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# On *Megaladapis madagascariensis*, an Extinct Gigantic Lemuroid from Madagascar; with Remarks on the Associated Fauna, and on Its Geological Age

C. I. Forsyth Major

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II. *On Megaladapis madagascariensis, an Extinct Gigantic Lemuroid from Madagascar; with Remarks on the Associated Fauna, and on its Geological Age.*

By C. I. FORSYTH MAJOR.

Communicated by HENRY WOODWARD, LL.D., F.R.S., V.P.G.S.

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I. INTRODUCTION.

MORE than forty years ago, the scientific world was startled by the discovery made in Madagascar, and announced by ISIDORE GEOFFROY SAINT-HILAIRE to the French Academy of Science,\* of the eggs and bones of a gigantic bird, to which the name of *Aepyornis maximus* was assigned.

Though these were not the first proofs of an extinct Vertebrate Fauna in that island,† the discovery of eggs, said to have eight times the volume of those of *Struthio*, was of a nature to excite a wider interest, and gave rise to many speculations.

\* ISID. GEOFFROY SAINT-HILAIRE, "Notice sur des ossements et des œufs trouvés à Madagascar dans des alluvions modernes et provenant d'un oiseau gigantesque." 'Comptes Rend. Acad. Sc.' du 27 janv. 1851, p. 101–107. Cf. 'Ann. des Sc. Nat.,' 3 série, "Zoologie," vol. 14, Paris 1850, p. 206–213.

† See 'Proc. of the Geol. Soc. of London,' vol. 1, 1833, No. 31, p. 479. P. GERVAIS, in 'Dictionn. des Sc. Natur.,' Supplément. 1841, p. 254: "L'Autruche d'Afrique n'a donné lieu à aucun travail nouveau que nous connaissons. Nous dirons seulement, comme pouvant se rapporter à un oiseau du groupe de ces animaux, que nous avons vu, il y a plusieurs années, des débris d'œufs qui paraissent avoir dû être du volume de ceux des Autruches, et que M. GOUDOT avait trouvés dans l'île de Madagascar, mais sans avoir à leur sujet des renseignements positifs."

Since that time, occasional, though not numerous discoveries, to which I shall have incidentally to refer hereafter, have somewhat increased our knowledge of the so-called sub-fossil Vertebrate Fauna of Madagascar.

Recently, the British Museum acquired remains of Vertebrata, discovered in a fossil condition in various parts of the island. One of the most remarkable is a Mammalian skull of strange aspect, which forms the subject of the present communication, and for which the name of *Megaladapis madagascariensis* is proposed.

I am indebted to Dr. HENRY WOODWARD, Keeper of the Geological Department, British Museum (Natural History), for the permission to describe it.

The specimen was sent from Madagascar by Mr. J. T. LAST, a collector of the Hon. WALTER ROTHSCHILD, and is said to have been found in a marsh at Amboulisatra, on the south-west coast of Madagascar, together with scanty remains of several other Vertebrata, to be referred to hereafter.

## II. DESCRIPTION OF THE SKULL.

The base of the skull being wanting in almost the whole length of the floor of the brain-case, the exceedingly short and low brain-cavity is exhibited. The bullæ osseæ are broken away, and the foremost facial portion is also wanting, so that nothing can be said about the anterior parts of the dentition, the canines and incisors. The right and left ramus of a mandibula, somewhat incomplete in their anterior and posterior portions, were found together with the cranium, and, apparently, belong to the same specimen.

The length of the whole skull may be approximately calculated at 250 millims., and supposes an animal of from three to four times the size of a common Cat.

By the worn condition of the teeth, the obliteration of most of the sutures of the very thick bones, and the strongly developed crests, it is shown that the individual was much aged.

One of the most striking features of this cranium consists in the enormous lateral development of the interorbital region of the frontals, so as to form a broad and elongate roof over the orbits, which protrude in a tubular form outwards and forwards, and are encircled by a complete bony ring, with thick rounded margins. Compared to the size of the skull, the diameter of the orbits is small, suggesting diurnal habits. Beneath the postorbital bar, the orbits open freely into the temporal fossa.

