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Article IV.—A CONTRIBUTION TO THE KNOWLEDGE OF *MŒRITHERIUM*

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INTRODUCTION

The very important and puzzling genus *Mœritherium* was discovered and described by Dr. C. W. Andrews. He seems to have considered that this genus, as well as *Palæomastodon*, might be on the direct line of ancestry of the Proboscidea and that *Mœritherium* might be ancestral to *Palæomastodon*, as can be judged from his statements as follows:

> One long-standing problem, viz., the place of origin of the Proboscidea, may perhaps be regarded as solved already.[1]

Dr. Andrews pointed out the great difference between the Middle Eocene [Qasr-el-Sagha Formation] *Mœritherium* and the Upper Eocene [Fluvio-marine Formation] *Palæomastodon*, and suggested that the more rapid rate at which evolution seemed to have proceeded in the earlier stages of development of many groups of mammals might perhaps in some cases be accounted for as follows:

[1] 1901, 'Preliminary note on some recently discovered extinct Vertebrates from Egypt (Part I),' Geol. Mag., Decade 4, VIII, p. 409.

Among the Ungulates, at least, the earlier members of a group are usually of small size, and as specialization advances an increase in bulk also takes place.[1]

Of these genera mentioned above, *Palæomastodon* and *Mœritherium* appear to be on the direct line of the ancestry of the Elephants and Mastodonts.[2]

Another peculiarity noticed in the remains of *Palæomastodon* is the great variability in the dimensions, even among adult individuals. When it is remembered that this animal is probably the transitional stage between the small *Mœritherium*, about the size of a tapir, and the large longirostrine mastodonts, this variability in size is particularly interesting as supplying the basis upon which selection could bring about a rapid increase in the dimensions of these early proboscideans, and, indirectly, give rise also to the remarkable series of changes (described elsewhere) which culminated in the production of that characteristic structure in this group, *viz.*, the prehensile trunk.[3]

On the other hand, Dr. Andrews did not overlook the resemblance which exists between *Mœritherium* and certain earlier sirenians, and observed:

The discovery of an early and comparatively generalized type like *Mœritherium* naturally raises the question of the relationship of the Proboscidea to other mammals, and although at present it is not possible to arrive at any definite conclusion as to the origin of the group, the view put forward by Blainville and others that they may be related to the Sirenia receives some support.[4]

After the discovery of the fact that *Mœritherium* occurs also in the Fluvio-marine Formation associated with *Palæomastodon*, Dr. Andrews seems to have become suspicious with regard to *Mœritherium* being a direct ancestor of *Palæomastodon*, as we see in the following statement of his:

The occurrence of a species of *Mœritherium*, probably identical with *M. lyonsi*, in the Upper Eocene beds [Fluvio-marine Formation] in association with *Palæomastodon* raises the question of whether *Mœritherium* can be ancestral to *Palæomastodon.* If it is not, at least it must be extremely similar and very closely related to the actual ancestor, for it presents all the proboscidean characters in exactly the more generalized condition that one would expect to find. Moreover, it may be pointed out that *Palæomastodon* does not occur in the Middle Eocene beds [Qasr-el-Sagha Formation] in which *Mœritherium* is abundant, while in the upper beds [Fluvio-marine Formation] *Palæomastodon* is common, and but few *Mœritherium* remains have been found.[5]

In Dr. Andrews' beautiful memoir on the Tertiary Vertebrates of Fayûm, he noticed the following more important characteristics of *Mœritherium:*

(1) The nasals are short and the nasal opening is not quite at the end of the snout;

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[1] 'On fossil Vertebrates from Upper Egypt,' Proc. Zoöl. Soc. London, 1902, p. 229.

[2] 'On the evolution of the Proboscidea,' Phil. Transact. Roy. Soc. London, Ser. B., CXCVI.

[3] 1903, 'Notes on an expedition to the Fayûm, Egypt, with description of some new Mammals,' Geol. Mag., Decade 4, X, p. 339.

[4] *Loc. cit.*, Phil. Transact., 1903, p. 116.

[5] 1906, 'Descriptive Catalogue of the Tertiary Vertebrates of Fayûm, Egypt,' British Museum, p. xvi.

(2) The bones of the back of the skull tend to become swollen by the presence of air cells;

(3) The maxilla send forward on the palate processes which help to support the enlarged second incisors.[1]

As to the life-habits of *Mœritherium*, he observes in the same memoir as follows:

The limbs are unfortunately not well known. The humerus differs considerably from that of the later Proboscidea, but some of the smaller species of *Palæomastodon* from the Upper Eocene [Fluvio-marine Formation] seem to supply intermediate forms; probably the difference arises from the fact that *Mœritherium* was a more or less amphibious type, while the later elephants became fitted for progression on firm ground. The femur approximates very nearly to the form found in the later Proboscidea.

As already mentioned, *Mœritherium* was probably an amphibious, shore, or swamp living animal, and it was no doubt owing to the continuation of the condition favorable to its mode of life that it persisted into the Upper Eocene [Fluvio-marine] period. In the meantime, however, either from this or some closely allied type, there had arisen another more adapted to terrestrial life and showing a great advance in the direction of the typical Proboscidea: to this creature the name *Palæomastodon* has been given.

Subsequently, after the American Museum had secured a splendid collection of mammalian fossils from the Fayûm, Professor Osborn published his own views about *Mœritherium* and *Palæomastodon*, which are partly opposed to those of Dr. Andrews. Several parts of his statement read as follows:

As first announced by Dr. C. W. Andrews, to whom we are chiefly indebted for our present knowledge, *Mœritherium* does anticipate the *Palæomastodon* type in the enlargement of the second pair of upper and lower incisors and in the general pattern of the grinding teeth. Since the wish is always father to the thought, and nothing is more to be desired than a primitive progenitor of the Proboscidea, it was altogether natural to place *Mœritherium* in or near the line of ancestry of the elephant, and in such ancestry, as a member of the Proboscidea, the animal has gone into general literature.

The question of habits and affinity seems so important and interesting that the writer has taken it up afresh with these additional materials. The inquiry was suggested by the general resemblance which the skull of *Mœritherium* bears to that of a sirenian as seen from above and in palatal view. *Mœritherium* not only had no proboscis, but was totally different from *Palæomastodon* both in its appearance and habits, and only very remotely related to this animal, if at all. The study shows, further, that *Mœritherium* is closer to the sirenians and less close to the Proboscidea than has hitherto been supposed.

A profound difference between these animals is brought out in comparing the top and side views of the skull, when it is seen that, whereas the eyes of *Palæomastodon* are in the typical mammalian position above the first permanent grinder, those of

[1] See footnote above.

Mœritherium are very far forward, well raised in the front part of the head, and of very diminutive size, as shown by the shallowness of the sockets. All these are also characters of the sirenian head. As indicated by the auditory meatus the ears are relatively in a more elevated position than in *Palæomastodon.* Both these peculiarities are adaptations to aquatic life to protect the sense organs and bring them near the surface of the water in swimming, so that they will emerge first and disappear last.

Comparison with *Hyrax*, the beaver, and other animals with an enlarged pair of front teeth tends to show that the upper and lower lips were heavy, and fleshy, somewhat similar in form and function, that is, in prehensile power, and that the blunt tusks may have been covered when the mouth was closed, somewhat as in the hippopotami. These tusks were feeding rather than fighting weapons, probably because *Mœritherium* was protected from attack by its aquatic habitat. The conclusion is that *Mœritherium* was a confirmed and continual river-living animal, feeding mainly under water and on the banks, more specialized for aquatic life than the hippopotami, as indicated by its feeble pelvis, but less specialized than the sirenians. It would not be far from the truth to say, from our present knowledge of the animal, that *Mœritherium* is an offshoot of the Proboscideo-Sirenian stock, with *slightly* nearer kinship to the elephants than to the sirenians.[1]

To these views of Professor Osborn, Dr. Andrews made a reply; of which the more important lines read as follows:

As to the characters of the eyes and ears, they seem to be purely adaptive, and are simply the result of the admittedly semi-aquatic habits of *Mœritherium,* and would not be expected to exist in purely terrestrial members of the group. The apparent height of the ears is, moreover, mainly the consequence of the small development of the occipital region of the skull compared with that found in the heavier-headed *Palæomastodon.* As to the arrangement of the jaws and the anterior teeth, it seems to represent exactly such a stage as a mammal with the normal Eutherian dentition would be expected to pass through before attaining the condition found in *Palæomastodon.*

Another argument in favor of the relationship of *Mœritherium* to *Palæomastodon* is the existence of forms like *Mœritherium trigonodon* and *Palæomastodon minor,* which, unfortunately at present are very imperfectly known, appear, both in their size and in some respects in their tooth structure, to be annected forms.

On the whole, it seems that the weight of evidence is in favor of regarding *Mœritherium* as a proboscidean, though perhaps not on the direct line of ancestry of *Palæomastodon,* and retaining some characters of the original Proboscideo-Sirenian stock.[2]

Professor Schlosser seems to have looked upon *Mœritherium* as rather not an aquatic form, though he appears to have considered it doubtful that it stands on the direct line of ancestry of *Palæomastodon.* Some parts of his statement read as follows:

In seinem Habitus dürfte *Mœritherium* wegen der Länge des Rumpfes, und der niedrigen Extremitäten eher einem Tapir als einem Proboscidier ähnlich gewesen

[1]1909, 'The feeding habits of *Mœritherium* and *Palæomastodon*,' Nature, LXXXI, pp. 139–140.
[2]1909, 'The systematic position of *Mœritherium*,' Nature, LXXXI, p. 305.

sein. Auch der Schädel sieht dem von Tapir ähnlicher als dem von *Mastodon*, dagegen verleiht die Länge des Schwanzes mehr das Aussehen eines Raubtieres.

Dass die Gattung *Mœritherium* den direkten Vorfahren *Palæomastodon* darstellt, erscheint einiger masen zwei felhaft, nicht nur deshalb, weil sie noch mit diesem zusammen gelebt hat, sondern hauptsächlich wegen der nicht geringen Verschiedenheit im Bau des Schädels und wegen der Form ihrer oberen Incisiven, die Backenzähne und allenfalls auch die unteren Incisiven von *Palæomastodon* lassen sich freilich ganz ungezwungen von jenen der Gattung *Mœritherium* ableiten.[1]

Professor Gregory, in his elaborate work on the 'Orders of Mammals,' pointed out several more important characters of *Mœritherium*, classifying them in accordance with the evidence for proboscidean relationship, for sirenian relationship, against proboscidean relationship and for hyracoid relationship, and concluded as follows:

The genus [*Mœritherium*] represents a very primitive offshoot from the Proboscideo-Sirenian stock. Its dentition and certain other characters indicate a nearer alliance with the Proboscidea than with the Sirenia, but it is far more primitive than any other known representative of either order.[2]

Recently, the same author, in his exhaustive study on the lacrymal bone of vertebrates, has expressed the following views:

The orbital region [of *Mœritherium*] is much more primitive than that of other Proboscidea, and suggests the sirenian type.[3]

As to the relations of the *Mœritheriidæ*, while it is quite possible that *Mœritherium* is related to the Sirenia (Osborn, 1909) the numerous detailed and peculiar resemblances to *Palæomastodon* in dentition and skull structure fully support Dr. Andrews in regarding it as the most primitive known member of the Proboscidea.

The lacrymal region of Proboscidea (p. 180) is specialized through the forward shifting of the orbits and thus affords no definite evidence of relationship with more primitive groups. The lacrymal region of *Mœritherium* is far more primitive than that of *Palæomastodon* and, in connection with other evidence, it supports the view that *Palæomastodon* was derived from a *Mœritherium*-like stage.

The Sirenia, although very highly specialized for aquatic life, show special resemblances with *Mœritherium* in the skull (including the orbital region) and dentition, and are generally regarded as a derivative of the proboscidean stem.[4]

The more the problem becomes complicated the more a precise revisional study is needed. It may possibly be out of the question, at present, to decide whether *Mœritherium* is proboscidean or not, whether it is an ally of *Palæomastodon* or not, or whether it resembles the earlier sirenians in a certain degree or not at all. Then, the questions we have to face are: (1) in what degree and in what manner, is *Mœritherium* allied with *Palæomastodon* and the other proboscideans; (2) in what

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[1]1911, 'Beiträge zur Kenntnis der Oligozänen Landsäugetiere aus dem Fayûm (Egypt),' Beitr. z. Pal. n. Geol. Österreich-Ungarns u. d. Orients, XXIV, pp. 154–155.

[2]1910, 'The Orders of Mammals,' Bull. Amer. Mus. Nat. Hist., XXVII, p. 368.

[3]1920, 'A Review of the Evolution of the Lacrymal Bone of Vertebrates with Special Reference to that of Mammals,' Bull. Amer. Mus. Nat. Hist., XLII, p. 180.

[4]*Loc. cit.*, p. 245.

degree and in what manner, does *Mœritherium* resemble the earlier sirenians, as well as (3) the hyracoids; (4) in what degree and in what manner, does *Mœritherium* differ from the earlier sirenians, as well as (5) from the hyracoids; (6) was *Mœritherium* an aquatic or semi-aquatic form, and in what degree was it so, if at all?

