height of the last outer lobe, unworn . . | | 66 " |

The crown of the upper right last molar tooth, represented in plate v. fig. 2, is complete, but the fangs are broken away. The tooth had barely protruded at its fore part, and is abraded from use only on the summit of the first external lobe. The front of the crown at its base exhibits the result of pressure or friction of the adjacent second true molar. The crown is composed of four pairs of lobes, springing from a broad base, with a conspicuous tubercular talon. It is widest opposite the first pair of lobes, slightly narrow at the next pair, then more abruptly at the third, and is more gradually

reduced to the rounded talon. Fore and aft it is nearly straight, but is slightly bent, with the concavity inward. The anterior two pairs of lobes are nearly equal, the succeeding pair is slightly reduced, and the fourth pair is reduced about one-fourth. The inner lobes expand medially fore and aft into stout buttresses, of which the contiguous ones conjoin in the valleys of the crown and obstruct the middle of their course for more than half the depth. The summits of the inner lobes, prolonged on their buttresses, are subdivided into rows of tubercles. The anterior buttress of the first inner lobe is continuous, with an equally strong tubercular ridge in advance of the position of the contiguous outer lobe, producing a conspicuous feature of the front of the crown. The posterior two inner lobes have their posterior buttresses nearly obsolete.

The outer lobes of the crown, narrower than the inner ones, are medially extended towards the latter rather than fore and aft, though in these positions tubercles springing from their base and occupying the valleys are rudiments of the buttresses of the inner lobes. The summits of the outer lobes are divided into transverse rows of rounded tubercles. The summits of the pairs of lobes are separated by angular notches, and deeper angular notches separate the summits of the inner lobes. In the second and fourth pairs of lobes the notches are rendered shallower, from the development of a medial tubercular offset from the contiguous inner lobe. The first outer lobe displays three eminences at its summit; the succeeding outer lobes, transverse rows of four eminences.

The talon of the crown is a strong semicircular projection of the base, from which springs a row of half a dozen unequal nipple-shaped eminences. The basal ridge, especially thick at the inner front part of the crown, extends interruptedly along the inner side and behind the talon, and is more conspicuously marked at the entrance of the valleys. Considerable irregular cementum occupies the deeper recesses of the crown.

The measurements of the specimen are as follows:

| | |
|---|---|
| Diameter of the crown fore and aft | 193 mm. |
| Diameter of the crown transversely at the anterior lobes | 97 " |
| Diameter of the crown transversely at the second lobes | 94 " |
| Diameter of the crown transversely at the third lobes | 87 " |
| Diameter of the crown transversely at the fourth lobes | 80 " |
| Height of the first inner lobe | 82 " |
| Height of the second inner lobe | 80 " |
| Height of the third inner lobe | 73 " |
| Height of the fourth inner lobe | 65 " |

Among the specimens of teeth of the Florida Mastodon from the bone-bed of Mixon's plantation are three isolated ones, which have the appearance of having belonged to the same individual. They consist of the crown of the right upper last molar, which has lost small portions from the first outer constituent lobe and talon, the greater portion of the crown of the corresponding left tooth comprising the three anterior pairs of constituent lobes, and the nearly complete crown of the right lower last molar. They are entirely unworn, almost devoid of cementum, and appear as if they had not yet protruded from the jaws to assume their functional position.

The crown of the upper last molars, of which the more complete right one is represented in plate vii. fig. 2, is larger and more robust than the specimen previously described, but otherwise has nearly the same form and proportions. The four pairs of constituent lobes have essentially the same arrangement, but their offsets in general appear better developed or more distinct. The inner lobes appear more deeply constricted inwardly, where they give off their buttresses. The outer lobes are more or less deeply divided in front and behind by grooves, which are scarcely apparent in the former tooth. Their inner offsets are better developed and more prominent, and at the summit are divided into a pair of conspicuous eminences instead of three smaller ones as in the former specimen. The summits of the first, third, and fourth pairs of lobes are well separated by angular notches. In the second pair of lobes from the more equal development of their medial offsets, together they form a transverse ridge of five eminences. In the third inner lobe the posterior buttress seems directed medially to join the contiguous outer lobe. In the fourth inner lobe a strong medial offset exists, which appears to be absent in the former tooth.

The talon consists of a pair of large but unequal conical eminences springing from the base of the crown, and giving each a tubercular offset forward. The basal ridge is more strongly developed in these specimens than any others of the Mastodon which have been brought to our notice. It is very thick and coarsely tubercular, extending from the inner part of the front of the crown along the inner side uninterruptedly to the talon. At the outer side of the crown it is thinner but continuous, and forms conspicuous eminences at the entrance of the valleys.

In the portion preserved of the left tooth the characters are essentially the same, but the second and third outer lobes are less well developed, and the surface irregularly rugged, apparently an anomalous condition.

The measurements of the complete specimen are as follows:

| | |
|---|---|
| Diameter of the crown fore and aft | 205 mm. |
| Diameter of the crown transversely at the anterior lobes | 107 " |
| Diameter of the crown transversely at the second lobes | 104 " |
| Diameter of the crown transversely at the third lobes | 99 " |
| Diameter of the crown transversely at the fourth lobes | 94 " |
| Height of the first inner lobe | 85 " |
| Height of the second inner lobe | 87 " |
| Height of the third inner lobe | 82 " |
| Height of the fourth inner lobe | 70 " |

Accompanying the teeth last described, and perhaps belonging to the same animal, is a portion of the crown of a lower right second molar, represented in plate iii. fig. 5. It consists of the posterior two pairs of constituent lobes with the talon. The lobes are worn at their summits, and the forward pair exhibit considerable exposed dentinal tracts, of which the larger outer one is quadrilobate, the inner transversely pyriform. The lobes accord with their homologues of the corresponding upper tooth, but the last outer one has its posterior buttress better developed than in its homologue. The talon is much larger, and consists of a conspicuous pair of conical eminences, of which the outer is the larger, and by an offset conjoins the buttress of the lobe in advance. The crown as usual is narrower than that of the upper tooth, and like it has considerable cementum. The transverse diameter of the crown at the posterior lobes is 79 mm.

Two isolated specimens of teeth in the collection are the fifth upper molars, apparently from the same individual. They are both imperfect, but so far as they are preserved they nearly accord in size and other respects with the corresponding teeth above described. The more complete tooth displays all the constituent lobes of its crown, worn to such an extent as to have dentinal areas exposed upon their summits. On the first and second inner lobes the exposed dentinal areas are shield-shape and conspicuously quadrilobate. The contiguous outer lobes exhibit transverse elliptical areas. The third inner lobe shows a narrow elliptical islet, extending from the summit of the former along its anterior buttress. The contiguous outer lobe, the least worn, shows a transverse row of three small dentinal islets. In this tooth the posterior buttress of the last inner lobe is more developed than usual. The fore and aft measurement of the crown is 130 mm.; the transverse diameter of the fore part of the other specimen is 88 mm.

Among the remains of the Florida Mastodon from Mixon's plantation, in the collection of 1890, are four isolated specimens of teeth, which from their general appearance are supposed to have pertained to the same animal, an individual of nearly the same age as those to which the previously described specimens belonged. They consist of the upper first and second true molars of the left side, and the second one of the right side, and the lower left second true molar.

The first and second upper molars, as represented in those of the left side in plate i. fig. 4, pretty closely resemble the corresponding teeth already described, both in construction and condition of wear, but are not quite so large. In the first molar the constituent lobes of the crown are well worn away, and the broad dentinal surfaces they display are on a level with the bottom of the inner valleys. The dentinal areas of the anterior lobes of the crown are conjoined by an isthmus, while the others are still separated by narrow necks of enamel. Strong processes of the basal ridge unite the bases of the contiguous inner lobes of the crown.

In the second molars, that of the right side is most worn, and to such a degree that dentinal areas are exposed on all the constituent lobes of the crown, while in the left one they are not exposed on the posterior pair of lobes, and of these the outer one is scarcely worn. In these teeth the inner lobes of the crown rather more conspicuously embrace the outer ones than in the same teeth previously described, and the internal basal ridge is more coarsely tubercular.

The measurements of the teeth are as follows:

| | |
|---|---|
| Fore and aft diameter of the crown of the first molar . . | 103 mm. |
| Transverse diameter at base of anterior lobes . . . | 65 " |
| Transverse diameter at base of posterior lobes . . . | 65 " |
| Fore and aft diameter of the crown of the second molar . | 136 " |
| Transverse diameter at base of anterior lobes . . . | 84 " |
| Transverse diameter at base of posterior lobes . . . | 86 " |

The second lower true molar tooth, represented in plate i. fig. 1, has the crown shorter fore and aft than the corresponding upper tooth, is also narrower transversely, and is of less uniform breadth, being narrowed forward. It is, further, more worn, as considerable dentinal areas are exposed on the summit of the last outer lobe and its anterior buttress, and minute ones on the contiguous inner lobe. The outer constituent lobes of the crown are closely like their homologues of the upper molars, but the inner lobes appear proportionately less wide transversely. The talon forms a conspicuous pair of large conical eminences at the back of the crown.

The measurements of the tooth are as follows:

| | |
|---|---|
| Diameter fore and aft of the crown | 126 mm. |
| Diameter transversely at base of the anterior lobes | 64 " |
| Diameter transversely at base of the posterior lobes | 78 " |

The crown of the right last lower molar tooth, represented in plate vi. fig. 1, is complete except that it is injured on the summits of the second pair of constituent lobes. It is longer fore and aft, narrower transversely, and of more uniform breadth in this direction than that of the upper molars. It is slightly bent in the length, with the convexity inward and a less degree of concavity outward. Like the upper molars, it is composed of four pairs of lobes, springing from a broad base and with a larger talon, assuming more the appearance of an additional pair of reduced lobes. The inner lobes are of less transverse breadth than their homologues, the outer ones of the upper teeth, due mainly to reduction in the medial offsets, which in this tooth exhibit but a single eminence at the summit, instead of a pair as in the upper teeth. The outer lobes are almost identical with their homologues of the latter, but the posterior buttresses of the posterior pair are better developed. The inner lobes are flattened internally, and the corresponding lateral faces are more abruptly defined from those in front and behind than in the upper molars. This condition of the inner lobes gives the inner surface of the crown a flattened appearance not present in the corresponding or outer surface of the upper molars. The outer lobes are almost identical with their homologues of the latter, but in the third and fourth the posterior buttresses are better developed.