The material of the genus in question secured by the American Museum is fairly rich and splendid, so a precise study of it may, I presume, contribute somewhat to our knowledge of this genus. Professor Henry F. Osborn, President of the American Museum, has generously and kindly submitted to me this material to study.

During this study I have received much kind help and advice from Professor Osborn, Doctor W. D. Matthew, Professor William K. Gregory and Mr. Walter Granger. I have the greatest pleasure in expressing here my hearty thanks to all these gentlemen, as well as to Mrs, L. M. Sterling, who prepared the drawings, and to Mrs. E. M. Fulda. who prepared the photographs in this report.

PALÆOBIOLOGY AND PHYLOGENETIC POSITION

A.—Characters Possibly Indicating Aquatic Adaptation

(1.) The skull, including occiput, is very low, and the upper surface of the skull runs almost evenly from the anterior ends of the nasals to the top of the lambdoid crest. This character, as stated by Andrews and Osborn, might be regarded as an aquatic adaptation. On the other hand, it cannot be regarded as exclusively so, since it might also be a primitive character. We see that *Saghatherium, Mixohyrax, Geniohyus, Pterodon, Apterodon*, etc., of the Fluvio-marine Formation of the Fayûm, had also the low and even skull.

(2.) The orbits are rather high and situated very far forward. Their high situation might possibly be, as pointed out by Osborn, a character of aquatic adaptation in certain degree. But, the roofs of the orbits are not flared upwards and the anterior borders of the same do not project outwards, quite unlike the conditions observed in the sirenians and hippopotami.

The anterior situation of the orbits might not be an aquatic adaptation. We see many mammals and reptiles profoundly adapted to an aquatic life with very posteriorly situated orbits. The small size of the orbits might also not be an aquatic adaptation.

(3.) The external nares are retired backwards to a short extent. The retirement of the external nares is either an aquatic adaptation or it is correlated with the possession of a more or less prehensile upper lip or proboscis. To which of these two adaptations might the said character of *Mœritherium* correspond?

The posterior border of the external nares of *Mœritherium* is not rounded but is indented by the insertion of the anterior parts of the nasals, which show a tendency partly to roof over the external nares. Such a structure is observed also in the other proboscideans, tapirs, *Alces*, *Saiga*, and many other terrestrial mammals, with a more or less prehensile upper lip or proboscis. The backwardly retired external nares of many aquatic mammals and reptiles face upwards and have rounded posterior borders. Judging from these facts, the backwardly retired external nares of *Mœritherium* might very probably correlate with the possession of a more or less prehensile upper lip—a step toward a proboscis—instead of being an aquatic adaptation.

(4.) The external auditory openings are on a high level. As pointed out by Osborn, this character might be an aquatic adaptation in a certain degree. On the other hand, it cannot be regarded so exclusively. We see the fact that the external auditory openings of very many ungulates, such as the amblypods, hyracoids, sirenians, titanotheres, tapirs, rhinoceroses, horses, pigs, elotheres, hippopotami, anthracotheres, oreodonts, camelids, tragulines, cervids, merycodonts, etc., are located on a high plane above the level of the occipital condyles. It is evident that some of these ungulates are aquatic in their habits, but it is also evident that others are not aquatic but thoroughly terrestrial.

On the other hand, the external auditory openings of *Palæomastodon* and *Trilophodon* are higher in their position relative to the occipital condyles than those of *Megabelodon*. Again, those of the short-jawed mastodonts and elephants are very high in their position relative to the occipital condyles. Within the limit of the proboscideans, the external auditory openings are higher in their position relative to the occipital condyles in those forms with a short skull than in those with a long skull; as well as in those forms with the ascending bars of the mandible erect or inclined forward rather than in those with the ascending bars inclined backward.

Thus, the highly placed external auditory openings of *Mœritherium* are a character in common with many groups of ungulates; a primitive character within the limit of the earlier proboscideans; and a character correlated with the short skull, as well as with the erect or forwardly inclined ascending bars of the mandible, within the limit of the Proboscidea as a whole. Consequently, the idea that the said character of *Mœritherium* is an aquatic adaptation must not be over-estimated.

To summarize, *Mœritherium* might not have been adapted very much to an aquatic life. Evidently, it might be less aquatic than hippopotami. Judging, however, from the structure of the cheek-teeth, as well as from the stratigraphical occurrence of the remains of this animal, there can be no doubt that its favorite haunts were watery districts.

B.—Characters Indicating Terrestrial and Non-aquatic Adaptation

(1.) The zygomatic arches lie very low and are not very stout. Those of the sirenians and hippopotami, on the contrary, lie very high, so that the upper surface of the head is very broad and flat, the upper edges of the zygomatic arches showing a tendency to reach nearly the level of the upper surface of the head. Moreover, those of the sirenians, especially, are very stout, being much stouter than those either of *Mœritherium* or of *Palæomastodon.*

(2.) The roofs of the orbits are not flared upwards and the anterior borders of the same do not project outwards, as already stated under *A* (2).

(3.) The backwardly retired external nares face forwards, instead of facing upwards, with their posterior border not rounded, showing a tendency to be partially roofed over by the anterior parts of the nasals, as already stated under *A* (3).

(4.) The olfactory lobes of the brain-case cast are very large, a character of non-aquatic mammals as pointed out by Andrews. Those of *Eotherium* and *Eosiren* are exceedingly small, a character of aquatic mammals.

(5.) The lower incisors are very close-set, and form together something like a spade. Such a spade-like arrangement of the lower incisors is also observed in *Palæomastodon, Trilophodon, Megabelodon,* boars, diprotodonts, etc. The mode of using the mandible with such a spade-like arrangement of the lower incisors may be conceived as being in the mode of the boars. Such an arrangement is an adaptive structure to digging and rooting in a terrestrial life. Moreover, even if we neglect the spade-like arrangement of the lower incisors, their very close setting is observed only among mammals of non-aquatic life. The lower incisors seen in some aquatic mammals are always well-spaced, a structure adapted to digging and rooting in an aquatic life and to seizing objects which float in or on water.

(6.) As far as I have examined the material in the American Museum, the vertebræ are opisthocœlous, instead of being biplanous. This character is common in terrestrial mammals, in contrast with aquatic mammals.

(7.) The lumbar vertebræ and sacrum are well differentiated, (Andrews) and the latter consists probably of four vertebræ (Schlosser).

(8.) Both the anterior and the posterior limbs are well developed (Andrews).

To summarize, *Mœritherium* might be a terrestrial form quite as stated by Andrews (former opinion) and by Schlosser. The life-habits of *Mœritherium* might be in some ways like those of tapirs and boars.

C.—Characters in Common with the Hyracoids

(1.) The skull is very short in comparison with the zygomatic width. This character is common also to some of the hyracoids in striking contrast to the earlier sirenians and even to the earlier proboscideans. *Palæomastodon* is more long-skulled than the present genus but is more short-skulled than *Trilophodon* and *Megabelodon.*

(2.) The skull, as well as the occiput, is very low, its upper surface running almost straight from the anterior ends of the nasals to the lambdoid crest. This character is evidently primitive and is common also to the hyracoids and very earlier sirenians, as already stated under *A* (1).

(3.) The sagittal crest is well developed along the median line of the parietal region, a character common to this genus, *Palæomastodon,* and many hyracoids, in contrast to the sirenians and other proboscideans.

(4.) The snout is very short and wide. The short snout is a common character of this genus and some of the hyracoids in contrast to the earlier sirenians and earlier proboscideans, while the wide snout is a characteristic of the proboscideans in contrast to both the hyracoids and sirenians.

(5.) The premaxilla and frontal are separated from each other by the maxilla and nasal, which meet to form the naso-maxillary suture. This character is common to this genus and the hyracoids in striking contrast to the sirenians and other proboscideans.

(6.) The roofs of the orbits are not flared upwards and the anterior borders of the same are not projected outwards, a character common to the hyracoids and proboscideans in contrast to the sirenians, as already stated under *B* (2).

(7.) The antorbital foramina are not extremely large and conspicuous, a character common to the hyracoids and proboscideans in contrast to the sirenians, although those of the hyracoids are very small and very anteriorly situated.

(8.) The outer borders of the snout and zygomatic arches in upper or lower view form together a very smooth continuous curve on either side. This character is common to the hyracoids and earlier proboscideans in contrast to the sirenians.

(9.) The zygomatic arches are set very low and are not very stout. This character is common to the hyracoids and proboscideans in contrast to the sirenians, as already stated under *B* (1).

(10.) The jugals extend from the posterior lower corners of the orbits to back of the glenoid fossæ. This posterior limit of the jugals is a common character of the hyracoids and proboscideans in contrast to the sirenians, although the anterior limit of the same just observed in this genus is quite characteristic of the proboscideans in striking contrast to both hyracoids and sirenians.

(11.) The zygomatic process of each squamosal reaches forward about to the middle of the zygomatic arch behind the orbit. This is a common character of some of the hyracoids and proboscideans. In some other hyracoids it reaches forward only to a considerable distance behind the middle of the post-orbital portion of the arch, and in the sirenians it reaches almost to the postorbital process.

(12.) The upper limit of the squamosals is a considerable distance below the level of the top of the parietal surface, that is not so high as almost to reach the same level. This is a proboscidean character and appears to be common also to some of the hyracoids in contrast to the sirenians and some other hyracoids. In the two last-named groups, the upper limit of the squamosals nearly reaches the level of the top of the parietal surface.

(13.) The external auditory openings are set very high. This character is common to many groups of the ungulates, as already stated under *A* (4). Moreover, those of this genus are placed rather higher even than those of certain sirenians.

(14.) The external auditory meatus is fairly well-closed in lower view, a character common to the proboscideans and hyracoids in striking contrast to the sirenians, though the degree of the closing of the meatus is more advanced in the proboscideans than in the hyracoids.

(15.) The squamosal, supraoccipital and exoccipital are fully in contact, all together, leaving no conspicuous slit between them, so that the periotic is not exposed on the occipital surface at all. This character is common to both the hyracoids and proboscideans in striking contrast to the sirenians.

(16.) The pterygoid processes, each of which is composed of the pterygoid, alisphenoid, and the posterior portion of the palatine, are not exceedingly stout and do not project downwards so far as to reach the level of the grinding surfaces of the upper cheek-teeth. This is a common character of both the hyracoids and proboscideans in striking contrast to the sirenians. In the last-mentioned group, they are exceedingly stout and project downwards as far as below the level of the grinding surfaces of the upper cheek-teeth.

(17.) In one very fine skull of *Mœritherium* belonging to the American Museum, I have noticed that the posterior alisphenoid canals and foramina ovalia are distinct from the nearly confluent openings of the foramen lacerum medium, carotid canal, foramen lacerum posterius, and condylar foramen. The distinctness of the posterior alisphenoid canals and foramina ovalia from the more posteriorly located foramina is a common character of the hyracoids and proboscideans in striking contrast to the sirenians. The confluence of the condylar foramina with the more anteriorly located foramina, however, is a character of the proboscideans, as well as of some individuals of the modern *Manatus*, in striking contrast to the hyracoids and sirenians, except as stated. In the sirenians, the posterior opening of the alisphenoid canal, foramen ovale, foramen lacerum medium, carotid canal, and foramen lacerum posterius of either side are all confluent, forming a large slit, while the condylar foramina are distinct from them, except in some individuals of modern *Manatus* in which these also are confluent with them.

(18.) The paroccipital processes are comparatively thin antero-posteriorly. This is a common character of the hyracoids and proboscideans in contrast to the sirenians.

(19.) The ascending bars of the mandible incline slightly forwards. This is a common character of the hyracoids, the sirenians with the possible exception of *Eotherium* (so far as Abel's restoration[1] of the mandible is correct), and certain short-jawed mastodonts and elephants, in contrast to *Palæomastodon* and the long-jawed mastodonts.

(20.) The mandibular rami do not show a conspicuous downward bending just behind the symphysial region. This is a common character of *Mœritherium* and the hyracoids in contrast to the sirenians and even many earlier proboscideans.

(21.) The symphysis is comparatively short, a character common to this genus, the hyracoids, sirenians, and short-jawed mastodonts and elephants in contrast to *Palæomastodon* and the long-jawed mastodonts.

[1]1913, 'Die Morphologie der eocänen Sirenen der Mittelmeerregion,' Palæontogr., LIX, p. 349.

(22.) I have noticed in two specimens in the American Museum presenting the symphysial regions of mandibles, that the groove on the upper surface of the symphysis is rather like a depression, being slightly concave antero-posteriorly, besides being strongly concave from side to side. Such a depression is also present as a part of the groove on the upper surface of the symphysis also in *Palæomastodon* and the long-jawed mastodonts. In certain hyracoids, also, such a depression is observed to be present on the upper surface of symphysis. In the sirenians, however, the depression which corresponds to that just mentioned in the hyracoids and proboscideans is present on the upper posterior or posterior surface of the symphysis and is extraordinarily strong, as a characteristic of this group.

(23.) The anterior mental foramina are not very large and conspicuous, a character common to the hyracoids and proboscideans in contrast to the sirenians.

(24.) The full number of the upper incisors and canines is present, as in the earlier hyracoids and earlier sirenians, though their arrangement is different from that in these groups.

(25.) The second lower incisors of both jaws are enlarged and tusk-like, being distinctly larger than the first. In the hyracoids, the second lower incisors are likewise enlarged and tusk-like.

(26.) The cheek-teeth are bunodont showing an inclination to be lophodont, quite like those of some sirenians and some other proboscideans, as well as some hyracoids, though those of these groups differ from each other in detail.

Among these twenty-six characters examined, sixteen, *viz.* (3), (6), (7), (8), (9), (10), (11), (12), (14), (15), (16), (17), (18), (22), (23), and (25), are common to both the hyracoids and proboscideans in contrast to the living or earlier sirenians; four, *viz.* (1), (4), (5), and (20), are common to the present genus and the hyracoids in contrast to the sirenians and proboscideans or earlier forms of them; four, *viz.* (2), (19), (21) and (24), are common to the present genus, the hyracoids, and sirenians in contrast to the other proboscideans; one, *viz.* (13), is common to many primitive groups of ungulates; and one, *viz.* (26), is common to all the hyracoids, sirenians, and older proboscideans. It may easily be seen that *Mœritherium* has many characters common both to the hyracoids and to other proboscideans in contrast to the living or earlier sirenians.

D.—Characters Distinctive from the Hyracoids

(1.) The mid-cranial region is long, slender, and tubular, a character common to this genus and the earlier sirenians in contrast to the hyracoids, later sirenians, and other proboscideans.

(2.) The snout is wide, a characteristic of proboscideans in contrast to the hyracoids and sirenians, except *Desmostylus.*

(3.) The external nares are situated some distance behind the anterior end of the skull, a character common to the sirenians and probossideans in contrast to the hyracoids.

(4.) The orbits are situated very far forward, a character common to this genus and the sirenians in contrast to the hyracoids and even other proboscideans.

(5.) In lateral view, the orbit is bordered above by the frontal and anteriorly as well as below by the maxilla, the jugal reaching only as far anteriorly as the lower posterior corner of the orbit. The situation of the lacrymal in this genus is not yet clear, though it is almost certain that no distinct lacrymal is present in front of the orbit; the lacrymal might either be absent or be present deep within the orbit. The condition of the border of the orbit just observed in this genus is a characteristic of the proboscideans, laying aside the problem of the situation of the lacrymal. In the hyracoids the orbit is bordered above by the frontal, anteriorly by the well-developed lacrymal and to a short extent by the maxilla, and below by the jugal, which reaches as far anteriorly as the anterior lower corner of the orbit. In the sirenians the orbit is bordered by the lacrymal, and anteriorly as well as below by the jugal, which reaches almost as far anteriorly and above as the anterior upper corner of the orbit.

(6.) The antorbital foramina are situated just below the orbits, a character common to the sirenians and proboscideans in contrast to the hyracoids, in which they are situated a considerable distance anterior to the orbits.

(7.) A large fossa is present on either side, just below the orbit, a characteristic of the proboscideans in contrast to the hyracoids and sirenians.

(8.) The zygomatic arches are widest posteriorly, as in many sirenians and proboscideans. In the hyracoids the maximum width is at the middle of the arch.

(9.) As already stated under *C* (10) and *D* (5), the anterior, as well as posterior, limit of the jugal of this genus shows a marked proboscidean characteristic; the jugal differs from that of the hyracoids in its much less anterior extension; and from that of the sirenians in its much less anterior and much more posterior extension.

(10.) As already stated under *C* (17), the condylar foramen is confluent with foramen lacerum posterius, a characteristic of the proboscideans in striking contrast to both the hyracoids and sirenians, except some individuals of modern *Manatus*.

(11.) The glenoid fossa and paroccipital process are close together, as in the proboscideans. In the hyracoids and sirenians they are widely separated.

(12.) The ascending bars of the mandible are very wide anteroposteriorly, being not very much narrowed upwards, so that the mandibular condyles are very far from the coronoid processes. This character is common to both the sirenians and proboscideans in contrast to the hyracoids.

(13.) The region of the mandibular angle projects very strongly downwards, so that the lower border of the ramus is concave just anterior to this region, as in *Palæomastodon* and the sirenians but in contrast to the hyracoids and other proboscideans.

(14.) The upper tusks correspond to the second incisors and are widely separated from each other, a characteristic of the proboscideans in contrast to the hyracoids and many sirenians. The first and second incisors are arranged almost interno-externally, instead of being anteroposteriorly, also a distinctive character from both the hyracoids and sirenians.

(15.) The cheek-teeth are very large in proportion to the size of the skull, a characteristic of the proboscideans in contrast to the hyracoids and especially sirenians.

(16.) The two rows of the upper cheek-teeth to the tusks are almost linear and parallel to each other, a characteristic of the proboscideans in contrast to the hyracoids and sirenians, though those of some individuals of the modern *Manatus* are rather linear and parallel within the limit of the cheek-teeth.

(17.) The premolars are very large and wide in proportion to the size of the molars, a peculiar characteristic of this genus in contrast to the hyracoids, earlier as well as certain later sirenians, and other proboscideans. The modern *Manatus*, however, has large premolars in proportion to the size of the molars.

Among these seventeen characters examined, nine, *viz.* (2), (5), (7), (9), (10), (11), (14), (15), and (16), are characteristics of the proboscideans in contrast to both the hyracoids and earlier or later sirenians; five, *viz.*, (3), (6), (8), (12) and (13), are common to both the sirenians and proboscideans in contrast to the hyracoids; two, *viz.* (1) and (4), are common to this genus and the sirenians in contrast to both the hyracoids and other proboscideans; and one, *viz.* (17), is a peculiar characteristic of this genus as against all the hyracoids, sirenians, except modern *Manatus*, and other proboscideans. It may easily be recognized that *Mœritherium* has many characteristics of the proboscideans, many characters common to both proboscideans and sirenians in contrast to the hyracoids, and quite a few characters common to this genus and the sirenians in contrast to both the hyracoids and other proboscideans.

E.—CHARACTERS IN COMMON WITH THE SIRENIANS

(1.) Skull, as well as occiput, very low (*A* 1 and *C* 2).

(2.) Mid-cranial region long, slender and tubular (*D* 1).

(3.) External nares situated a distance behind anterior end of skull (*A* 3 and *D* 3).

(4.) Orbits situated very anteriorly (*D* 4).

(5.) Antorbital foramina situated just below orbits (*D* 6).

(6.) Zygomatic arches widest posteriorly (*D* 8).

(7.) The elevated external auditory openings (*A* 4 and *C* 13).

(8.) The general shape and proportions of the frontal lobes, temporal lobes, and cerebellum, except the olfactory lobes, of the brain-case cast of *Mœritherium* much resemble those of *Eosiren* (Andrews' figure[1]), but not so much those of *Eotherium* (Owen's figure[2] and Abel's figure[3]). This resemblance has been cited by Dr. Andrews and Prof. Gregory. It might to a great extent be due to convergence, owing chiefly to the similarity of their evolutionary stages, as may be judged from the facts that the olfactory lobes of *Mœritherium* are quite different from those of the sirenians and that the brain-case cast of *Eotherium*, which is geologically older than both *Eosiren* and *Mœritherium*, differs from that of *Mœritherium* much more than does that of *Eosiren*.

(9.) Ascending bars of the mandible incline slightly forwards (*C* 19).

(10.) Ascending bars of the mandible very wide antero-posteriorly, being not very much narrowed upwards (*D* 12).

(11.) The region of the mandibular angle projects very strongly downwards, so that the lower border of the ramus is concave just anterior to this region (*D* 13).

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[1]1906, 'Descr. Cat. Tert. Vert. Fayûm, Egypt.,' Brit. Mus., p. 202, text-fig. 65.
[2]1875, Quart. Journ. Geol. Soc. London, XXXI, p. 100, Pl. III.
[3]1913, Palæontogr., LIX, Pl. (IV) XXXIII, figs. 3–5.

(12.) Symphysis comparatively short (*C* 21).

(13.) Full number of the upper incisors and canines present (*C* 24).

(14.) Cheek-teeth bunodont showing an inclination to be lophodont (*C* 26).

(15.) The scapula and humerus of *Mœritherium* resemble those of *Eosiren*. (Andrews.)

(16.) The pelvis of *Mœritherium* more or less resembles that of *Eotherium*. (Andrews.)

Among these sixteen characters examined, five, *viz.* (3), (5), (6), (10), and (11), are common to both the proboscideans and sirenians in contrast to the hyracoids; four, *viz.* (1), (9), (12), and (13), are common to this genus, the sirenians, and hyracoids in contrast to the other proboscideans; three, *viz.* (8), (15), and (16), are common vaguely to this genus and the earlier sirenians; two, *viz.* (2) and (4), are common to this genus and the sirenians in contrast to the hyracoids and other proboscideans; one, *viz.* (7), is common to many groups of the ungulates. It may easily be recognized that the characters common to the proboscideans and sirenians but not found in the hyracoids are rather numerous, while there are but a few characters common to *Mœritherium* and the sirenians as against the hyracoids and other proboscideans.

F.—Characters Distinctive from the Sirenians

(1.) Skull very short in comparison with the zygomatic width (*C* 1).

(2.) Sagittal crest well developed (*C* 3).

(3.) Snout very short (*C* 4).

(4.) Snout is wide (*C* 4 and D 2).

(5.) The backwardly retired external nares face forwards, with their posterior border not rounded, as a characteristic of the proboscideans in contrast to the sirenians (*B* 3).

(6.) Premaxilla and frontal separated from each other by the maxilla and nasal, which meet in the naso-maxillary suture (*C* 5).

(7.) Orbits very small and shallow, as in the proboscideans. In the modern *Manatus* the orbits are likewise small but not shallow.

(8.) In the lateral view the orbit is bordered above by the frontal, and forwards as well as below by the maxilla, the jugal reaching anteriorly only as far as the lower posterior corner of orbit (*D* 5).

(9.) Roofs of the orbits not flared upwards, and the anterior borders of the same not projected outwards (*A* 2, B 2, and *C* 6).

(10.) Antorbital foramina not extremely large or conspicuous (*C* 7).

(11.) A large infraorbital fossa (*D* 7).

(12.) The outer borders of the snout and zygomatic arches in upper or lower view form together a very smooth, continuous curve on either side (*C* 8).

(13.) Zygomatic arches set very low and not very stout (*B* 1 and *C* 9).

(14.) Jugals extend from posterior lower corners of the orbits to back of glenoid fossæ (*C* 10 and *D* 9).

(15.) Zygomatic process of squamosal reaches anteriorly only to middle of zygomatic arch (*C* 11).

(16.) Upper limit of squamosal considerably below top of the parietal surface (*C* 12).

(17.) Auditory meatus fairly well closed inferiorly (*C* 14).

(18.) Squamosal, supraoccipital and exoccipital fully in contact, so that periotic is not exposed on occipital surface (*C* 15).

(19.) Pterygoid processes (pterygoid, alisphenoid and the posterior portion of palatine) not especially stout and do not project downwards to level of grinding surface of upper cheek-teeth (*C* 16).

(20.) Posterior alisphenoid canals and foramina ovalia distinct from the more posteriorly located foramina, and the condylar foramina are confluent with the more anteriorly located foramina (*C* 17 and *D* 10).

(21.) Paroccipital processes thin antero-posteriorly (*C* 18).

(22.) Glenoid fossa and paroccipital process approximated (*D* 11).

(23.) Olfactory lobes of the brain-case cast very large (*B* 4 and *E* 8).

(24.) Mandibular rami not conspicuously bent downward behind symphysis (*C* 20).

(25.) Symphysial depression is on upper, but not upper posterior or posterior surface of symphysis (*C* 22).

(26.) Anterior mental foramina are not conspicuously large (*C* 23).

(27.) The second, not the first, incisors of both jaws are enlarged and tusk-like (*C* 25 and *D* 14 in part).

(28.) First and second incisors of both jaws arranged not antero-posteriorly but interno-exteriorly (*D* 14 in part).

(29.) Cheek-teeth very large in proportion to size of skull (*D* 15).

(30.) The two rows of the upper cheek-teeth to the tusks are almost linear and parallel (*D* 16).

(31.) Premolars large and wide in proportion to size of molars (*D* 17).

(32.) Scapula like that of sirenians in the posterior sweep of blade, but the very well developed coracoid process is an important distinction. (Andrews.)

(33.) Humerus resembling that of sirenians in certain characters, but differs notably in its length and slenderness, in the very well developed supinator ridge, in details of the shape of the distal end, etc. (Andrews.)

(34.) Pelvis resembling that of *Eotherium*, but differing in the more distinctly developed sacral surface, in position of the fossa for attachment of rectus femoris muscle and in the larger and less rounded obturator foramen. (Andrews.) As to *Eosiren*, which was contemporaneous with *Mœritherium* and the later sirenians, their pelves are much more distinctly different.