From the talon springs a pair of conical eminences, much larger than those in the accompanying upper molar, and bounded behind by a strong tuberous base. The pair of eminences are about half the size of the lobes in advance, and are related to them as a fifth reduced pair. A strong basal ridge extends from the front of the crown along the outer side to the talon, but interrupted or thinning away at the base of the first outer lobe.

The measurements of the tooth are as follows:

| | |
|---|---|
| Diameter fore and aft of the crown | 225 mm. |
| Transverse diameter at base of first pair of lobes | 86 " |
| Transverse diameter at base of second pair of lobes | 88 " |
| Transverse diameter at base of third pair of lobes | 88 " |
| Transverse diameter at base of fourth pair of lobes | 84 " |
| Height of first external lobe | 69 " |

| | |
|---|---|
| Height of second external lobe . . . . . | 88 mm. |
| Height of third external lobe . . . . . | 78 " |
| Height of fourth external lobe . . . . . | 74 " |
| Height of fifth external lobe . . . . . | 52 " |

Associated with the specimens just described were four others, the isolated crowns of last molar teeth, which, from their general appearance on first inspection, were regarded as having pertained to the same individual animal, but further examination renders this reference doubtful. They are so far different from the last molars already described as to make it uncertain whether they are the upper with the lower true ones or whether they are all of the latter character. Even viewed in the former light it would still be questionable whether they had belonged to the same individual, for the wearing to which they have been subjected, though slight, yet shows some difference in extent in what would appear to be the upper and lower teeth. Two of the specimens are evidently the crowns of lower molars, and more especially seem to have belonged to the same individual, as the more anterior ones above described. The others contrasted with the former might be considered to have pertained to the corresponding upper teeth, but compared with the previously described last molars, differing from both upper and lower ones, on the whole most resemble the latter in proportions and in the development of the talon. For convenience of description, as their true position seems uncertain, they will be regarded as upper molars.

The crowns of the lower molars are nearly complete, though the left one is much fractured and otherwise mutilated. Of the others, the left one is complete, while the other consists of the greater portion comprising the anterior three pairs of constituent lobes. All the specimens are remarkable for the unusual quantity of cementum which invests them and fills their deeper recesses, greatly exceeding that in most of the Mastodon teeth under examination.

The complete crown of the supposed upper molar, represented in plate vii. fig. 1, has more the proportions of the last lower molar previously described than of the undoubted upper ones. It is fore and aft longer, and its talon much more fully developed, even exceeding in this respect that of the lower molar. The four pairs of constituent lobes accord rather with those of the undoubted upper molars than with those of the latter. The incomplete crown of the right molar, consisting of its anterior portion, viewed alone, would have been unhesitatingly accepted as pertaining to the upper tooth. The outer lobes of the crown in these teeth are all devoid of medial tubercular

offsets, which are present in more or less of the last molars previously described, both upper and lower. The extension of the buttress of the first internal lobe at the front of the crown is conspicuously more robust than in the former specimens, but the basal ridge along the inner side of the crown is less well developed.

The talon is a stout mass, the segment of a sphere, with a group of three conical eminences, of which the intermediate one is the largest and extends behind the others.

The enamel is abraded from wear only on the extreme summit of the first inner lobe, but appears polished from friction on the contiguous outer lobe, extending upon its anterior buttress. The front of the crown exhibits a slight abrasion due to contact with the contiguous tooth.

The measurements of the tooth are as follows:

| | |
|---|---|
| Fore and aft diameter of the crown | 220 mm. |
| Transverse diameter at base of first pair of lobes | 95 " |
| Transverse diameter at base of second pair of lobes | 92 " |
| Transverse diameter at base of third pair of lobes | 89 " |
| Transverse diameter at base of fourth pair of lobes | 88 " |
| Height of first inner lobe | 63 " |
| Height of second inner lobe | 69 " |
| Height of third inner lobe | 64 " |
| Height of fourth inner lobe | 59 " |

Of the last lower molars, above mentioned, the more complete crown of the right one is represented in plate vi. fig. 2. Like the specimens just described, they had recently protruded, but they are slightly more worn, the right more than the left one. In the former the enamel is abraded on the summits of both lobes of the second pair, but to a less extent on those of the first pair, extending on the anterior buttress of the first outer one. In the left tooth the enamel is abraded on the summit of the second outer lobe and in a less degree on those of the anterior pairs of lobes extending on the anterior buttress of the outer one. Both teeth are also worn in front of the crown over a considerable extent of surface, due to contact with the fifth molars. This wearing in front closely accords with that at the back of the crown of the specimen of a fifth lower molar, previously described, as also do the comparatively small worn surfaces on the front of the upper molars above described, with similar ones on the fifth upper molars, rendering it probable that all the eight molars last described belonged to the same individual.

The lower molars under examination are fore and aft slightly shorter, as well as transversely narrower, than in the supposed upper molars, a condition in the former respect which is not usual in known species of Mastodon.

In comparison with the specimen of the last lower molar previously described, it is smaller, being fore and aft slightly shorter, as well as transversely narrower, a condition in the former respect not usual in known species of Mastodon. The crown is less flattened internally, and it is devoid of the basal ridge externally. The internal constituent lobes are more conical or less angular, and the medial offsets of both internal and external lobes are less well developed, while their summits are more convergent.

The talon is formed of a transverse pair of conical lobes, with a posterior intermediate smaller conical eminence. The former are larger than in the first-described lower last molar, and more closely crowd on the lobes in advance.

The measurements of the tooth are as follows:

| | |
|---|---|
| Diameter of the crown fore and aft | 215 mm. |
| Diameter transversely at base of the first pair of lobes | 84 " |
| Diameter transversely at base of the second pair of lobes | 84 " |
| Diameter transversely at base of the third pair of lobes | 80 " |
| Diameter transversely at base of the fourth pair of lobes | 75 " |
| Height of first outer lobe | 70 " |
| Height of second outer lobe | 82 " |
| Height of third outer lobe | 75 " |
| Height of fourth outer lobe | 68 " |
| Height of fifth outer lobe | 52 " |

Five fragments representing four different tusks are present, three of them showing a well-marked enamel band, while the others appear to have lost this feature by weathering. In addition to the enamel band, two of the fragments have small patches of cement adjoining, which seem to indicate that the entire tusk where not covered with enamel was coated with a layer of cement. The enamel is longitudinally coarsely striated, and shows numerous minute pits, which are thickest in the smallest tusk.

The measurements of the tusks are as follows:

| | | |
|---|---|---|
| Transverse diameter | 66 mm. | 39 mm. |
| Vertical | 51 " | 32 " |
| Width of enamel band | 48 " | 29 " |

# RHINOCEROS

## *Aphelops fossiger*

THE occurrence of rhinoceros remains in Florida was noted by Dr. Leidy in the "Proceedings of the Academy of Natural Sciences of Philadelphia" for 1884, page 118, and in the Proceedings for 1885, pages 32 and 33, he described a species which he named *Rhinoceros proterus*, basing it upon a last upper molar. Subsequently a large number of teeth and bones were received from Florida belonging to the same species. Unfortunately, no portion whatever of the skull was preserved, but a comparison of the teeth and bones with the type of *Aphelops fossiger* (Cope), and with other Western material, shows that at most *Rhinoceros proterus* can be considered only as a subspecies of *Aphelops fossiger*, which may be distinguished as follows: similar to *A. fossiger*, but with slightly smaller molars, having thinner crests; a better development of the cingulum on pm. $\frac{3}{3}$ and $\frac{4}{4}$, bones of the feet averaging a little heavier and more rugose. Dental formula, i. $\frac{1}{1}$, c. $\frac{0}{1}$, pm. $\frac{4}{3}$, m. $\frac{3}{3}$. The cutting surface of the upper incisor, plate ix. fig. 4, ascribed to this subspecies by Dr. Leidy, is elongate, rounded from front to back, and somewhat rounded on the side. The lower incisor, plate xii. fig. 1, is long, with a short, triangular, enamel-covered point. The lower canine, plate xii. figs. 2, 3, and 4, is long and much curved, with the convexity inward, the cutting portion wearing to a long, smooth, chisel-like point. The young unworn canine shows a long, triangular, sharp-cutting edge.

An anticrochet is developed on all upper teeth back of the second premolar. The inner angles of protoloph and metaloph are united by the backwardly directed crochet in pm. 2, 3, 4, the crochet becoming free on the first molar. Professor Osborn, "Bull. Mus. Comp. Zool.," xx. part iii. pages 92 and 93, states that the anticrochet is absent in pm. 4 of *fossiger*, but the specimens in hand show that this may or may not be the case. The fourth premolar of one specimen, plate ix. fig. 3, from Florida, bears a rudimentary crista, while in one example of *fossiger* the corresponding tooth has the crista well developed and uniting with the metaloph to form a small fossette. In other examples of both *proterus* and *fossiger* the crista is absent, so that the presence

or absence of this portion of the tooth would seem in itself a character of comparatively little value.*

The inner, pinched-up, basal portions of the protoloph and metaloph, the foreshadowing of the pillar, are slightly narrower in *proterus* than in *fossiger*, and the cingulum is usually better developed on pm. 3 and 4. As a rule, too, the crests approach each other more closely in the Florida specimens than they do in *fossiger*, so that the pits produced by the wear of the teeth appear earlier and endure longer. This is best seen in the third upper molar of *fossiger*, which has a comparatively large anterior fossette, but the character is not constant, and different teeth vary much. In one specimen of *fossiger* in particular, plate viii. fig. 14, the fossette is abnormally large, there is a rudimentary crista, and the metaloph is directed backward as in the first and second molars.