Among these thirty-four characters examined, thirteen, *viz.* (2), (9), (10), (12), (13), (15), (16), (17), (18), (19), (21), (25), and (26), are common to both the hyracoids and proboscideans in contrast to the sirenians or earlier sirenians; ten, *viz.* (4), (8), (11), (14), (20), (22), (27), (28,), (29), and (30), are characteristic of the proboscideans in contrast to both the hyracoids and earlier or later sirenians; three, *viz.* (5), (7) and (23), are characteristic of the proboscideans in contrast, at least, to the earlier or later sirenians; three, *viz.* (32), (33), and (34), are characters vaguely distinctive of this genus from the earlier or later sirenians; three, *viz.* (9), (13), and (23) [these characters are referred to in duplicate], are characters of some of the terrestrial mammals in contrast to the aquatic ungulates; and one, *viz.* (31), is characteristic of this genus in contrast to all the hyracoids, sirenians, and other proboscideans or earlier forms of these groups. It may easily be recognized that *Mœritherium* has many characters common to both the hyracoids and proboscideans in contrast to the earlier or later sirenians, and many characteristics of the proboscideans in contrast to both the hyracoids and later sirenians or earlier sirenians.

G.—Proboscidean Characters

(1.) Sagittal crest well developed, as in *Palæomastodon* (*C* 3 and *F* 2).

(2.) Snout wide (*C* 4, *D* 2, and *F* 4).

(3.) External nares retracted, though to a short extent, and facing forwards; their posterior borders are not rounded but indented by the insertion of the anterior ends of nasals (*A* 3, *B* 3, *D* 3, *E* 3, and *F* 5).

(4.) Orbits very small (*F* 7).

(5.) In lateral view the orbit is bordered above by the frontal, and forwards as well as below by the maxilla, the jugal reaching only as far anteriorly as the lower posterior corner of the orbit (*D* 5 and *F* 8).

(6.) Roofs of the orbits not flared upwards and the anterior borders of the same not projected outwards (*A* 3, *B* 2, *C* 6, and *F* 9).

(7.) Antorbital foramina situated just below orbits (*D* 6 and *E* 5).

(8.) Antorbital foramina not very large or conspicuous (*C* 7 and *F* 10).

(9.) A large fossa is present on either side, just below the orbit (*D* 7 and *F* 11).

(10.) Outer borders of the snout and zygomatic arches in upper or lower view form together a smooth, continuous curve on either side (*C* 8 and *F* 12).

(11.) Zygomatic arches rather weak and situated low (*B* 1, *C* 9, and *F* 13).

(12.) Zygomatic arches widest posteriorly (*D* 8 and *E* 6).

(13.) Jugals extending from the posterior lower corners of orbits to back of glenoid fossæ (*C* 10, *D* 9, and *F* 14).

(14.) Zygomatic process of each squamosal reaching only as far anteriorly as about the middle of the zygomatic arch behind the orbit (*C* 11 and *F* 15).

(15.) Upper limit of squamosal considerably below the level of the tops of the parietal surface (*C* 12 and *F* 16).

(16.) Auditory meatus fairly well closed in lower view (*C* 14 and *F* 17).

(17.) Squamosal, supraoccipital and exoccipital fully in contact all together, so that the periotic is not exposed on the occipital surface (*C* 15 and *F* 18).

(18.) Pterygoid processes, each of which consists of the pterygoid, alisphenoid and the posterior portion of palatine, not exceedingly stout and not projecting downwards so far as to reach the level of the grinding surface of the upper cheek-teeth (*C* 16 and *F* 19).

(19.) Posterior alisphenoid canals and foramina ovalia distinct from the more posteriorly located foramina; condylar foramina confluent with the more anteriorly located foramina (*C* 17, *D* 10, and *F* 20).

(20.) Paroccipital processes not very stout and thick, but thin antero-posteriorly (*C* 18 and *F* 21).

(21.) Glenoid fossa and paroccipital process on either side set close to each other (*D* 11 and *F* 22).

(22.) Olfactory lobes of the brain-case cast very large (*B* 4, *E* 8, and *F* 23).

(23.) Ascending bars of mandible very wide antero-posteriorly, being very narrow upwards (*D* 12 and *E* 10).

(24.) Region of the mandibular angle projecting very strongly downwards, so that the lower border of the ramus is concave just anterior to this region (*D* 13 and *E* 11).

(25.) Symphysial depression on the upper, but not upper posterior or posterior surface of the symphysis (*C* 22 and *F* 25).

(26.) Anterior mental foramina not very large or conspicuous (*C* 23 and *F* 26).

(27.) Second incisors of both jaws enlarged and tusk-like (*C* 25, D 13, and *F* 27).

(28.) Upper tusks, which correspond to the second incisors, widely separated from each other (*D* 14).

(29.) Lower incisors very close set and forming together something like a spade as a whole (*B* 5).

(30.) Cheek-teeth bunodont showing an inclination to be lophodont (*C* 26 and *E* 14).

(31.) Cheek-teeth very large in proportion to size of skull (*D* 15 and *F* 29).

(32.) The two rows of the upper cheek-teeth are almost parallel to each other throughout (*D* 16 and *F* 30).

(33.) Vertebræ opisthocœlous instead of biplanous (*B* 6).

(34.) Lumbar vertebræ and sacrum well differentiated (*B* 7).

(35.) Anterior and posterior limbs well developed (*B* 8).

Among these thirty-five characters examined, seventeen, *viz.* (1), (6), (8), (10), (11), (14), (15), (16), (17), (18), (20), (25), (26), (29), (33), (34), and (35), are common to both the proboscideans and hyracoids in contrast to the recent or earlier sirenians; eleven, *viz.* (2), (3), (5), (9), (13), (19), (21), (27), (28), (31), and (32), are characteristic of the proboscideans in contrast to both the hyracoids and the earlier or later sirenians; seven, *viz.* (6), (11), (22), (29), (33), (34), and (35) [these characters are referred to in duplicate], are characters of some of the terrestrial mammals in contrast to the aquatic ungulates; four, *viz.* (7), (12), (23), and (24), are common to both the proboscideans and sirenians in contrast to the hyracoids; two, *viz.* (4) and (22), are characteristic, at least, of the proboscideans in contrast to the recent or earlier sirenians; and one, *viz.* (30), is common to all the proboscideans, sirenians and hyracoids. It may easily be recognized that *Mœritherium* has many characters common to both the proboscideans and hyracoids in contrast to the sirenians, and many characteristics of the proboscideans in contrast to both the hyracoids and sirenians.

H.—Peculiar and Pre-palæomastodont Characters

(1.) *Mœritherium* is very peculiar in having the skull very short in comparison with the zygomatic width. In the series of *Palæomastodon, Trilophodon,* and *Megabelodon,* the first is more short-skulled than the second, and the second is more so than the third. Now, *Mœritherium* is more short-skulled than *Palæomastodon.*

(2.) *Mœritherium* is very peculiar in having the naso-fronto-parietal region very long in proportion to the length of the snout. This region is slightly longer than the premaxillary region in *Palæomastodon;* nearly as long as, or slightly shorter than, the latter in *Trilophodon;* and much shorter in *Megabelodon.* In *Mœritherium* the naso-fronto-parietal region is exceedingly long, being very much longer than the premaxillary region.

(3.) *Mœritherium* is very peculiar in having the zygomatic arches very long in proportion to the length of the skull. The zygomatic arches in the region behind the orbits are, in *Mœritherium,* about as long as, or slightly longer than, three-fifths the basilar length; in *Palæomastodon* and *Trilophodon,* one-half to two-fifths; and in *Megabelodon,* two-fifths to one-third.

(4.) *Mœritherium* is very peculiar in having the almost tubular mid-cranial region, the interorbital width being exceedingly small. This width is about one-half the zygomatic width in *Palæomastodon;* about two-thirds in *Trilophodon;* and about three-fourths in *Megabelodon.* Now, in *Mœritherium,* this width is about one-third the zygomatic width.

(5.) The sagittal crest is very well developed in *Mœritherium,* occupying about one-half, or more, of the distance between the anterior ends of the nasals and the top of the lambdoid crest. The sagittal crest is present also in *Palæomastodon,* occupying less than one-third the same distance. In *Trilophodon* and *Megabelodon,* this crest is no longer present, but is replaced by a pair of temporal crests; the intertemporal width is very small in the former, and rather great in the latter.

(6.) The very anterior situation of the external nares of *Mœritherium* is also very peculiar among the proboscideans. The external nares are situated just above the diastema between C and P^2 in *Mœritherium;* almost above P^4 or M^1 in *Palæomastodon;* almost above M^2 in *Trilophodon;* and almost above M^3 in *Megabelodon.*

(7.) The very anterior situation of the orbits of *Mœritherium* is also very peculiar. The orbits are situated just above P^{2-3} in *Mœritherium;* just above M^{1-2} in *Palæomastodon;* just above M^{2-3} in *Trilophodon;* and just above M^3 in *Megabelodon.*

(8.) The relative position of the external nares and orbits of *Mœritherium* is also very peculiar among the proboscideans. In *Palæomastodon*, the posterior border of the external nares lies just a little before the anterior borders of the orbits; in *Trilophodon* the former lies a little or moderately behind the latter; and in *Megabelodon* the former lies far behind the latter. Now, in *Mœritherium* the former lies moderately before the latter.

(9.) The external auditory openings are situated above the level of the upper borders of the occipital condyles in *Mœritherium;* about at the same level in *Palæomastodon;* about at the same level as the level of the middle of the occipital condyles in *Trilophodon;* and about at the level of the lower borders of the occipital condyles in *Megabelodon.* Moreover, it should be remembered that many short-jawed mastodonts and elephants have the external auditory openings situated above the level of the upper borders of the occipital condyles. As already stated under *A* (4) it appears that those proboscideans which have short skulls and erect to anteriorly inclined ascending bars of the mandibles, have highly situated external auditory openings, and those proboscideans which have long skulls and posteriorly inclined ascending bars of the mandibles, have lowly situated auditory openings.

(10.) The anterior limits of the temporal vacuities, in palatal view, of *Mœritherium* lie almost on the frontal plane, which passes through the boundaries between P^4 and M^1. Those of *Palæomastodon* lie almost on the frontal plane, which passes through somewhere between the first ridge of M^2 and that of M^3; and those of *Trilophodon* and *Megabelodon* lie on the frontal plane which cuts some parts of M^3.

(11.) The mandible of *Mœritherium* is short and is about as long as or slightly shorter than the skull. That of *Palæomastodon* is slightly longer than the skull; that of *Trilophodon* much longer; and that of *Megabelodon* nearly twice as long.

(12.) The anterior part, free of cheek-teeth, of the mandible of *Mœritherium* is peculiarly short, being only about as long as one-sixth the mandible. That of *Palæomastodon* is about two-fifths as long as the mandible; that of *Trilophodon* three-sevenths to one-half as long; and that of *Megabelodon* one-half to three-fifths as long.

(13.) The ascending bars of the mandible of *Mœritherium* incline slightly forwards. Those of *Palæomastodon* are nearly erect or incline slightly backwards; and those of *Trilophodon* and *Megabelodon* incline more distinctly backwards.

(14.) The region of the mandibular angle of *Mœritherium* projects markedly downwards, so that there is a distinct concavity on the lower border of the mandibular ramus, just anterior to this region. The mandible of *Palæomastodon* has, also, such a convexity and a concavity on each mandibular ramus; but these characters in this genus are more feeble and less marked than in *Mœritherium*. *Trilophodon* has either such a convexity and a concavity, very feeble, or none at all, and *Megabelodon* none at all.

(15.) The lower border of the mandible of *Mœritherium* bends upwards at about the part corresponding to the posterior end of the symphysis. That of *Palæomastodon* is almost linear or very slightly bends downwards at about the same part; and that of *Trilophodon* and *Megabelodon* more distinctly bends downwards.

(16.) The symphysis of the mandible of *Mœritherium* is rather short. That of *Palæomastodon* is fairly long; that of *Trilophodon* very long; and that of *Megabelodon* extremely long.

(17.) The symphysial depression of *Mœritherium* lies among I_2 and $P_{2\text{-}3}$, occupying nearly the entire length of the symphysial groove; that of *Palæomastodon* lies a distance anterior to the posterior border of the symphysial region as well as to the premolars, occupying an anterior part of symphysial groove; that of *Trilophodon* lies farther anterior than the posterior border of symphysial region as well as the cheek-teeth, occupying only an anterior part of the symphysial groove; and that of *Megabelodon* lies still farther anterior to the same, occupying still less part of symphysial groove.

(18.) The dental formulæ of *Mœritherium*, *Palæomastodon*, *Trilophodon* and its allied Mastodonts, are:

Mœritherium:	$I\frac{(1).1.(1)}{(1).1.(1)}$	$C\frac{(1)}{0}$	$P\frac{0.1.1.1}{0.1.1.1}$	$M\frac{1.1.1}{1.1.1}$
Palæomastodon:	$I\frac{0.1.0}{0.1.0}$	$C\frac{0}{0}$	$P\frac{0.1.1.1}{0.0.1.1}$	$M\frac{1.1.1}{1.1.1}$
Trilophodon, etc.:	$I\frac{0.1.0}{0.1.0}$	$C\frac{0}{0}$	$P\frac{0.0—(1).(1).(1)}{0.0—(1).(1)}$	$M\frac{1.1.1}{1.1.1}$

(19.) The upper tusks of *Mœritherium* are very short in comparison with those of the other proboscideans. Those of *Palæomastodon* are moderately long; those of *Trilophodon* are very long, being distinctly longer than those of the preceding; those of *Megabelodon* are also very long, being longer in the adult than those of the preceding; and those of the short-jawed mastodonts and elephants, with almost horizontal to upwardly-bent upper tusks, are excessively long, being much longer in the adult than those of *Trilophodon* and *Megabelodon*.

(20.) *Mœritherium* is peculiar in having the premolars very large in proportion to the size of the molars or, in other words, in having the series of the cheek-teeth increase their size backwards very gradually. The degree of increase in size backwards of the series of the cheek-teeth is more rapid in *Palæomastodon* than in *Mœritherium;* more so in *Trilophodon* than in *Palæomastodon;* and more so in *Megabelodon* than in *Trilophodon.*

(21.) The ridge formulæ of the cheek-teeth of *Mœritherium, Palæomastodon,* and *Trilophodon,* are as follows:

Mœritherium:	$Dm\frac{?\ ?\ ?}{?\ ?\ 2}$	$P\frac{1.1(+1).1(+1)}{1(+1).1(+1).1(+1)}$	$M\frac{2.2.2.(+1)}{2.2.2.(+1)}$
Palæomastodon (A):	$Dm\frac{?\ ?\ ?}{?\ ?\ ?}$	$P\frac{1.\quad 1.\quad 2.}{1.1(+1).2}$	$M\frac{2(+1).2(+1).2(+1)}{2(+1).2(+1).2(+1)}$
Palæomastodon (B)[1]:	$Dm\frac{1.2.3}{1.2.3}$	$P\frac{1.\quad 1—1(+1).2}{1(+1).2}$	$M\frac{3.3.2(+1)—3}{3.3.3—3(+1)}$
Trilophodon:	$Dm\frac{1—2.2.3}{1—2.2.3}$	$P\frac{2.2}{2.2}$	$M\frac{3.3.4}{3.3.4}$

(22.) In *Mœritherium* all the three pairs of premolars and the three pairs of molars of both jaws were functional at the same time. In *Palæomastodon* all the three pairs of premolars and three pairs of molars of the upper jaw and the two pairs of premolars and three pairs of molars of the lower jaw were so; in *Trilophodon* only three or two pairs of cheek-teeth of both jaws were so; and in *Megabelodon* only two pairs of cheek-teeth of both jaws were so.

(23.) In *Mœritherium* the trefoil pattern of cusps of the cheek-teeth is not developed at all. In one group of *Palæomastodon* also, such a pattern of cusps is not developed, while in another group of the same genus such a pattern of cusps is more or less well developed. In *Trilophodon, Megabelodon, Chœrolophodon, Rhynchotherium, Dibelodon, Tetralophodon,* and *Pentalophodon,* such a trefoil pattern of cusps is very well developed. Thus *Mœritherium* stands before *Palæomastodon* in this character also. Again, in *Zygolophodon* and *Mastodon* such a pattern of cusps is not developed at all. Thus, *Mœritherium* appears to represent a generalized type of both the *Palæomastodon* (B)—*Trilophodon–Megabelodon* phylum and the *Palæomastodon* (A)—*Zygolophodon-Mastodon* phylum, within the limits of the above-mentioned character.

In all the twenty-three characters examined, *Mœritherium* is structurally a pre-*Palæomastodont* type, so far as we admit the conception that *Palæomastodon, Trilophodon,* and *Megabelodon* form together a fair series of evolutionary stages. It is, of course, beyond doubt that the structural gap between *Mœritherium* and *Palæomastodon* is fairly great. Notwithstanding such a great structural gap between them, yet the fact should not be neglected that *Mœritherium* stands structurally before *Palæomastodon* in so many characters as just stated above.

[1]I am going to distinguish this group as a genus distinct from the typical *Palæomastodon.* See my future paper now being prepared.

I have adopted chiefly the series of *Palæomastodon, Trilophodon,* and *Megabelodon* to judge the structural position of *Mœritherium,* simply because these three genera appear, as declared by Professor Osborn, to represent structurally, geologically, and palæozoögeographically a fair series, which might have evolved in one and the same direction (not one and the same evolutionary course). As to the short-jawed mastodonts and elephants, they had their evolutionary directions obviously different from that of the just-mentioned series.

I.—Natural Position of Mœritherium

It may be evident from the preceding statements that *Mœritherium* differs strongly from either the hyracoids or the sirenians in many characters, on the one hand, and has many proboscidean and pre-Palæomastodont characters on the other hand. If much weight should be given to the sirenian resemblances of *Mœritherium,* then more weight should be given to its hyracoid resemblances. In my opinion *Mœritherium* is to be treated as a very archetypal member of the proboscideans as correctly stated by Andrews at the first.

Mœritherium has many pre-Palæomastodont characters. Consequently a presumed ancestral type of *Palæomastodon* should resemble *Mœritherium* in many characters. On the other hand, the structural gap between *Mœritherium* and *Palæomastodon* is fairly great. Then it might have happened, either that *Palæomastodon* arose from a very much earlier stage of *Mœritherium,* or from an ancestral type, yet unknown to us, which resembled *Mœritherium* in certain ways. At any rate, *Mœritherium* appears to me to stand near the phylogenetic base of the *Palæomastodon* phylum, if not actually ancestral to the same.

We are familiar with the conceptions that the short-jawed type of *Tetralophodon* was not strictly an evolutionary successor to the last stage of *Trilophodon;* that *Stegodon* was not strictly an evolutionary successor to the last stage of *Tetralophodon* or *Pentalophodon;* and that *Elephas* was not an evolutionary successor to the last stage of *Stegodon.* We should not be surprised to see the evidences that *Palæomastodon* was not strictly an evolutionary successor to the last stage of *Mœritherium.*

J.—Evolutionary Tendencies in the Earlier Proboscideans

As already stated, the lower jaws of *Mœritherium, Palæomastodon, Trilophodon,* and *Megabelodon,* having their incisors formed together something like a spade, display a structure adapted to the digging and rooting in a terrestrial life. The mode of using such a lower jaw may suggestively be conceived in observing the life-mode of the suids. In *Mœritherium*, however, the second pair of the lower incisors shows a tendency of being tusk-like, not as in the suids. This proper tendency observed in *Mœritherium* may be of very great significance.

As I have already stated in my study of the palæobiology of *Desmostylus*,[1] the development of the tusks and jaws appears to me to correlate with each other in two ways: first, the antero-posterior elongation of the tusks correlates with that of their own jaw; and, second, the antero-posterior elongation of the tusks plus jaw correlates with that of the opposite tusks plus jaw, so far as the tusks of both jaws are functionally mating. The tendency of the lower, as well as the upper, second incisors to be tusk-like, observed in *Mœritherium*, is very interesting from this point of view.

The external nares of *Mœritherium* show a tendency to retire backwards. This character may also be very important for the problem of the phylogeny of the proboscideans, because such a retirement of the external nares correlates with the development of a retractile or prehensile upper lip or a proboscis, so far as the retired external nares faces forwards and its posterior border is indented by the insertion of the anterior ends of the nasals. Doubtless *Mœritherium* might not have a well-formed proboscis, though, again doubtless, it might have a more or less retractile or prehensile upper lip—a first step toward a proboscis. Judging from the degree of the retirement of the external nares, the presumed prehensile upper lip of *Mœritherium* might be in a condition more rudimentary than that of modern tapirs.

The retirement of the external nares might yield a suitable space for the development of the upper incisor tusks, for well-developed and heavy upper tusks need long and powerful premaxillæ for the support of their bases. If the case be the canine tusks, there may be no need for either the external nares to retire or for the premaxillæ to become long and powerful; the upper canine tusks have their support in the maxillæ and are situated lateral to the external nares. Such a condition is clearly seen in the upper canine tusks of *Desmostylus*. The condition seen in *Mœritherium*, on the contrary, is quite similar to that observed in *Eosiren*, *Halitherium*, *Halicore*, etc., as well as *Palæomastodon*, mastodonts, and elephants.

So far as the characters are concerned, we can fairly conceive an evolutionary stage somewhat resembling *Palæomastodon* by supposing a further development of the evolutionary tendencies already acquired by

[1]1918, Sci. Rep. Tôhoku Imp. Univ:, Series B, III, No. 2.

Mœritherium. But, if we neglect *Mœritherium*, we may not be able to conceive at all how the structures observed in the *Palæomastodon* phylum have arisen.

K.—Phylogenetic Relations Among the Hyracoids, Earlier Proboscideans, and Sirenians

That the proboscideans and sirenians are very closely related to each other in their earlier stages of evolution has been maintained by many eminent authors, such as Blainville, Andrews, Osborn, Gregory, etc. It is, of course, very obvious that their earlier stages resemble each other in certain ways. Nevertheless, it is also obvious that the differences observed between the series of *Prorastomus, Eotherium, Prosiren, Eosiren, Miosiren, Halitherium*, etc., and the series of *Mœritherium, Palæomastodon, Trilophodon*, and *Megabelodon* are very great. The first series started from long-skulled types (*Prorastomus, Eotherium*, etc.) and became more and more short-skulled, while the second series started from short-skulled types (*Mœritherium* and *Palæomastodon*) and became more and more long-skulled (though the naso-fronto-parietal region became progressively shortened). So far as the length of the skull is concerned, the two series took their evolutionary courses, not parallel nor divergent, but they crossed each other. Then, the divide or common base of these two series might naturally be traced back very far from the stage of *Mœritherium*. Consequently, the phylogenetic relation between the two series should be somewhat less close than considered by those authors who emphasize chiefly the resemblances between *Mœritherium* and the earlier sirenians.

A number of the similarities between *Mœritherium* and the earlier sirenians should be due to their phylogenetic closeness; another series of resemblances should be due to convergence, owing to the fact that *Mœritherium* is situated somewhat near the cross-way of the evolutionary courses of the two series; and still other similarities should be due to their being primitive, being common to all the three groups of the hyracoids, earlier sirenians, and earliest proboscideans. Doubtless no known sirenian can be looked upon as an ancestral type of *Mœritherium* and doubtless *Mœritherium* cannot be looked upon as an ancestral type of any known sirenian.

Mœritherium resembles the hyracoids in many characters already stated; and the resemblance between them appears to be rather stronger than even that between *Mœritherium* and the sirenians. On the other hand, *Mœritherium* differs from the hyracoids also in many characters already stated. Doubtless no known hyracoid can be looked upon as an ancestral type of *Mœritherium.*

Consequently, both the sirenians and proboscideans might have descended from unknown ancestors which stand even before the hyracoids so far as known.

SYSTEMATIC

Andrews distinguished three species of *Mœritherium, viz., M. lyonsi,* a larger form of both the Qasr-el-Sagha and Fluvio-marine Formations; *M. gracile,* a smaller form of the Qasr-el-Sagha Formation; and *M. trigodon* a smaller form of the Fluvio-marine Formation. Schlosser divided Andrews' *M. lyonsi,* from the stratigraphical and morphological standpoint, into two species, *viz., M. lyonsi,* restr., a larger form of the Qasr-el-Sagha Formation, and *M. andrewsi,* a larger form of the Fluvio-marine Formation. Further, he inclined to look upon the larger and smaller forms of each formation as a sexual difference within one and the same species; consequently, he recognized only two species of *Mœritherium, viz., M. lyonsi,* including both the larger and smaller forms of the Qasr-el-Sagha Formation and *M. andrewsi,* including both the larger and smaller forms of the Fluvio-marine Formation. If his view be at all correct, his *M. andrewsi* should be called *M. trigodon,* according to the law of priority.

As far as judged from the material belonging to the American Museum, which includes two skulls corresponding to the larger and smaller forms of the Fluvio-marine Formation, the two forms cannot at any rate be looked upon as a sexual difference of one and the same species; the smaller skull has much stronger sagittal and occipital crests and a much wider occiput, and the external auditory openings are much more distant from each other, than in the larger skull. This fact may indicate the specific distinction of the larger and smaller forms. Moreover, I noticed from the material of the American Museum and from Andrews' statement that the difference between the larger and smaller forms of the Qasr-el-Sagha Formation is greater than that between the larger and smaller forms of the Fluvio-marine Formation. Consequently, the two forms of the Qasr-el-Sagha Formation, also, might better be looked upon as two distinct species. Thus, I have come to recognize four species of *Mœritherium,* which may be distinguished as follows:

(1.) Larger form of the Qasr-el-Sagha Formation. Lower premolars very short: P^{2-4}, ca. 69 mm. (Andrews); lower molars very long, M_{1-3}, ca. 104 mm. (Andrews). All the lower cheek-teeth very wide. P_2, triangular, its widest part corresponding to the posterior lobe. P^{2-4}, 67–78 mm.; M^{1-3}, 85 mm. (Andrews).........*M. lyonsi.*

(2.) Smaller form of the Qasr-el-Sagha Formation. Lower premolars not very short in comparison with the length of lower molars: P_{2-4}, ca. 62 mm. (specimens in the American Museum); lower molars very short: M_{1-3}, 83 mm. (specimen in the American Museum). All the lower cheek-teeth are narrow. P^{2-4}, 62 mm. (Andrews); M^{1-3}, 75 —ca. 79 mm. (Andrews)................................*M. gracile.*