The following table gives the measurements of the molar teeth of *proterus* and *fossiger*, the first row of figures giving the antero-posterior diameter, the second row the transverse:

| | M. I. | M. II. | M. III. |
|---|---|---|---|
| Proterus . . | .57 x .60 mm. | .61 x .65 mm. | .66 x .54 mm. |
| Proterus . . | .51 x .55 " | .58 x .60 " | .60 x .51 " |
| Proterus . . | | .63 x .68 " | |
| Fossiger, 1350 . | .68 x .69 " | .75 x .69 " | .55 x .45 " |
| Fossiger, 1349 . | .66 x .69 " | .76 x .68 " | .75 x .56 " |
| Fossiger, 1348 . | .58 x .72 " | .68 x .74 " | .67 x .68 " |
| Fossiger, 1347 . | .38 x .72 " | .55 x .77 " | .68 x .70 " |
| Type . . | .49 x .66 " | .66 x .68 " | .73 x .65 " |

The antero-posterior measurement depends greatly on the amount of wear which the tooth has undergone and also on the curvature of the tooth, a little more curve adding materially to the measurement. The measurements given above are all taken in a straight line along the widest portions of the teeth. The measurements of teeth of *Aphelops fossiger* are of interest, as the skulls represent individuals of very different ages. In 1350 the third molar is exposed for a height of .30 mm., in 1349 it is fully through but unworn, in

* In the *American Naturalist* for March, 1894, page 241, Mr. Hatcher describes the dentition of a specimen of *Aphelops fossiger*, suggesting that it may prove to be a new species, but unless other specimens exactly similar should be found, I should consider it merely a case of individual variation. Furthermore, the numerous specimens examined show that the crista and crochet are by no means constant in their development, and that too much stress should not be laid on them as characters.

1348 the third molar is in use, while 1347 is a very old animal in which the teeth are worn down nearly to the roots. As indicated by this series, there is a gradual decrease in length and increase in width of the third molar. The premolars and molars are well shown on plate viii.

The number of lower teeth in the collection is much less than that of the upper grinders, and they do not appear to have been so consociated with these as to render it possible to state to which of the two species under consideration they belonged. Those shown in plate x. figs. 1, 2, 8, 9, and 10, probably from their size, belong to *A. proterus*, and well represent the change in appearance brought about by wear.

The only well-preserved portion of the vertebral column is an axis, lacking the posterior epiphysis, but a few other more or less imperfect cervicals are also present. The general character of this axis, like that of *fossiger*, is stout and rugose. The articular surface of this and one other axis is continuous from side to side; in a third specimen there is a narrow interval between the articular surface of the odontoid and of the lateral facets.

Measurements are as follows:

| | Proterus. | | Fossige . |
|---|---|---|---|
| Width across articular facets . | .147 mm. | | .147 mm. |
| Depth of articular facets . . | .36 " | .45 mm. | .42 " |
| Width across postzygapophyses . | .86 " | .86 " | .112 " |
| Diameter of neural canal . . | .36 " | .34 " | .39 " |

Scapula.—The glenoid portion is all that is present of the scapula, and there is nothing to distinguish it from the corresponding portion of the scapula of *fossiger*. The glenoid fossa measures .80 mm. long and .60 mm. wide.

Humerus.—The only humerus approaching completeness, plate xiv. fig. 6, lacks the tuberosities. It is somewhat slender, and the deltoid ridge is not so pronounced as in a corresponding bone of *fossiger*, but the humeri of both are remarkable for the great and abrupt projection of the epicondyle.

| | Proterus. | Fossiger. |
|---|---|---|
| Length between articulations . . | .305 mm. | .308 mm. |
| Width across epicondyle . . . | .127 " | .138 " |

Ulna.—The ulna is represented by one complete specimen, plate xiv. fig. 5, the olecranal portion of another, and the distal extremities of three. Two of these last are much larger and more massive than the other, and considerably exceed in size the specimen figured.

Measurements are as follows:

| | Proterus. | | Fossiger. | |
|---|---|---|---|---|
| Length over all | | .300 mm. | .310 mm. | .350 mm. |
| Upper part of articular surface to outside of olecranon | .126 mm. | .121 " | .115 " | .143 " |
| Depth of olecranon at middle | .79 " | .84 " | .78 " | .87 " |

These evidently do not belong to *R. longipes* of Leidy, from the fact that this species more nearly resembles *R. unicornis* in build, and the distal end of the ulna should be wider than these specimens.

RADIUS.—There are no characters by which the radii of *proterus* (of which we have four complete examples) and *fossiger* can be separated, both being short, massive, and considerably dilated at either extremity. The larger of the two radii, whose measurements are given below, is figured on plate xiv. fig. 7, and was ascribed with a query to *R. longipes* by Dr. Leidy. For reasons given under the description of that species, it probably belongs to the species under consideration.

| | Proterus. | | Fossiger. | |
|---|---|---|---|---|
| Length | .270 mm. | .212 mm. | .290 mm. | .250 mm. |
| Proximal width | .88 " | .85 " | .98 " | .85 " |
| Distal width | .93 " | .83 " | .102 " | .83 " |

FEMUR.—The femur is represented by the proximal portion of two specimens, the distal ends of five, and the median part of the shaft of one. Its length, as indicated by these fragments, was about the same as that of *fossiger*, or about 40 to 42 cm. The great trochanter is low and wide, the lesser trochanter is represented by a ridge, while the third trochanter is very small in one specimen and large in another, although by no means like the third trochanter of *R. unicornis*. In a specimen of *fossiger* lacking the proximal epiphysis, the third trochanter is practically obsolete. The fragments indicate that the inner, upper portion of the shaft was thinner in *proterus* than in *fossiger*, but this may be an individual peculiarity of the bones of one or the other of the specimens. The distal portions of the femora are like the other bones, very variable.

Their measurements are as follows:

| | Proterus. | | Fossiger. |
|---|---|---|---|
| Greatest width | .115 mm. | .122 mm. | .123 mm. |
| Greatest width of articular surface | .90 " | .96 " | .102 " |
| Greatest antero-posterior width | .126 " | .135 " | .143 " |

TIBIA.—The short, massive tibia, plate xv. fig. 5, is represented by five complete examples and portions of several others. These are all adult, and very closely resemble the tibiæ of *fossiger*. The external condylar articulation is, as a rule, not quite so pointed anteriorly and not so triangular in shape as the corresponding part of the tibia of *fossiger*, but this is a point of little value. It is apparently not uncommon for the fibula to ankylose with the tibia in *fossiger*, but no specimen of *proterus* presents this peculiarity.

Subjoined are measurements of several tibiæ:

Measurements of the calcaneum are as follows:

| | Proterus. | | | Fossiger. | | |
|---|---|---|---|---|---|---|
| Extreme length . . | .202 mm. | .220 mm. | .247 mm. | .220 mm. | .250 mm. | .270 mm. |
| Width, posterior part of proximal end . . | .100 " | .115 " | .105 " | .103 " | | .112 " |
| Width, anterior face of distal end . . | .73 " | .78 " | .80 " | .78 " | .78 " | .82 " |

TARSUS.—The calcaneum, plate xi. figs. 1 and 2, is noteworthy for the roundness of the calcaneal projection, the vertical and transverse measurements of the body of the bone differing but little, whereas in *R. unicornis* the vertical measurement much exceeds the transverse.

The astragalus, plate xiii. fig. 4, is wide and low, the tibial groove shallow, the cuboid articulation wide; these conditions being the reverse of those found in *R. unicornis*. There is nothing to distinguish the two bones just described from the corresponding bones of *fossiger*.

The various facets of both astragalus and calcaneum exhibit a wonderful amount of variation, and two specimens could readily be selected which might well be considered as belonging to two distinct species, were not every intermediate condition present. For distinctive purposes the shape and, to a great extent, the arrangement of these facets must be considered worthless.

## *Aphelops malacorhinus*

*Rhinoceros longipes* was described by Dr. Leidy in the "Proceedings of the Philadelphia Academy of Sciences" for 1890, page 183, where descriptions and measurements are given of a lower canine and second and fourth metacarpal, and it is noted that other bones and teeth were contained in the collections

from Florida. A comparison of the teeth and some of the bones with those of the type of *Aphelops malacorhinus* in the collection of Professor Cope shows the identity of the two species, and that *Rhinoceros longipes* is merely a synonyme of *A. malacorhinus*. Remains of this species, as in Western deposits, are much less abundant than those of *A. fossiger*, and comparatively few teeth are included in the collections from Florida.

The differences between the molars of *A. malacorhinus* and *A. fossiger* are well marked, and consist in the greater simplicity of structure of the molar of *A. malacorhinus*, the smaller size of the fossettes, and consequent closer approximation of the various crests. (See plate x. figs. 11 to 16.) There is no constriction of the inner part of either protoloph or metaloph into a separate column, these two crests, when viewed from the inner side, appearing as two simple cones united for some distance above their bases. The cingulum is much developed, and exhibits a tendency to give off little conical projections on the inner edge. The surface of the enamel is quite smooth, lacking the vertical striations present in *fossiger* and its subspecies *proterus*.

Strictly speaking, the molars bear no anticrochet, although there is a slight angularity of the protoloph where the anticrochet would be produced, but the crochet is well developed, and there is a tendency towards the production of a crista which may, as in plate x. fig. 11, unite with the crochet. In the type of *A. malacorhinus* there is no anticrochet on either pm. 3 or 4. The differences between the teeth of *A. malacorhinus* and *A. fossiger* are just such as prevail between those of the African *R. bicornis* and the Asiatic *R. unicornis*.

The canine ascribed to this species, plate xi. fig. 11, is very large and heavy, straighter than the canine of *A. fossiger*, more rounded in section, and more pointed anteriorly.

There are no vertebræ in the collection which appear to belong to this species.

Humerus.—The distal end of the humerus, plate xvi. fig. 7, is not only much larger than any specimen of this bone belonging to *A. fossiger*, but lacks the great and abrupt projection of the external condyle. The posterior projection of the internal condyle is also less pronounced than in *fossiger*, and the humerus more nearly resembles that of *R. unicornis*. The supinator ridge is not pronounced, and the shaft of the bone is rounder than in *fossiger*.

Radius.—Two radii were ascribed to *R. longipes* by Dr. Leidy, but the specific identity of one, plate xiv. fig. 1, was justly queried, for while larger than any of the Florida specimens of *proterus*, it is no larger and no more

rugose than some radii of *A. fossiger* from Kansas. The articular proximal portion, plate xiv. fig. 2, which is all that is preserved of the second radius, indicates an animal generally larger than *fossiger*, and, if one may use the term, less pronounced in structure. It articulates perfectly with the distal end of the right humerus shown in plate xvi. fig. 7, and may have belonged to the same animal.

CARPUS.—The scaphoid, plate xiii. fig. 8, is more massive and its radial articular face more triangular in outline than the corresponding bone in an immature specimen of *R. unicornis*. The unciform, which has its posterior projection broken off, is slightly smaller, but a little more heavily built than in the same specimen of *unicornis*, and it, as well as the fourth metacarpal, exhibits articulations for the rudimentary fifth metacarpal.