(3.) Larger form of the Fluvio-marine Formation. Lower premolars not very short in comparison with the length of lower molars; P_{2-4}, 70 (specimen in the American Museum)—73 mm. (Andrews); lower molars rather long: M_{1-3}, 99 (Andrews)—100 mm. (specimen in the American Museum). All the lower cheek-teeth are narrow. P_2, fusiform in upper view, its widest part corresponding to the middle part. P^{2-4}, 70–75 mm. (Andrews); M^{1-3}, yet unknown, but M^{1-2}, ca. 61 mm. (British Museum cast in the American Museum). Skull large and heavily built. Sagittal crest rather weak. Zygomatic width rather small in comparison with the length of skull. Distance between the two external auditory openings, as well as the width of occiput, small, being smaller even than in the next form..................*M. andrewsi.*

(4.) Smaller form of the Fluvio-marine Formation. Lower premolars not very short in comparison with the length of lower molars: P_{2-4}, ca. 63 (specimen in the American Museum)—70 mm. (ditto, as well as Andrews); lower molars ra'her short: M_{1-3}, 93 (specimens in the American Museum)— 98 mm. (Andrews). All the lower cheek-teeth very narrow: P_2, fusiform in upper view, its widest part corresponding to the middle part. P^{2-4}, 60–63 mm. (specimen in the American Museum); M^{1-3}, 83–85 mm. (ditto). Skull, small and lightly built. Sagittal and occipital crests very strong. Zygomatic width very large in comparison with the length of skull. Distance between the external auditory openings, as well as the width of occiput, very large..*M. trigodon.*

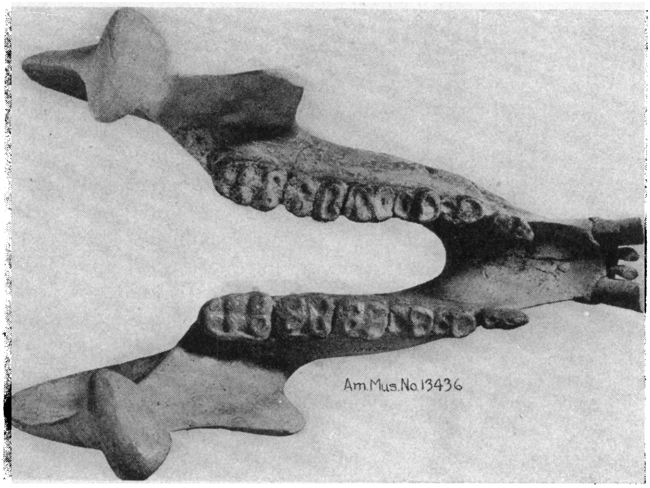
(1.) **Mœritherium lyonsi** Andrews

M. lyonsi Andrews, 1901, Tagebl. d. V. International Zool. Congr. Berlin, No. 6, p. 4[1]; Andrews, 1901, Geol. Mag., Decade IV, VIII, pp. 403–406, text-fig. 2; Andrews, 1903, Phil. Trans., Ser. B., CXCVI, pp. 113–117, text-figs. 14–17; Andrews, 1904, Geol. Mag., Decade V, I, pp. 109–112, text-fig. 1; Andrews, 1906, 'Descr. Cat. Tert. Vert. Fayûm, Egypt,' Brit. Mus., pp. 120–126, *pars*, Pl. x, figs. 1–5, Pl. xi, figs. 1–9. Schlosser, 1911, 'Beitr. z. Pal. u. Geol. Österreich-Ungarns u. d. Orients,' XXIV, pp. 131–135, Pl. xvi (viii), figs. 1–5.

Specimens.—No. 13444; two of the three fragments of mandibular rami of this specimen number appear to belong to this species. They are very peculiarly weathered, as a characteristic of the weathered specimens from the Qasr-el-Sagha Formation, with much-weathered and badly preserved molars *in situ*. Qasr-el-Sagha Formation of the Fayûm.

The dimensions of the teeth of these fragments, in comparison with those of Andrews' specimens, are tabulated as follows (in mm.):

[1]This paper was not seen by me.



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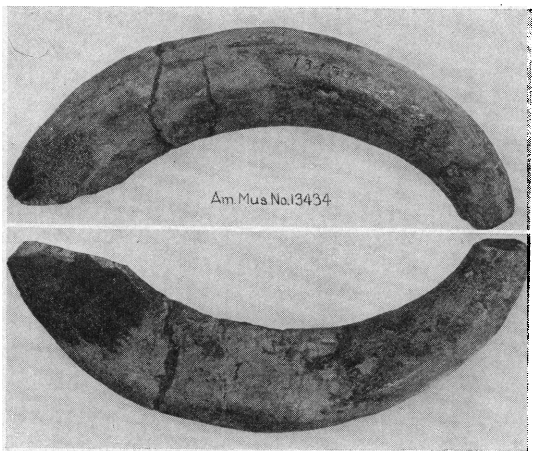

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Fig. 1. *Mœritherium lyonsi* Andrews. Mandible, Amer. Mus. No. 13436.
One-fourth natural size. Superior view.

Fig. 2. *Mœritherium lyonsi* Andrews. Second upper right incisor tooth, Amer. Mus. No. 13434.
One-half natural size. Upper figure, internal view; lower figure, external view.

		Lower Teeth			Upper Teeth			
		No. 13444	ditto	(Andrews)	(Andrews)			
P2	length	..	..	22	27	..	..	.....
	width	..	..	16	23?	..	..	.....
P3	length	..	..	23	26.5	..	..	.....
	width	..	..	21	29.5	..	..	.....
P4	length	..	..	25	23	..	..	.....
	width	..	..	23	27.5	..	..	.....
M1	length	..	..	26.5	29	..	..	.....
	width	..	..	24.5	27	..	..	.....
M2	length	29	28	35	26?	30	..	.....
	width	25	25	39	23.5	28	..	.....
M3	length	40	39	42	....	32	..	37 $\pm$[1]
	width	28	28	30	....	28	..	30 $\pm$[1]
Length of P2-4		..	..	69 $\pm$[1]	68	..	67	.....
Length of M1-3		..	..	104 $\pm$[1]	....	..	85	.....

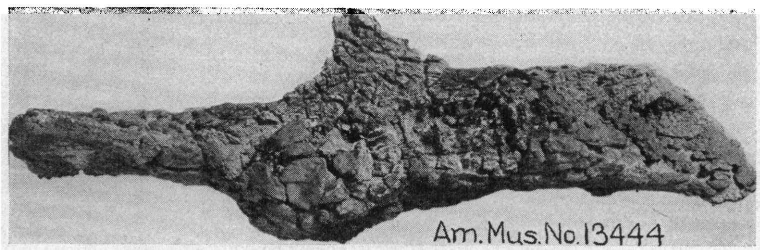


Fig. 3. *Mœritherium lyonsi* Andrews. Amer. Mus. No. 13444, left ramus of mandible, incomplete.
One-half natural size. Superior view.

Andrews reported a skull with the two upper tusks, *viz.*, I^2 which measure about 28 mm. in transverse as well as to and fro diameter, from the Qasr-el-Sagha Formation. This specimen might probably belong to the present species, as stated by Andrews.

(2.) **Mœritherium gracile** Andrews

M. gracile.—ANDREWS, 1902, Geol. Mag., Decade 4, IX, p. 292; ANDREWS, 1906, 'Descr. Cat. Tert. Vert. Fayûm, Egypt,' Brit. Mus., pp. 127–128, Pl. XVII, figs. 1–3; SCHLOSSER, 1911, 'Beitr. z. Pal. u. Geol. Österreich-Ungarns u. d. Orients,' XXIV, pp. 131–132.

[1]These dimensions are estimated from Andrews' figures.

Specimens.—No. 13443; mandible, with P_3–M_3 of the left side and M_{1-3} of the right side *in situ.* No. 13444; one of the three fragments of mandibular rami of this specimen number, with badly preserved molars *in situ.* No. 13445; fragment of a right mandibular ramus of a young individual, with the teeth broken away. No. 13446; fragment of a left mandibular ramus, with the crowns of the teeth broken away. All from the Qasr-el-Sagha Formation of the Fayûm.

The mandible of No. 13443 measures 305 mm. in length without incisors, 8.5 mm. in length of symphysis, 55 mm. and 50 mm. in the distance between the two first molars and the two last molars respectively, 225 mm. in the bicondylar width and 76 mm. in the height of the mandibular ramus at M_1 without the teeth. In this specimen the symphysial depression already cited is observed to be present. In the fragmentary mandible of No. 13446, the same depression is clearly observed, also.

The dimensions of the cheek-teeth of the specimens at hand, in comparison with those of Andrews', are tabulated as follows (in mm.):

		Lower Teeth			Upper Teeth	
		No. 13443 right-left		No. 13444	(Andrews)	
P2	length	....	....	..	22	..
	width	....	....	..	18	..
P3	length	....	22	..	20	..
	width	....	15	..	23	..
P4	length	....	21	..	20	..
	width	....	18	..	21?	..
M1	length	23	23	22	23	25
	width	20	19	19?	23	21
M2	length	28	28	27	24	27
	width	22.5	23	22	25	23
M3	length	34	33	..	28	28
	width	24	24	..	24	25
Length of P2-4		63± (alveoli)	63± ditto)	..	62	..
Length of M1-3		84	84	..	75	79±[1]

The alveoli of each I_1 and I^2 of the mandible of No. 13443 measure 10 mm. and 20 mm. in transverse diameter, respectively; the lateral extension of, and the minimum distance between, the two alveoli of lower tusks are 50 mm. and 9 mm. respectively. The two alveoli of first

[1]This dimension is estimated from Andrews' figure.

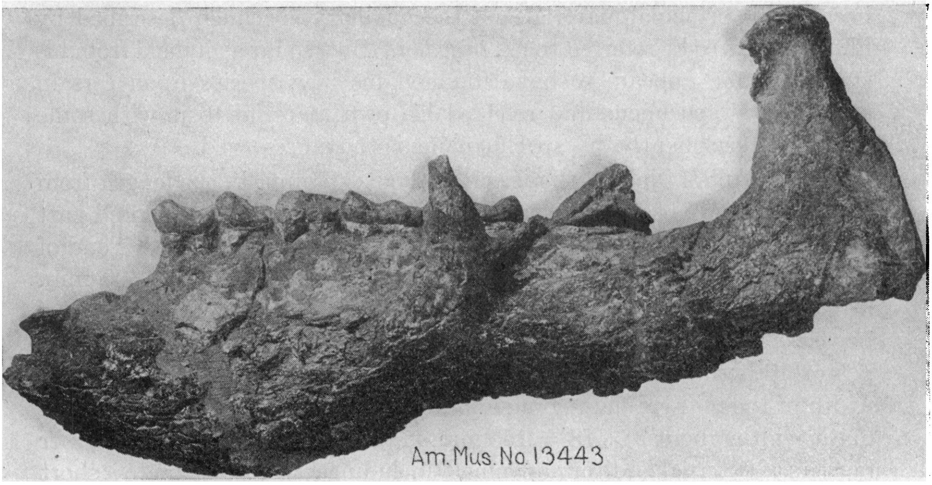


Fig. 4. *Mœritherium gracile* Andrews. Amer. Mus. No. 13443, left ramus of mandible, incomplete.
One-fourth natural size. Lateral view, left side.

incisors are situated just below and anterior to the part corresponding to minimum distance between the two alveoli of tusks. Judging from these alveoli, the lower first incisors might be located not strictly inside, but inside and below and anterior to, the pair of lower tusks, which might be rather closely set to each other. These lower tusks appear to be distinctly smaller than those of *M. lyonsi* and *andrewsi*.

(3.) **Mœritherium andrewsi** Schlosser

M. lyonsi ANDREWS, 1906, 'Descr. Cat. Tert. Vert. Fayûm, Egypt,' Brit. Mus., pp. 128–129, *pars*, Pl. VIII, fig. 1, Pl. IX, figs. 1, 2, and 4.

M. andrewsi SCHLOSSER, 1911, 'Beitr. z. Pal. u. Geol. Österreich-Ungarns u. d. Orients,' XXIV, pp. 130–131, *pars*.

SPECIMENS.—No. 13432; right half of a full-grown skull, without teeth, well preserved in the limit of the parts represented. No. 13434; right upper tusk, *viz.* I^2, with well-worn crown. Extra no.; left first upper incisor, with imperfectly preserved crown. No. 13437, greater part of a mandible, with the right series of cheek-teeth, except P_4 which might have been accidentally lost in the life of the animal, and with left M_{2-3} *in situ*. All from the Fluvio-marine Formation of the Fayûm.