METACARPALS.—The second metacarpal is decidedly lighter than that of *unicornis*, while the fourth metacarpal is practically of the same size in the two animals. Plate xiii. figs. 6 and 7.

FEMUR.—Only the distal portion of a femur, plate xvi. fig. 8, is present, and this has a portion chipped off the outer condyle. It is distinguishable from the distal end of the femur of *A. fossiger* only by its superior size, while in turn it is smaller than the corresponding portion of the femur of Indian rhinoceros. It agrees in size with part of a femur of *A. malacorhinus* in the possession of Professor Cope.

TIBIA.—The distal end of the tibia, plate xvi. fig. 5, is wide and transversely flattened, the inner face is also flattened, while the outer is very sharp, the general character of the bone being square and angular. The transverse diameter is much greater than the antero-posterior diameter, which is not the case in the tibia of *fossiger*, while the tibia of *malacorhinus* was also much longer than that of the other species.

Rather curiously in the present specimen, the distal end of the fibula is ankylosed with the tibia, which, as previously noted, often occurs in Western specimens of *fossiger*, but has not yet been found in the Florida representatives of that species.

The astragalus, plate xvi. fig. 6, is slightly wider than high, with the tibial groove deeply cut and the cubo-navicular articulation rather narrow fore and aft, contrasting in these points with *A. fossiger* and resembling *R. unicornis*.

The calcaneum, plate xi. figs. 3 and 4, is remarkable for its shortness and depth, again differing from *fossiger* and agreeing with *R. unicornis*. It is interesting to note that the long metatarsals of *malacorhinus* are associated

with so short a calcaneum, while the metatarsals of *fossiger*, which mark the extreme of shortness in the group, are joined with a comparatively long calcaneum. The inner facet for the astragalus is deeper than wide, and its long axis forms an angle of 40° to 45° with the outer face of the calcaneum. In *fossiger* the inner astragaline facet is longer than deep, and its long axis forms an angle of about 90° with a line drawn vertically to the outer face of the calcaneum. The cuboid facet looks almost directly downward, while in *fossiger* it looks sharply inward.

| | Malacorhinus. | | Unicornis. | Fossiger. | |
|---|---|---|---|---|---|
| Extreme length . . | .122 mm. | .113 mm. | .135 mm. | .126 mm. | .116 mm. |
| Width . . . . . | .90 " | .83 " | .85 " | .74 " | .62 " |
| Depth of process . | .63 " | .76 " | .75 " | .45 " | .37 " |
| Width of process . | .50 " | .50 " | .57 " | .35 " | .35 " |

# HIPPOTHERIUM

## *Hippotherium princeps*

THIS species was founded on a right upper molar, represented in plate xix. fig. 12. This specimen in size and extent of folding of the enamel so closely resembles a corresponding tooth of *Equus major* that it was at first assigned to that species by Dr. Leidy, the name *Hippotherium princeps* being applied to it upon Professor Cope pointing out that the anterior inner pillar was free. This is the sole distinction observable between this tooth and a corresponding tooth of *E. major*; while the pillar is, in transverse section, alike in the two, being convex on the outer aspect and concave on the inner free edge, the general appearance being, roughly speaking, heart-shaped. Among the few teeth of *E. major* in the collection of the United States National Museum is one in which the isthmus connecting the anterior pillar with the adjacent lake is extremely narrow, so narrow in fact as to be almost obsolete.

In view of this, and considering the great discrepancy in size that prevails between this tooth of *H. princeps* and those of the other known species of the genus, it would seem best for the present to consider *H. princeps* a dubious species, and should no other specimens be found, the tooth may be regarded as an abnormal tooth of *E. major*, showing a reversion in character.

F. A. L.

## *Hippotherium gratum* (*H. ingenuum* Leidy)

Is represented by two upper molars, an astragalus, and a single phalanx.

One of the molars is from a young individual and quite unworn, the upper part of the tooth tapering inward. The other molar, plate xix. fig. 10, is from an animal of moderate age, and shows the enamel folds very prettily. The anterior internal pillar is, in cross-section, a pretty regular ellipse, and is situated opposite the centre of the tooth. The posterior inner pillar is, in the present state of the tooth at least, poorly defined, being marked off from the

posterior crescent by a slight notch only. The free borders of the lakes have each a single infolding of enamel, while their apposed borders are folded into several narrow but not greatly complicated sinuses.

| | |
|---|---|
| Fore and aft diameter of tooth | 18 mm. |
| Transverse diameter of tooth | 17 " |

The astragalus, plate xviii. fig. 15, is characterized by the prominence of the trochlear keels, but, except in size, does not differ otherwise from the astragalus of the horse.

| | |
|---|---|
| Greatest height of astragalus on inner face | 36 mm. |
| Width of astragalus across navicular face | 28 " |

The proximal phalanx, plate xviii. fig. 16, ascribed to this species seems from its length and slenderness to belong to a hind leg. Its posterior upper face is deeply and widely excavated for the tendon.

| | |
|---|---|
| Greatest length of phalanx | 58 mm. |
| Greatest proximal width | 24 " |
| Greatest distal width | 20 " |

F. A. L.

## *Hippotherium plicatile*

Five molars and a number of bones of the extremities, mostly incomplete, are assigned to this species. A right upper molar, plate xix. fig. 2, probably the third, has the anterior internal pillar quite regularly elliptical in section, and the posterior pillar well marked off by infoldings of enamel. The adjacent borders of the lakes have numerous infoldings of enamel, giving a very complicated pattern, while their free borders are slightly wavy with the usual re-entrant fold, and the inner border of the anterior lake comprises several large and numerous small folds.

| | |
|---|---|
| Fore and aft diameter of tooth | 20 mm. |
| Transverse diameter of tooth | 23 " |

The radius, plate xix. figs. 3 and 4, resembles that of the horse, on a smaller scale. The ulna is complete and, except for a distance of 45 mm. at its proximal portion, united with the radius; the distal articulation is marked off from that of the radius by a shallow groove.

| | |
|---|---|
| Length of radius | 245 mm. |
| Proximal articular breadth | 57 " |
| Distal articular breadth, including ulna | 46 " |

The metacarpal, shown in plate xix. fig. 9, is long, slender, and round, with roughened surfaces for the contact of digits II. and IV. continued down the posterior face for the greater part of its length, with a well-defined ridge between them. The trochlear keel runs completely around the distal articular surface, which terminates anteriorly in a considerable hollow.

| | |
|---|---|
| Length of metacarpal | 230 mm. |
| Width of proximal articular face | 35 " |
| Width of distal articular face | 31 " |

The distal end of a tibia, plate xix. fig. 5, presents no peculiarities, and measures as follows:

| | |
|---|---|
| Greatest width | 56 mm. |
| Greatest antero-posterior diameter on internal face | 37 " |
| Greatest antero-posterior diameter on external face | 28 " |

The astragalus, plate xviii. fig. 14, has the proximal and distal internal tuberosities well developed, even more so than in the horse, differing in this respect from the astragalus of *H. isosensum* described by Professor Cope. On a larger scale it resembles the astragalus of *H. gratum*, previously described.

Its measurements are:

| | |
|---|---|
| Height of internal face | 49 mm. |
| Breadth of cubo-navicular face | 37 " |

Two fragments of metatarsals belonging, if not to the same individual, to two of the same size, indicate the length of this bone to have been about 235 mm. The proximal end, plate xix. fig. 7, is cut out for the second and fourth digits, and the articular faces for these metatarsals extend the entire length of the bone. They are more widely separated, except at their proximal ends, than the second and fourth metacarpals, and instead of a ridge are divided by a shallow groove. The trochlear ridge runs completely around the distal articular face, being carried well up behind, where it is also the most prominent. This articulation terminates anteriorly in a very shallow depression, instead of in a very deep one, as is the case with the distal articular face of the metacarpal. The width of the distal articular face is 30 mm.

Two proximal phalanges which, from the differences in their proportions, evidently belong one to the fore the other to the hind leg, are proportionately heavier and more rugose than the corresponding bones of the horse, differing in this respect entirely from the phalanx ascribed to *H. gratum.*

The measurements of these phalanges, the anterior of which is shown in plate xix. fig. 8, are as follows:

| | |
|---|---|
| Length of anterior phalanx | 51 mm. |
| Breadth at proximal end | 34 " |
| Breadth at distal end | 27 " |
| Length of posterior phalanx | 56 " |
| Breadth at proximal end | 33 " |
| Breadth at distal end | 27 " |

The metapodials and phalanges of this species are proportionately longer and more slender than the corresponding bones in *H. occidentale.*

F. A. L.

# PROCAMELUS

IN the "Proceedings of the Academy of Natural Sciences of Philadelphia" for 1886, on page 12, Dr. Leidy gave the names of *Auchenia major*, *medius*, and *minimus*, to fossils from Archer County, Florida, indicating three species of cameloid animals. No characters were given save the length and breadth of the astragalus.

The largest of these three species belongs to the genus *Procamelus*, and would therefore stand as *Procamelus major* Leidy, and it is quite probable that the two other species also belong in the same genus, although in the absence of teeth this cannot be positively asserted.

The entire dental series of *P. major* is not present, there being no specimens of the first premolars, upper incisors, or second lower premolars, and it is by no means easy to determine whether certain curved caniniform teeth are canines or first premolars. The dentition, however, may be characterized as follows: i. $\frac{1}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{4}$, m. $\frac{3}{3}$. The second and third molars are very similar to those of *P. robustus*, the first molars, second and third premolars much larger. Thus, taking the teeth which are actually present, plate xvii. figs. 6–10, the combined lengths of lower pm. 3 and 4 and m. 1, 2, and 3 is 155 mm. in *P. major* and 145 mm. in *P. robustus*. The length of the lower tooth line, composed of pm. 2 and m. 1, 2, and 3, in *Camelus dromedarius* and *C. bactrianus* is respectively 142 and 152 mm. There is more of a ridge on the posterior internal edge of the first pillar of m. 3 in *P. major* than in *P. robustus*, while the middle pillar is externally less symmetrical, its posterior portion tending to form an angle. The same differences also exist between this tooth and the corresponding tooth of *Camelus*. The posterior extremity of m. $\frac{3}{3}$ is more rounded in *P. major* than in *P. robustus*, and the outer edge of the third pillar is convex instead of concave as in *Camelus*. The last lower premolar is about the size of that of *C. bactrianus* and a little larger than that of *C. dromedarius*. The upper premolars and molars of *P. major*, plate xvii. figs. 1–5, have a well-developed cingulum, and this in some cases bears a good-sized tubercle opposite the furrow dividing the two pillars of the molars.

The identity of the species to which the names *Auchenia medius* and *minimus* are applied cannot be regarded as definitely settled, for there are no

teeth present assignable to either species, although two small caniniform teeth are included in the collection which seem to belong to the smallest species. Among some Florida fossils belonging to Mr. S. A. Robinson, of Orlando, is a second right upper molar, plate xvii. fig. 18, which may belong to *A. medius*. It is unworn, very much smaller than the second molar of *P. major*, and almost identical in size with the same tooth of *P. occidentalis*. It agrees almost exactly with the corresponding tooth of *P. gracilis*, shown in plate lxxvi. fig. 2, vol. iv., "U. S. Geographical Surveys West of the 100th Meridian." The species is there called *P. occidentalis*, but in the "Report of the Geological Survey of Texas" for 1892 Professor Cope points out that it is really *P. gracilis*.

The astragali ascribed to *A. minimus* agree in size with those of *P. gracilis* from Texas, and there is a possibility that the two species may prove to be identical, although the length and proportions of the metatarsus and phalanges seem to indicate that *A. minimus* was a little the larger of the two and stood somewhat higher on its legs.

The appended descriptions, with the exception of the section pertaining to the phalanges, had been prepared by Dr. Leidy.

F. A. L.

Among the fossil remains from Mixon's bone-bed, collected at different times, are many bones, with fragments of others and teeth, mostly isolated specimens, of extinct species of Llama. Many astragali, numbers of calcanei, phalanges, patellæ, and articular ends of the larger limb-bones, from their relative proportions, indicate apparently at least three distinct species. The specimens referred to each of these also show variations in size, in some cases to such a degree as to render their reference less certain. The largest species was considerably larger than the Camel, the second species was somewhat smaller than that animal, and the third one was little more than half the size of the first, but yet considerably larger than the existing Llama.

A series of the largest specimens of the fossil astragali, plate xviii. figs. 1, 5, and 7, in comparison with those at our command, pertaining to the Camel, Llama, and Huanaco, exhibit the following measurements:

| | P. major. | P. medius. | P. minimus. | Camel. | Llama. | Huanaco. |
|---|---|---|---|---|---|---|
| Length of astragalus internally . | 100 mm. | 67 mm. | 56 mm. | 75 mm. | 43 mm. | 39 mm. |
| Width of astragalus distally . . | 65 " | 46 " | 35 " | 50 " | 28 " | 25 " |

The associated teeth, mostly isolated specimens, in size are nearly all correlated with the bones of the larger species, but in comparison with those of the Camel, while they generally seem too small for the largest extinct Llama, they on the other hand seem too large for the second-sized species indicated by the bones.

A number of well-preserved molar teeth though detached from one another have every appearance of having belonged to the same individual, and these indicate the continuous series, below as well as above, to have been five in number. The true molars are like those of the Camel, and approximate them in size, while the premolars are larger, with the first of the series better developed, and in both jaws equally permanent with the rest.

The comparative measurements of the teeth with those of a Camel are as follows:

| | Fossil teeth. | | Recent Camel. | |
|---|---|---|---|---|
| Diameters. | Upper. | Lower. | Upper. | Lower. |
| Fore and aft, last molar | 40 mm. | 50 mm. | 40 mm. | 49 mm. |
| Transverse, last molar | 33 " | 23 " | 25 " | 21 " |
| Fore and aft, second molar | 37 " | 36 " | 39 " | 37 " |
| Transverse, second molar | 32 " | 23 " | 28 " | 22 " |
| Fore and aft, first molar | 33 " | 32 " | 30 " | 37 " |
| Transverse, first molar | 31 " | 21 " | 27 " | 21 " |
| Fore and aft, last premolar | 25 " | 22 " | 22 " | 21 " |
| Transverse, last premolar | 25 " | 14 " | 22 " | 12 " |
| Fore and aft, penultimate premolar | 23 " | | 17 " | 17 " |
| Transverse, penultimate premolar | 16 " | | 14 " | 9 " |

The fossil molar teeth just indicated give together continuous series a little longer than in the Camel, though they seem hardly large enough to belong to the largest species of *Auchenia* indicated by the largest associated bones, and yet too large for the second-sized species indicated by other bones, so that it is uncertain whether they belong to either of these or to a third species of intermediate size.

A last upper molar tooth moderately worn and two teeth from another individual, consisting of a much-worn first upper molar and the outer portion of the preceding premolar, are larger than the corresponding teeth of the former lot, and more probably belong to the largest species, *P. major*, indicated by the accompanying bones.

The measurements of the specimens are as follows:

| | |
|---|---|
| Fore and aft diameter of last molar | 46 mm. |
| Transverse diameter of last molar | 37 " |
| Fore and aft diameter of first molar | 33 " |
| Transverse diameter of first molar | 33 " |
| Fore and aft diameter of last premolar | 28 " |

An isolated last upper molar, little worn and well preserved, plate xvii. fig. 17, submitted to my examination by Dr. J. C. Neal, previously to finding the former specimens, is smaller than either of the above corresponding teeth and probably represents the second-sized species, *A. medius*, indicated by the bones. Its fore and aft diameter is 36 mm., its transverse diameter 27 mm.

Some additional specimens, a last upper molar, a last premolar, plate xvii. fig. 12, and fragments of several other upper molars, accord in proportions with the first described lot of teeth.

The fossil molar teeth while resembling those of the Camel in construction seem to have the crowns proportionately somewhat less long, of rather greater breadth transversely, with the inner sides of the upper teeth and the outer sides of the lower ones less vertical or more sloping, and the opposite sides of the same teeth rather more prominently folded.

The upper penultimate premolar, or the first tooth of the continuous molar series, has a better developed crown than in that of the Camel, and it is inserted like the succeeding premolar by three well-produced fangs. The crown is wider fore and aft than in the Camel and shows a greater disposition to form an inner lobe, which in the fossil tooth appears as a thick, crescentic fold deeply notched at the middle.

The corresponding lower premolar is a reduced form of that behind it, and is inserted by a pair of well-produced fangs in closer apposition. The fore part of the crown is not reflected inward as in the last premolar, but is directed forward and presents an acute border in the same position. The worn triturating surface of the last lower premolar exhibits an elliptical enamel-pit, which is absent in the preceding tooth from the corresponding inner fold not having penetrated the crown so deeply.

Scapula.—Of five specimens of the glenoid extremity of the scapula in the collection, two pertain to *A. major* and three to *A. minimus*. They accord with the corresponding portion of the same bone in the Llama.

Their comparative measurements are as follows:

| | P. minimus. | P. major. | Llama. |
|---|---|---|---|
| Depth from coracoid process to lower border of glenoid fossa | 65 mm. | 127 mm. | 55 mm. |
| Height of glenoid fossa | 45 " | 85 " | 38 " |
| Transverse breadth | 41 " | 75 " | 33 " |

HUMERUS.—A mutilated proximal end of the humerus of *P. major* accords in anatomical character with the corresponding portion of the same bone in the Llama.

Its comparative measurements are as follows:

| | P. major. | A. llama. |
|---|---|---|
| Breadth fore and aft of the head | 105 mm. | 43 mm. |
| Breadth from side to side | 90 " | 43 " |

Of six specimens of the distal extremity of the humerus in the collection three belong to *P. minimus* and three to *P. major*. They likewise accord with the corresponding portion of the same bone in the Llama.

Their comparative measurements are as follows:

| | P. minimus. | P. major. | A. llama. |
|---|---|---|---|
| Breadth of the distal articulation | 50 mm. | 95–102 mm. | 42 mm. |

RADIUS AND ULNA.—Plate xv. figs. 9 and 10. Ten specimens in the collections from Mixon's plantation are extremities of forearm bones, which closely accord in anatomical character with corresponding portions of the same bones in the living Llama. From their proportionate sizes four pertain to *P. minimus*, one to *P. medius*, and the remainder to *P. major*. Of the first, two are mutilated proximal extremities, the others the complete distal extremities, of which one is represented in plate xvi. fig. 3. The second is a distal extremity, represented in plate xv. fig. 10. The last consist of a mutilated upper extremity, two complete distal extremities, of which one is represented in plate xv. fig. 9, and the detached epiphyses of two others of the latter.

The comparative measurements of specimens of the distal extremities of the bones are as follows:

| | P. minimus. | | P. medius. | P. major. | Llama. |
|---|---|---|---|---|---|
| Extreme breadth | 59 mm. | 54 mm. | 76 mm. | 122 mm. | 45 mm. |
| Extreme fore and aft diameter | 40 " | 37 " | 52 " | 77 " | 31 " |
| Breadth of the carpal articulation | 48 " | 43 " | 69 " | 100 " | 35 " |

CARPUS.—Of the bones of the carpus referable to the species of *Auchenia*

in the collections from Mixon's plantation, there are fifty-four isolated specimens. Of these, forty-six are referable to *A. major*, consisting of eleven scaphoids, five lunars, seven cuneiforms, four pisiforms, one trapezoid, ten magnums, and seven unciforms. One is a magnum of *P. medius*, and the rest pertain to *P. minimus*, consisting of two scaphoids, one lunar, one cuneiform, two pisiforms, and one magnum. The bones accord pretty closely in anatomical character with those of the living Llama. All of them, however, are distinct or separate, from which we may infer that they permanently continued in this state, whereas in the Llama ordinarily we find the scaphoid and lunar and the magnum and trapezoid co-ossified.

METACARPALS.—Three specimens in the collection from Mixon's are upper extremities of metacarpals, representing the three species of *Procamelus*. The best preserved specimen, about seven inches in length, pertains to *P. minimus*, and is represented in plate xvi. fig. 1. All accord in anatomical character with the corresponding part of the same bones in the living Llama.

Measurements of the specimens are as follows:

| | P. minimus. | P. medius. | P. major. |
|---|---|---|---|
| Breadth transversely . . . | 48 mm. | 64 mm. | 86 mm. |
| Breadth fore and aft internally . | 34 " | 40 " | 55 " |
| Breadth fore and aft externaly . | 36 " | 44 " | 58 " |

PATELLA.—Fourteen patellæ in the collections from Mixon's plantation present the anatomical character of the bone in the living Llama. Four of them are proportioned in size with the *P. minimus*, two with the *P. medius*, and eight with the *P. major*.