As to the specific name, if Schlosser's own material, which he purposely described in his paper, be the type of his new species, then the specific name *andrewsi* cannot be adopted for the present species;

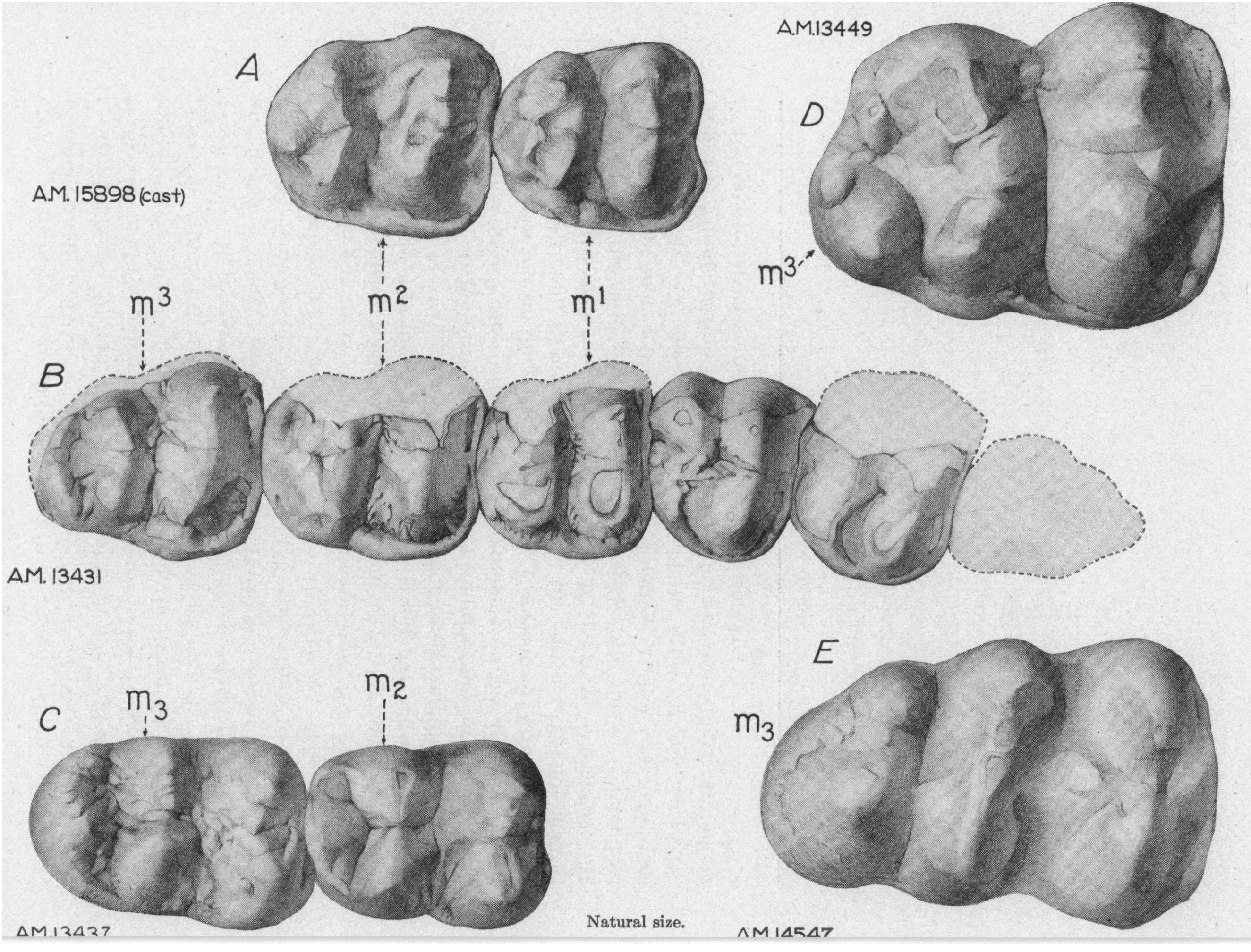
because his principal material, not the auxiliary specimen described by him, appears to be referred to *M. trigodon.* But, so far as judged from his statement, he appears to have founded his new species upon certain of Andrews' specimens and referred his own material to it with some doubt. Consequently, his specific name is to be preserved.

The skull of No. 13432 measures about 345 mm. in the length from the anterior end of nasal to the occipital crest (including a restored part to a short extent), about 380 mm. in the length from the anterior end of premaxilla to the outer posterior border of squamosal, about 300 mm. in the length from the anterior border of orbit to the outer posterior border of squamosal, about $2 \times 45 = 90$ mm. in the distance between the postorbital processes of frontals, about $2 \times 35 = 70$ mm. in the minimum width of the mid-cranial region, about $2 \times 145 = 290$ mm. in the zygomatic width, about $2 \times 78 = 156$ mm. in the distance between the upper borders of external auditory openings (including a restored part to a short extent), about $2 \times 93 = 186$ mm. in the width of occiput (including a restored part to a short extent), and about 50 mm. in the length of the diastema between the alveoli of C and P^2. In this skull the sagittal crest is developed, but much weaker than that of the skull of No. 13430, which is referred to *M. trigodon,* notwithstanding the former is much larger than the latter. The orbital region is fairly well preserved in this skull; the maxilla runs up along the anterior border of the orbit and meets both the nasal and frontal, and no undoubted lacrymal is observed, quite as stated by Andrews. If the lacrymal might originally be present at all, it might be located deep within the orbit: the bottom of the orbit of this skull is broken away.

The mandible of No. 13437 measures 310 mm. in length back from the anterior border of P_2, 72 mm. and 75 mm. in height of ramus at P_3 and M_1 respectively without the teeth, and 205 mm. in height at condyle. The dimensions of the cheek-teeth of this specimen, in comparison with those of Andrews, are tabulated (in mm.) on p. 132.

The first upper incisor of the extra-number at hand measures 16.5 mm. in the side to side, and 14.5 mm. in the to and fro, diameter of the

Fig. 5. Life-size comparison of molars of *Mœritherium* and *Palæomastodon* drawn for the Proboscidea Memoir by Mrs. L. M. Sterling under the direction of Henry Fairfield Osborn. *A,* Amer. Mus. No. 15898, *M. andrewsi* Schlosser (cast), upper molar teeth; *B,* Amer. Mus. No. 13431, *M. trigodon* Andrews, upper premolars and molars; *C,* Amer. Mus. No. 13437, *M. andrewsi* Schlosser, lower molars; *D,* Amer. Mus. No. 13449, *Palæomastodon* sp., upper molar; *E,* Amer. Mus. No. 14547, *Palæomastodon* species, lower molar. All but the last of the right side.



Natural size.

crown. It is larger than that described by Schlosser, which seems likely to belong to *M. trigodon.* The upper tusks, *viz.* I^2, of No. 13434 at hand measures about 140 mm. in straight length, 26 mm. and 29 mm. in the transverse and the antero-posterior diameter respectively, and about 38 mm. in the height of the fairly worn crown on the outer side. Andrews reported an upper tusk measuring 26 mm. in width from the Fluvio-marine Formation. It appears to coincide well with the present tusk in its width and seems to belong also to this species. Both the present and Andrew's specimens, representing tusks, are distinctly larger than one reported by Schlosser, which may probably belong to *M. trigodon.* The American Museum has one more tooth of extra-number from the Fluvio-marine Formation, which appears likely to represent a left third upper incisor of some species of *Mœritherium.* Its crown is triangular, with the anterior and posterior borders, as well as the internal basal cingulum, distinctly serrate; one of the serræ on either border is much more prominent than the others, appearing to represent the paracone on the anterior border and the metacone on the posterior border. It measures 14 mm. in length, 8 mm. in width and 13 mm. in the height of the crown. It is not clear at present whether this tooth might belong to *M. andrewsi* or *trigodon.* At any rate, all the three upper incisors of *Mœritherium* appear to have had the crown and root well differentiated. Further, Andrews reported two lower tusks, I_2, one measuring 28 mm. and the other 20 mm. in width, from the Fluvio-marine Formation. The former seems likely to belong to the present species and the latter to *M. trigodon.*

		Lower Teeth				Upper Teeth			
		No. 13437	(Andrews)			(Andrews)			
P2	length	24	..	..	26	27	25	..	26
	width	11	..	..	14	20	20	..	22
P3	length	29	..	28	27	25	25	26	26
	width	17.5	..	18	19	28	28	..	32
P4	length	....	..	25	24	21	22	21	22
	width	....	..	21	21	28	27	..	29
M1	length	29	..	28	30	32	29	29	31
	width	21	..	21	22	26	25	..	27
M2	length	32.5	33	34	32	32	33	32	..
	width	26	..	27	27	29	28	..	..
M3	length	37	37	..	40	..	..	..	..
	width	26	26	..	28	..	..	..	..
Length of P2-4		70	..	..	73	73	70	..	75
Length of M1-3		100	..	..	99	..	..	..	..

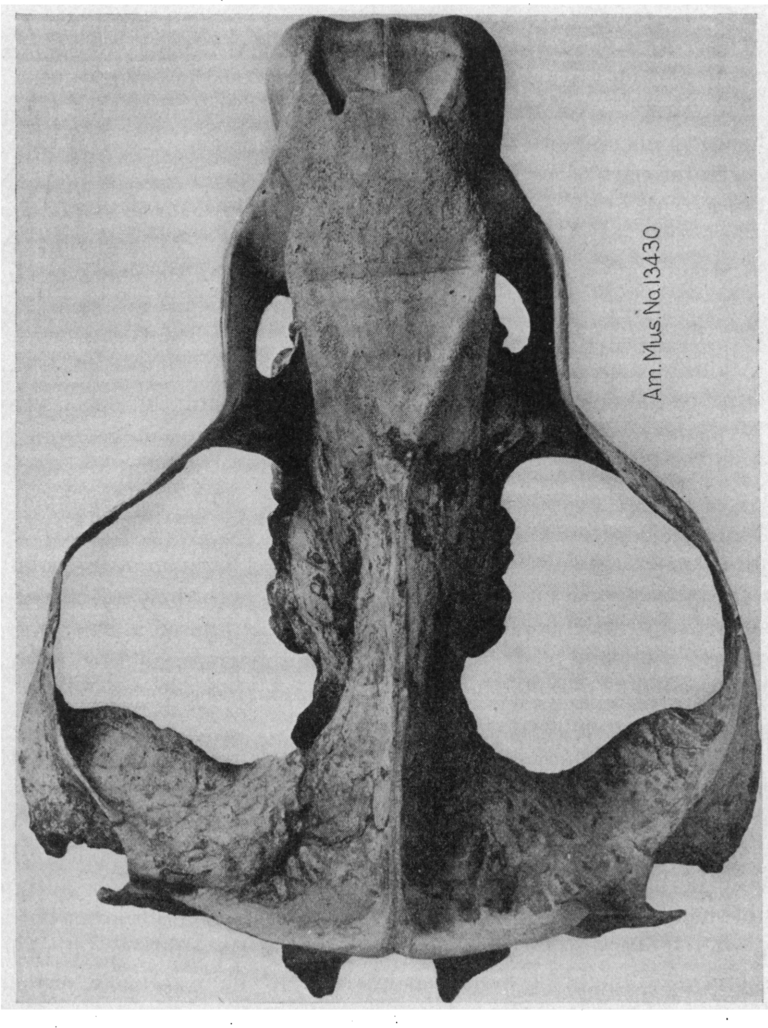


Fig. 6. *Mœritherium trigodon* Andrews. Amer. Mus. No. 13430, skull. About one-fourth natural size. Superior view.

(4.) **Mœritherium trigodon** Andrews

M. trigodon.—Andrews, 1904, Geol. Mag., Decade 5, I, p. 112.

M. trigonodon.—Andrews, 1906, 'Descr. Cat. Tert. Vert. Fayûm, Egypt,' Brit. Mus., pp. 128–129, Pl. ix, fig. 5; Schlosser, 1911, 'Beitr. z. Pal. u. Geol. Österreich-Ungarns, u. d. Orients,' XXIV, p. 130.

M. lyonsi—ANDREWS, 1906, 'Descr. Cat. Tert. Vert. Fayûm, Egypt,' Brit. Mus., pp. 128–129, *pars*, text-fig. 43, Pl. IX, fig. 3.

M. andrewsi.—SCHLOSSER, 1911, 'Beitr. z. Pal. u. Geol. Österreich-Ungarns u. d. Orients,' XXIV, pp. 130–131, *pars*, Pl. XVI (VIII), figs. 6 and 7.

SPECIMENS.—No. 13430; greater part of a full-grown skull, bearing all the upper cheek-teeth *in situ*. No. 13431; fragment of a skull, including a greater part of a right half of palate, bearing P^3-M^3 *in situ*. No. 13433; left M^2 attached to a fragment of upper jaw. No. 13435; fragment of a right ramus of mandible, with all the cheek-teeth *in situ*. No. 13436; fragment of a left ramus of mandible, with all the cheek-teeth *in situ*. No. 13439; right P_4 and M_1, with their roots broken away. All from the Fluvio-marine Formation of Fayûm.

Andrews appears to have laid much weight upon the shape and structure of the posterior talon of M_3 in distinguishing this species from his *M. lyonsi* (=*lyonsi*+*andrewsi*). As far as I can judge from the specimens in the American Museum and Andrews' statement and figures, such a character may not be adequate enough to be looked upon as specific; because, firstly, the posterior talon of M_3 appears to be one of the most variable structures in the teeth of *Mœritherium* and, secondly, its appearance to the naked eye seems to differ according to the degree of age and of wearing of the tooth. The seeming difference according to the degree of age and of wearing of the tooth appears to hold true also as to the secondary tubercles between the principal ones of each lobe, as well as the basal cingulum of the molars.