Comparative measurements of specimens are as follows:

| | P. minimus. | | P. medius. | P. major. | | | Llama. |
|---|---|---|---|---|---|---|---|
| Extreme length . | 63 mm. | 61 mm. | 89 mm. | 122 mm. | 117 mm. | 104 mm. | 55 mm. |
| Extreme breadth . | 33 " | 32 " | 48 " | 58 " | 56 " | 49 " | 26 " |
| Thickness . . | 27 " | 29 " | 43 " | 59 " | 55 " | 44 " | 22 " |
| Length of articular surface . . | 55 " | 60 " | 80 " | 98 " | 102 " | 100 " | 45 " |
| Breadth of articular surface . . | 30 " | 30 " | 38 " | 50 " | 53 " | 44 " | 22 " |

TARSUS.—Of smaller bones of the tarsus referable to *Procamelus* in the collections from Mixon's there are twenty-six isolated specimens. Of these, twenty pertain to *P. major*, consisting of nine cuboids, of which seven are of the left side, five naviculars, four ecto-cuneiforms, and two meso-cuneiforms.

The others pertain to *P. minimus* and consist of three cuboids, all of the right side, two naviculars, and an ecto-cuneiform. In anatomical character they accord with the same bones in the living Llama.

ASTRAGALUS.—In the collection from the bone-bed of Mixon's plantation are sixteen isolated astragali, approximating in anatomical character those of the living Llama, and, judging from their proportionate size, pertaining to the three extinct species indicated. Five of the specimens most approaching in size those of the Llama, but larger, are probably referable to *P. minimus;* two are nearly complete, the others mutilated, and one of the former is represented in plate xviii. fig. 7. They differ among themselves in size and slightly also in other points. From the astragalus of the living Llama they differ most in the rather more grooved condition of the posterior calcanean articular surface and in the complete separation of this from the outer one by a conspicuous irregular grooved tract.

The measurements of the specimens in comparison with an astragalus of the recent Llama are as follows:

| Astragalus. | P. minimus. | | | | A. llama. |
|---|---|---|---|---|---|
| Length externally . . | 49 mm. | 54 mm. | | 56 mm. | 43 mm. |
| Length internally . . | 45 " | | 51 mm. | 51 mm. 51 " | 39 " |
| Breadth of tibial trochlea . | 28 " | 33 " | 35 " | 33 " | 26 " |
| Breadth of distal extremity | 33 " | | | 34 " | 28 " |

According to Gervais, the astragalus of *A. castelnaudii*, from Tarija, South America, measured 42 mm. in length, therefore considerably smaller than in *P. minimus* and approximating that of the recent *A. llama.*

Two astragali, according with the former in anatomical character, but considerably larger, and approximating in size those of the Camel, are referable to the second associated species, the *P. medius.* One of the specimens is represented in plate xviii. fig. 5. They are about the size of the astragalus described by Gervais and referred to *A. weddellii*, from Tarija, South America.

The measurements of the specimens in comparison with the astragalus of the latter and of the Camel are as follows:

| Astragalus. | A. medius. | | A. weddellii. | Camel. |
|---|---|---|---|---|
| Length externally . . | 67 mm. | 66 mm. | 65 mm. | 75 mm. |
| Length internally . . | 61 " | 61 " | | 67 " |
| Breadth of tibial trochlea . | 38 " | 42 " | | 43 " |
| Breadth of distal extremity . | 45 " | | | 50 " |

The remaining nine astragali are referable to the largest associate species, the *P. major*. The specimens differ among themselves slightly in size and other points. One of them is represented in plate xviii. fig. 1. They are much larger than in the Camel, and they strikingly differ in the separation of the calcanean articular surfaces by the conspicuous groove or step, variable in character in the different specimens.

The measurements are as follows:

| Astragalus of P. major. | 1. | 2. | 3. | 4. | 5. |
|---|---|---|---|---|---|
| Length externally . . | 100 mm. | 98 mm. | 102 mm. | | 98 mm. |
| Length internally . . | 93 " | 92 " | 94 " | 98 mm. | |
| Breadth of tibial trochlea . | 60 " | 58 " | 59 " | | 59 " |
| Breadth of distal extremity | 66 " | 64 " | | 71 " | 67 " |

| Astragalus of P. major. | 6. | 7. | 8. | 9. |
|---|---|---|---|---|
| Length externally . . | 100 mm. | 101 mm. | 96 mm. | 98 mm. |
| Length internally . . | 96 " | 95 " | 89 " | 89 " |
| Breadth of tibial trochlea . | 59 " | 61 " | 58 " | 67 " |
| Breadth of distal extremity . | 66 " | 67 " | 63 " | 66 " |

METATARSALS.—Of five specimens of upper extremities of metatarsals in the collections from Mixon's referable to *Procamelus*, three belonged to *P. minimus*, the others to *P. major*. The former are all of the right side, and therefore belong to as many individuals. The best preserved specimen pertaining to this species is represented in plate xvi. fig. 1. It is a foot in length, and when complete was about fifteen inches, indicating a proportionately longer foot than in the living Llama. The specimens all accord in anatomical character with the corresponding part of the same bones in the latter.

Measurements of the specimens are as follows:

| | P. minimus. | P. major. |
|---|---|---|
| Breadth transversely . . . . . | 41 mm. | 81 mm. |
| Breadth fore and aft internally . . . | 38 " | 62 " |
| Breadth fore and aft externally . . . | 37 " | 62 " |

PHALANGES.—Plate xviii. figs. 2 to 6 and 8 to 10. A number of phalanges are present belonging to the species named *Procamelus major*, several ascribable to *P. minimus*, but only one entire phalanx and the proximal portion of a second of *P. medius*. These phalanges are all of the Llama type, the proximal phalanges being longer, more slender, and much less expanded at the distal end than in the camel. In this respect, however, *P. major* is somewhat

intermediate, the phalanges having a little more resemblance to those of the camel than the corresponding bones of *P. medius* or *minimus*. The median phalanges are not thin and flattened as in *Camelus*, but are stout, while the terminal phalanges are also stouter than in the Camel. *P. minimus* is remarkable for the length of the proximal phalanges, which in this respect exceed those of the existing *Auchenia llama*, although the articular surfaces of the two are of nearly the same size. Two phalanges from the forefoot of *P. minimus*, one of which is shown in plate xvi. fig. 8, are a little more than one-fourth longer than the corresponding bones of *P. gracilis*, shown in plate lxxix. fig. 7 of Vol. IV., "Report of the U. S. Geographical Surveys West of the 100th Meridian," and there called *Procamelus occidentalis*. Compared with *Holomeniscus hesternus* and *H. sulcatus* the proximal phalanges of *P. major* are shorter and heavier.

There are not sufficient specimens present to show whether or not there is the same discrepancy in size between the phalanges of the fore and hind feet that is found in existing camels and llamas.

PLATE VII.

1

2

## PLATE VIII.

All figures natural size.

*Aphelops fossiger.*

Figs. 1 and 2. First upper left premolar.

Figs. 3 and 4. First upper right premolar.

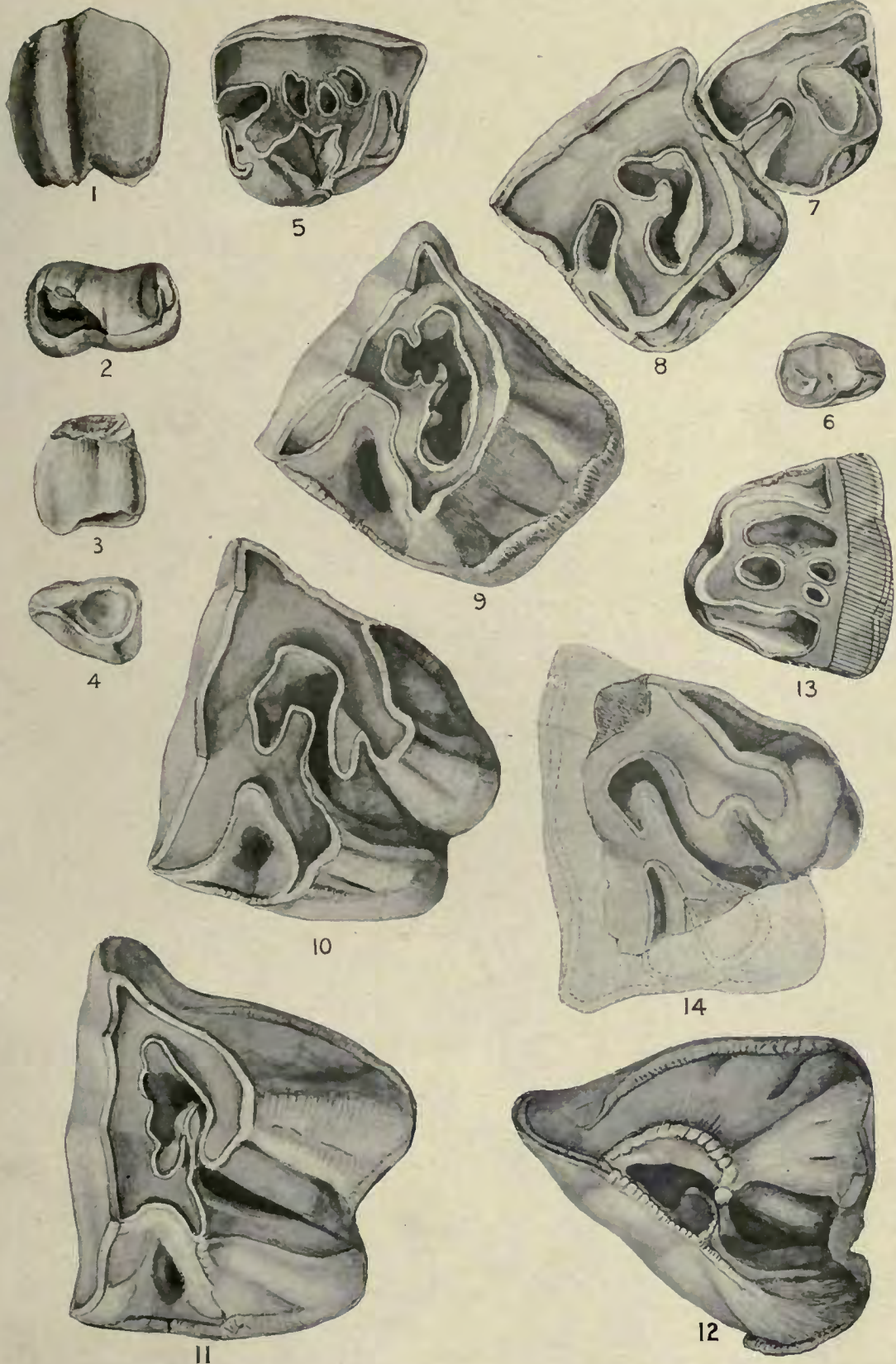
Fig. 5. Second upper right milk molar.

Figs. 6 to 12. Series of teeth from the upper right side of one individual. 6 to 9, premolars; 10 to 12, molars.

Fig. 13. Second upper left milk molar. *Rhinoceros meridianus.*

Fig. 14. First or second upper right molar.

PLATE VIII.



## PLATE IX.

All figures three-fourths natural size.

*Aphelops fossiger.*

Fig. 1. First upper left molar.

Fig. 2. Fourth upper left premolar, unworn.

Fig. 3. Fourth upper left premolar.

Fig. 4. Upper incisor.

Fig. 5. Third upper right milk molar.

Fig. 6. Second upper left molar.

Fig. 7. Second upper left molar.

Fig. 8. Second upper right molar, unworn.

Fig. 9. Second upper left milk molar, little worn.

Fig. 10. Second upper right milk molar, much worn.

Fig. 11. Third upper left milk molar, little worn.

Fig. 12. Third upper left milk molar.

Fig. 13. Third upper left molar.

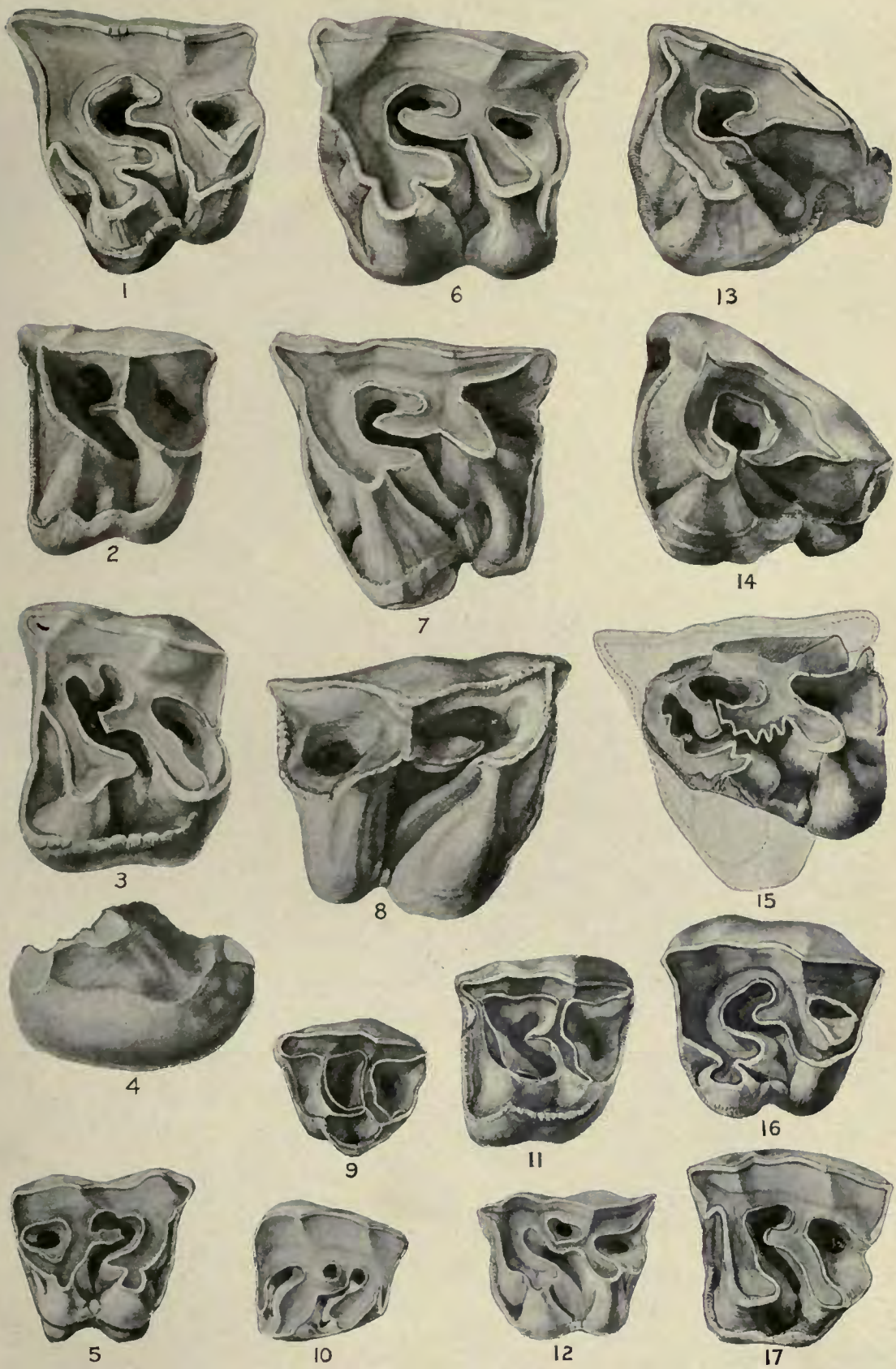
Fig. 14. Third upper left molar.

Fig. 15. Second upper left molar, abnormal.

Fig. 16. Fourth upper left milk molar.

Fig. 17. Third upper left premolar.

PLATE IX.



## PLATE X.

All figures three-fourths natural size.

*Aphelops.*

Figs. 1 and 2. Lower left molars.

Figs. 3 and 4. Second lower right premolar.

Figs. 5 and 6. First lower right premolar.

Figs. 7 and 8. Second lower left molar, little worn.

Figs. 9 and 10. Lower left molar.

*Aphelops malacorhinus.*

Fig. 11. First upper left molar.

Fig. 12. Second upper right premolar.

Fig. 13. Third upper left premolar.

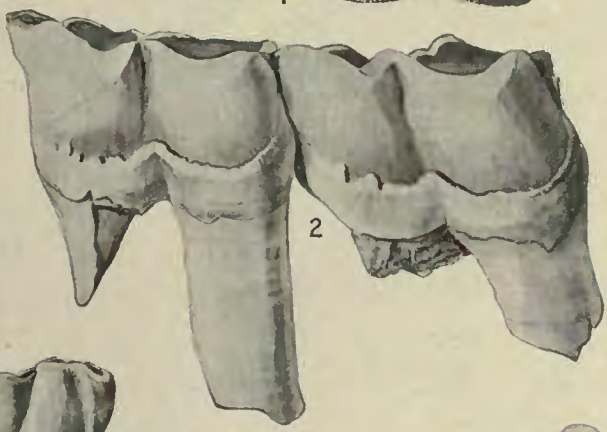
Fig. 14. Fourth upper left premolar.

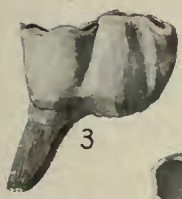
Fig. 15. First upper left molar.

Fig. 16. Second upper left molar.

PLATE X.


1


2


3


4


5


6


7

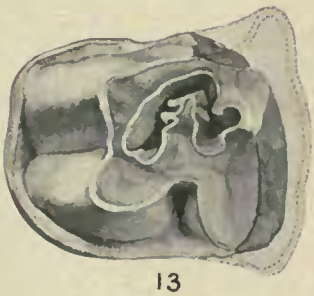

8

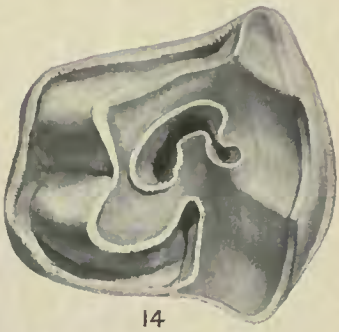

9

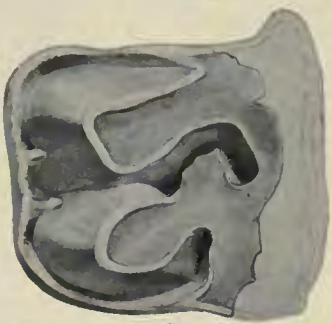

10

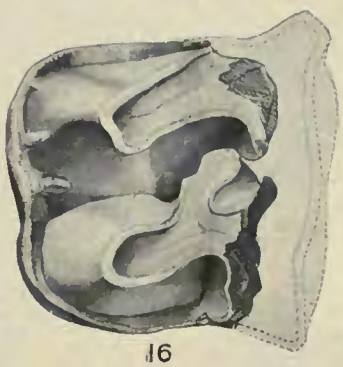

11


12


13


14


15


16

## PLATE XI.

All figures one-half natural size.

*Aphelops fossiger.*

Figs. 1 and 2. Right calcaneum.

*Aphelops malacorhinus.*

Figs. 3 and 4. Right calcaneum.