The skull of No. 13430 measures 240 mm. in the length from the point at which the vertical plane tangential to the anterior borders of both P^2 meets the median longitudinal line on the palate, to the basion, 145 mm. in the length from the same point to the median point of the posterior border of palate, about 180 mm. in the length from the anterior limit of the temporal vacuity in palatal view to the posterior lower border of squamosal, 42 mm. in the minimum width of the mid-cranial region (this dimension might be somewhat less than it ought to be in primary condition, as this part of this specimen appears to be crushed secondarily from side to side), 280 mm. in the zygomatic width, about 190 mm. in the distance between the upper borders of external auditory openings (including reliably restored parts to a slight extent), 220 mm. in the width of occiput, 91 mm. in the lateral extension of the two occipital condyles, 52 mm. in the width of palate between the two P^2, 34 mm. in the same between the two M^1, and about 150 mm. in the maximum height of the skull, including the upper cheek-teeth (including a restored part of sagittal crest to a slight extent). In this skull the sagittal and occipital

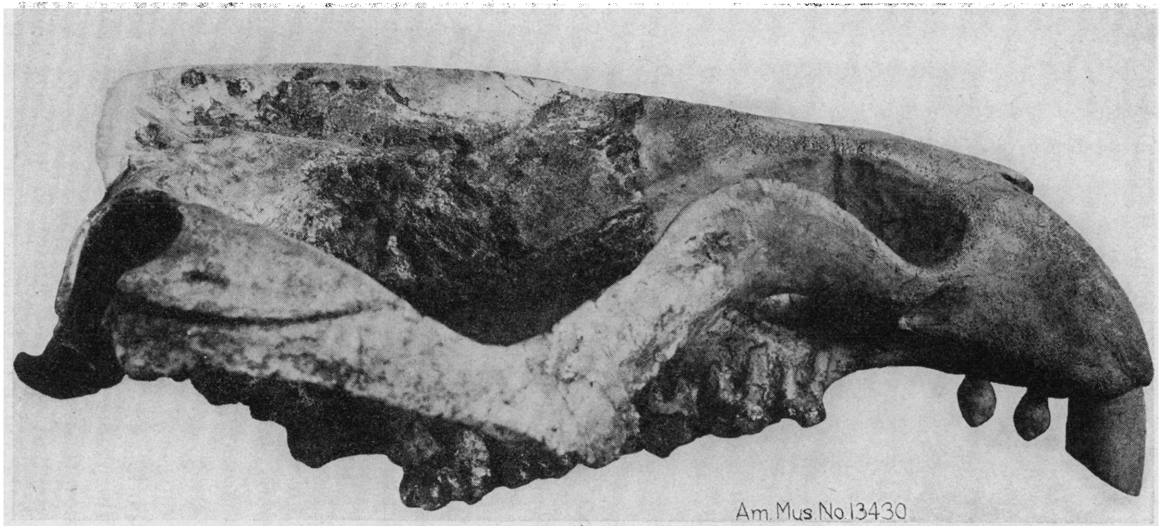


Fig. 7. ***Mœritherium trigodon*** **Andrews. Amer. Mus. No. 13430, skull.**
About one-fourth natural size. Lateral view, right side.

crests are extraordinarily well developed; and the occiput is strongly concave, so that its upper half, including the lambdoid crest, inclines distinctly backwards.

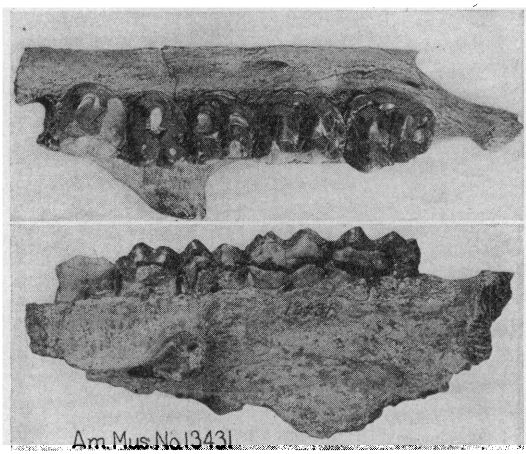


Fig. 8. *Mœritherium trigodon* Andrews. Amer. Mus. No. 13431, right maxilla.

One-fourth natural size. Upper figure, occlusal view; lower figure, external view, right side.

The fragment of the skull of No. 13431 measures $2 \times 19.5 = 39$ mm. in the width of palate between the two P^2 (alveolus) and $2 \times 15 = 30$ mm. in the same between the two M^1.

The mandibular ramus of No. 13435 measures 84 mm. in height at P_3 without the tooth, and about 30 mm. in the length of diastema between I_2 and P_2 (including an estimated part to a slight extent). There are two anterior mental foramina on the outer surface of this ramus, one locating below the anterior lobe of P_3 and the other below the middle part of P_4; both the foramina are very small. A small but distinct foramen is present on the anterior surface of the ascending bar, just behind M_3. The mandibular ramus of No. 13436 measures about 73 mm. in height at P_3 without the tooth. Two anterior mental foramina are observed to be present also in this ramus, one situated below the anterior lobe of P_3 and the other below the anterior lobe of P_4.

Schlosser has pointed out that Andrews' specimen shown in his Pl. IX, fig. 3, under the name of *M. lyonsi* might refer to *M. trigodon,* though Schlosser himself has been inclined to look upon the last mentioned species as a female type of *M. andrewsi.* Again, Andrews' specimen shown in this text-fig. 43 seems to me to belong to *M. trigodon.*

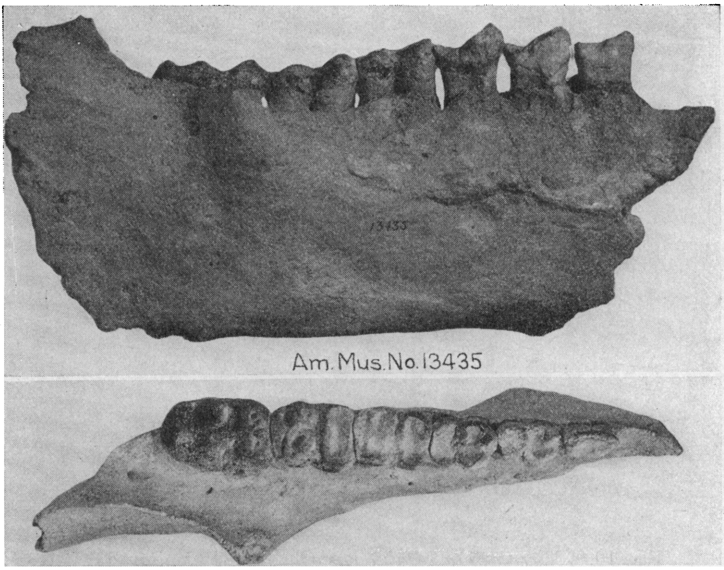


Fig. 9. *Mœritherium trigodon* Andrews. Amer. Mus. No. 13435, right ramus of mandible, incomplete.
One-fourth natural size. Upper figure, external view; lower figure, superior view.

The dimensions of the cheek-teeth of the specimens at hand, in comparison with those of Andrews', are tabulated as follows (in mm.):

		Lower Teeth						Upper Teeth			
		No. 13435	No. 13436	No. 13439	(Andrews)			No. 13430		No. 13431	No. 13433
								right	left		
P2	length	19.5	23?	..	..	23	..	19	22?	......	..
	width	10	11	..	..	11	..	21	18?	......	..
P3	length	22	24?	..	..	25	..	23	23.5	24	..
	width	15	14?	..	..	17	..	26	24?	25?	..
P4	length	23	23.5	25	..	24	22	20.5	20	22	..
	width	18	18.5	19	..	20	..	24	23?	25.5	..
M1	length	27	24	27.5	26	..	27	25	22	24	..
	width	21	19	21	..	..	21	25	26.5?	24	..
M2	length	29	31	..	32	..	..	29	28	30	29
	width	24	24	..	..	..	..	28	27	25?	24
M3	length	37	37	..	40	..	..	31	32	30	..
	width	26.5	25	..	24	..	..	26.5	27	26	..
Length of P2-4		63	70	..	..	70	..	60	63	......	..
Length of M1-3		93	93	..	98	..	..	85	83	84	..

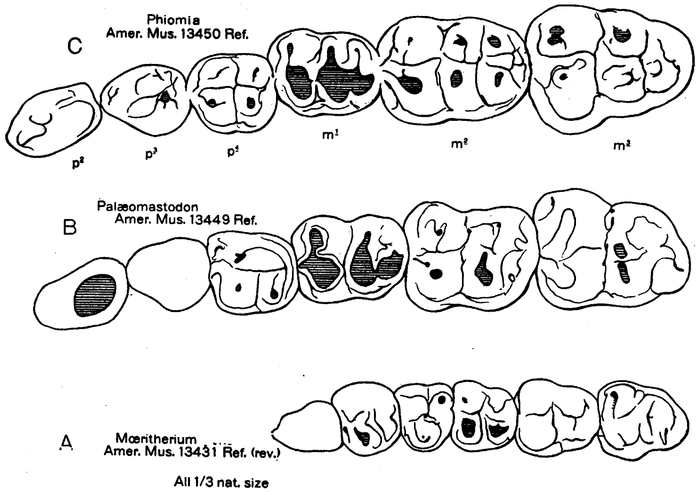


Fig. 10. *Mœritherium*, *Palæomastodon*, and *Phiomia*. Left upper grinding teeth. *A*, *Mœritherium*, Amer. Mus. No. 13431; *B*, *Palæomastodon*, Amer. Mus. No. 13449; *C*, *Phiomia*, Amer. Mus. No. 13450.

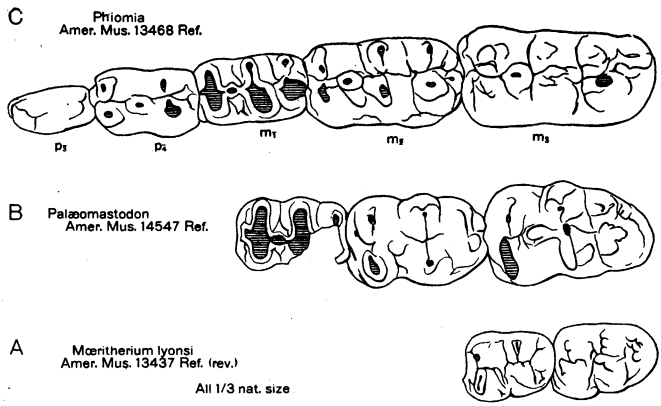


Fig. 11. *Mœritherium*, *Palæomastodon*, and *Phiomia*. Left lower grinding teeth. *A*, *Mœritherium lyonsi* Andrews, Amer. Mus. No. 13437 (reversed), second and third lower molars; *B*, *Palæomastodon*, Amer. Mus. No. 14547, first, second and third lower molars; *C*, *Phiomia*, Amer. Mus. No. 13468.

As already stated, one of Andrews' specimens from the Fluvio-marine Formation, representing a lower tusk, I_2, which measures 20 mm. in width, may belong to this species. Schlosser's specimen, representing a fragment of an upper jaw with I^1 and I^2, which measures 14 mm. and 21 mm. in width respectively, may probably refer to this species, also as already cited.

Summary of the Systematic Part

I have now reviewed the four species of *Mœritherium* and discussed their mutual relationship. The ranges of the hitherto known dimensions of the tusks and cheek-teeth of these four species may be tabulated (in mm.) as follows:

Lower Teeth

		lyonsi	*gracile*	*andrewsi*	*trigodon*
P_2	length	22		24—26	19.5—23
	width	16		11—14	10—11
P_3	length	23	22	27—29	22—25
	width	21	15	17.5—19	14?—17
P_4	length	25	21	24—25	22—25
	width	23	18	21	18—20
M_1	length	26.5	22—23	28—30	24—27.5
	width	24.5	19—20	21—22	19—21
M_2	length	28—35	27—28	32—34	29—32
	width	25—30	22—23	26—27	24
M_3	length	39—42	33—34	37—40	37—40
	width	28—30	24	26—28	24—26.5
Length of P_{2-4}		69+	63+	70—73	63±70
Length M_{1-3}		140+	84	99—100	93—98
Width of I_2			20+	28	20

Upper Teeth

		lyonsi	*gracile*	*andrewsi*	*trigodon*
P^2	length	27	22	25—27	19—22?
	width	23?	18	20—22	18?—21
P^3	length	26.5	20	25—26	23—24
	width	29.5	23	28—32	24?—26
P^4	length	23	20	21—22	20—22
	width	27.5	21?	27—29	23?—25.5
M^1	length	29	23—25	29—32	22—25
	width	27	21—23	25—27	24—26.5
M^2	length	26?—30	24—27	32—33	28—30
	width	23.5—28	23—25	28—29	24—28
M^3	length	32—37±	28		30—32
	width	28—30±	24—25		26—27
Length of P^{2-4}		67—68	62	70—75	60—63
Length M^{1-3}		85	75—79±		83—85
Width of I^2		28		26	21

As far as judged from the absolute and relative dimensions of the cheek-teeth, *M. andrewsi* and *trigodon* appear to be more closely allied with each other than are *M. lyonsi* and *gracile*. And, as far as judged from the relative dimensions of the lower cheek-teeth, *M. gracile* appears to be more closely allied with *M. andrewsi* and *trigodon* than *M. lyonsi* does to the same. Consequently, *M. lyonsi* and *gracile* appear not to be sexual dimorphic types of one and the same species, and *M. andrewsi* and *trigodon* appear so also. Moreover, it appears to be more probable that *M. gracile* might be an ancestral type of both *M. andrewsi* and *trigodon* than that *M. lyonsi* and *gracile* might be ancestral types of *M. andrewsi* and *trigodon* respectively.