*Aphelops fossiger.*

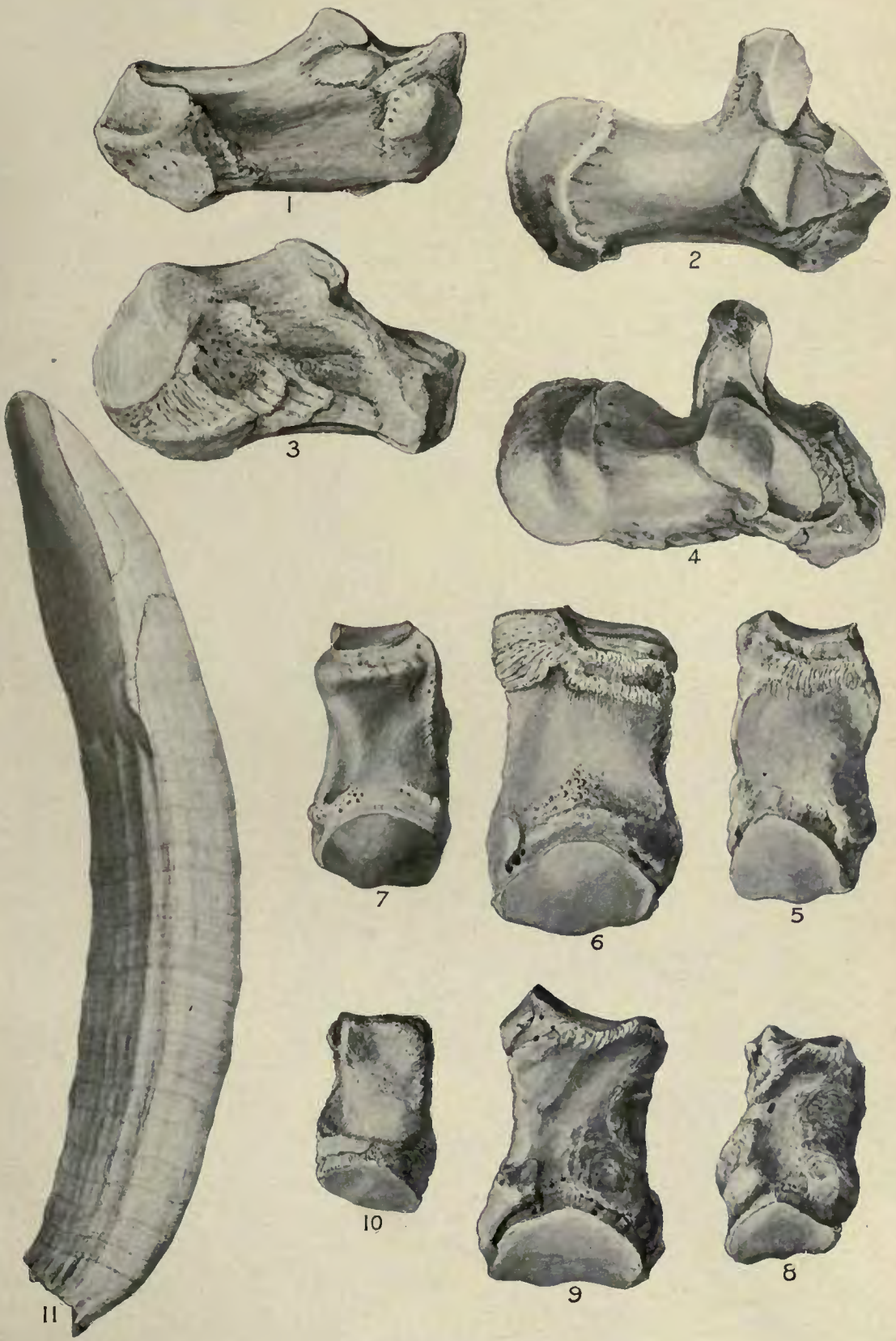
Figs. 5, 6, and 7. Second, third, and fourth right metacarpals.

Figs. 8, 9, and 10. Second, third, and fourth right metatarsals.

*Aphelops malacorhinus.*

Fig. 11. Left lower tusk.

PLATE XI.



## PLATE XII.

All figures three-fourths natural size except figure 2, which is three-eighths.

*Aphelops fossiger.*

Fig. 1. Lower left inner incisor.

Fig. 2. Lower left outer tusk. Inner view.

Fig. 3. Lower left outer tusk. Back view of anterior portion.

Fig. 4. Anterior portion of an unworn lower tusk.

Figs. 5, 6, and 7. Proximal, median, and ungual phalanges of second digit of forefoot.

Fig. 8. Upper view of figure 7.

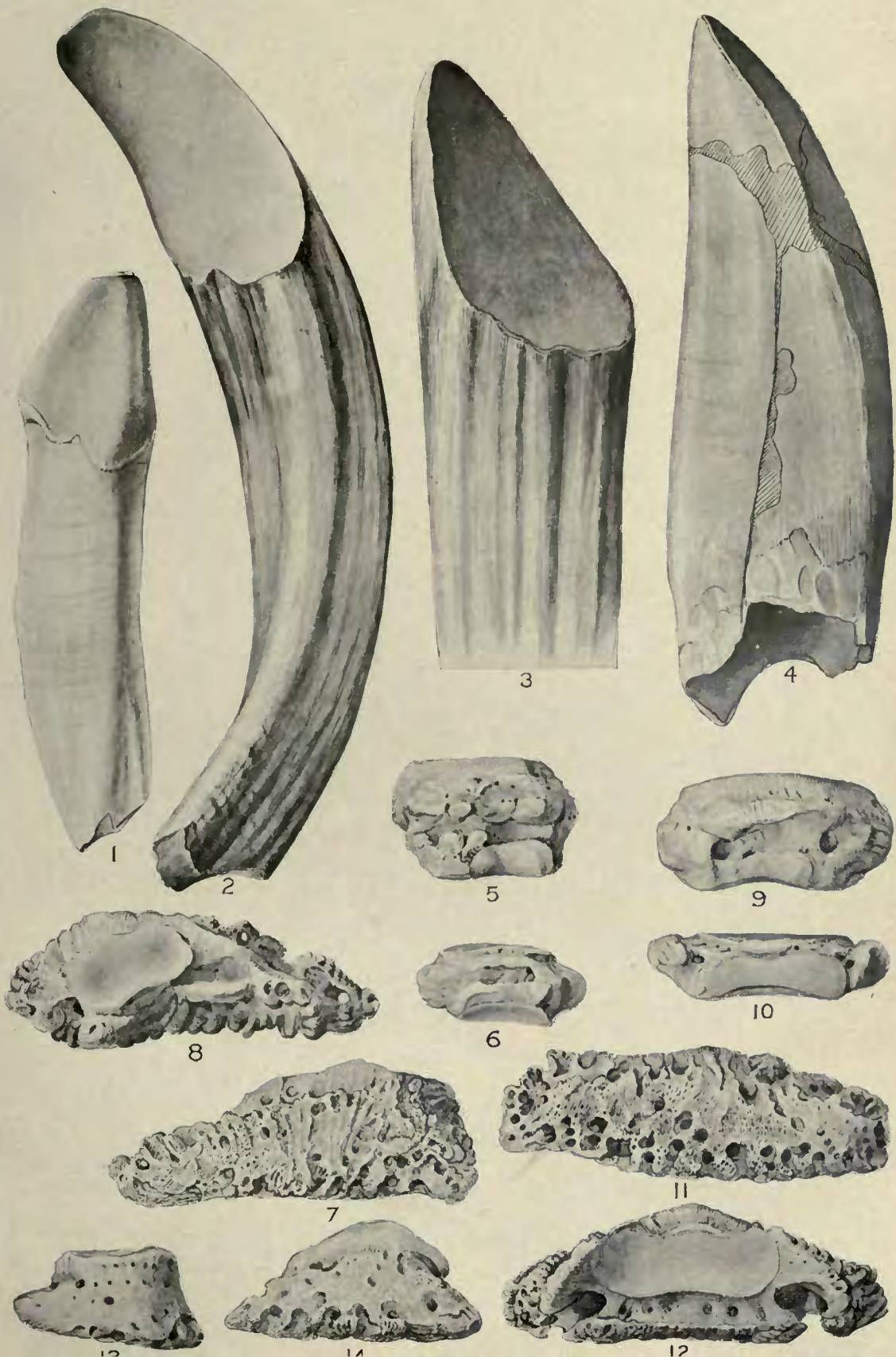
Figs. 9, 10, and 11. Proximal, median, and ungual phalanges of third digit of forefoot.

Fig. 12. Upper view of figure 11.

Fig. 13. Ungual phalanx of second digit of hind foot.

Fig. 14. Ungual phalanx of third digit of hind foot.

PLATE XII.



## PLATE XIII.

All figures three-fourths natural size.

*Aphelops fossiger.*

Figs. 1, 2, and 3. Second, third, and fourth left metacarpals.

Fig. 4. Left astragalus.

Fig. 5. Left scaphoid.

*Aphelops malacorhinus.*

Fig. 6. Second left metacarpal.

Fig. 7. Fourth left metacarpal.

Fig. 8. Left scaphoid.

PLATE XIII.

## PLATE XIV.

All figures three-eighths natural size.

*Aphelops fossiger.*

Fig. 1. Right radius.

Fig. 3. Right humerus, distal end.

Fig. 4. Right humerus, distal end.

Fig. 5. Right ulna.

Fig. 6. Right humerus.

Fig. 7. Right radius.

*Aphelops malacorhinus.*

Fig. 2. Right radius, proximal end.

PLATE XIV.

## PLATE XV.

All figures three-eighths natural size.

*Aphelops fossiger.*

Figs. 1, 2, and 3. Portions of left femur.
Fig. 4. Left patella. Posterior aspect.
Fig. 5. Left tibia.
Fig. 6. Left fibula.
Figs. 7 and 8. Right astragali.

*Procamelus major.*

Fig. 9. Left radius and ulna. Distal extremity.

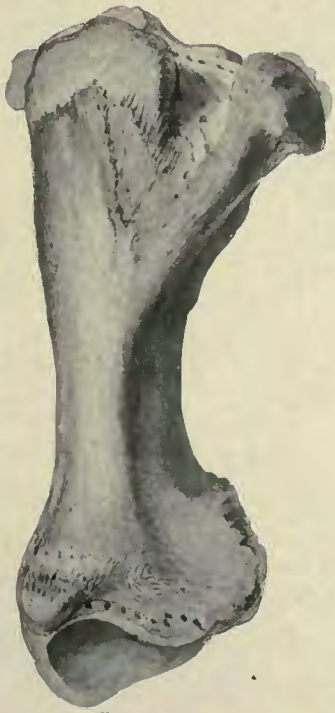
*Procamelus medius.*

Fig. 10. Left radius and ulna. Distal extremity.

PLATE XV.

1

4



5

6

2

7

8

3

9

10

## PLATE XVI.

All figures three-eighths natural size.

*Procamelus minimus.*

Fig. 1. Right metatarsal. Proximal extremity.

Fig. 2. Right metacarpal. Proximal extremity.

Fig. 3. Left radius and ulna. Distal extremity.

Fig. 4. Right humerus. Distal extremity.

*Aphelops malacorhinus.*

Fig. 5. Left tibia and fibula. Distal portion.

Fig. 6. Right astragalus.

Fig. 7. Right humerus. Distal portion.

Fig. 8. Right femur. Distal extremity.

Fig. 9. Right radius. Posterior aspect.

Fig. 10. Right patella. Posterior aspect.

PLATE XVI.