The foramina lacrymalia are situated externally to the margin of the orbits. The lacrymal bones, as far as can be ascertained, are of small dimensions. On account of the partial obliteration of their sutures, the limits of the nasals cannot be quite exactly determined; these bones are not flattened, but convex from side to side, and separated by a groove from the maxillaries; they extend backwards with attenuated dimensions as far as the middle of the orbits. The facial portion is elongate and the maxillaries high.

The middle line of the frontals is feebly convex, forming an anterior continuation of the sagittal crest; from the convex middle line the frontals slope down gently on both sides, the roof of the orbits being again gently raised, so that the frontal region between these last and the middle line is somewhat depressed. Behind the orbits the frontals are much narrowed, and stretch backwards on the superior surface as well as laterally, the almost obliterated coronal suture being distant 31 millims. from the posterior margin of the orbits. Corresponding to the suture we find a very slight lateral constriction of the bone, behind which the parietals extend, with a breadth about equal to that of the frontals, and separated in the middle by a sagittal crest, which is less remarkable for its height than for its extraordinary thickness and flatness. Backwards from the orbits the crests divide into two portions, which continue anteriorly in a curved line, and come to an end on the roofs of the orbits.

Behind the molar series the maxillaries stretch upwards and backwards to an unusually great extent, and in this region are greatly inflated by aërial sinuses, which extend forward in the facial region above the molar series, and communicate behind with the frontal.

The occipital region is truncated, and divided by a median strong and sharp crest into two hollows. It is considerably narrowed, as is the whole of the skull, backwards from the orbits. The vertical direction of the occipital condyles, as well as the narrow but high *foramen magnum*, appears to be in connection with this lateral compression of the skull.

The zygomatic arch is high and but moderately projecting outwards, thus contributing to the general narrowed appearance of the posterior portion of the skull.

The cranio-facial angle is extremely obtuse, as in most lower Mammals; but whilst in these last the angle is open downwards, it would seem to be open upwards in *Megaladapis*, in consequence of both the facial and the cranial portion being somewhat bent upwards, the first anteriorly, the second posteriorly. Corresponding with this upward bending of the facial portion, the palate is convex in an antero-posterior direction, the convexity looking downwards.

Other characters of the cranium will be mentioned and discussed in the following paragraphs.

*Mandibula*.—The symphysial suture is completely obliterated. The inferior outline of the bone forms an almost straight line, with a slight downward bending anteriorly. The upper alveolar margin is far from parallel with the lower one; when this last is held horizontally it appears that the upper margin, and accordingly the series of the teeth, form an arched line, curving upwards anteriorly. This structure corresponds to a similar upward curving of the superior dental series, and is, of course, in relation with the upward bending of the facial portion. As a consequence, the anterior portion of the horizontal mandibular ramus is considerably higher than is the hinder (see measurements). The lower third of the horizontal ramus is attenuated, as compared to the upper two-thirds, there being a longitudinal groove on

the inner inferior part of the bone, more deepened in the posterior moiety, more shallow anteriorly.

The ascending ramus is considerably attenuated, and, as far as can be judged from the part preserved (the posterior and superior portion being broken), it was notably elongate antero-posteriorly.

In the right mandibular ramus four teeth are preserved, viz., the three molar and the posterior premolar; anterior to this last, the alveolus of a second, double-rooted premolar is visible.

The cusps of the inferior *molars* are obliquely disposed, the two outer ones alternating with the three inner ones, the anterior of which is very feebly developed. The two outer cusps are divided by a *sulcus*, which scarcely reaches the centre of the molar. The third molar is provided with a talon, consisting of a single strong cusp. An outer basal cingulum exists on the outer side of the three molars. The premolar has a single outer cusp, from the anterior and posterior side of which depart two crescents, which terminate on the interior side in a moderately developed anterior and posterior cusp; while between them a central interior cusp, somewhat stronger, and almost completely coalesced with the single outer cusp, is seen.

The *superior molars* (three in number) are of a simple tritubercular type, there being two external and one internal cusp. This last is deeply divided from the postero-external cusp; but from its anterior side a crest extends towards the outer part of the antero-external cusp. The superior premolars were three in number, as far as can be judged; two are in place, and anteriorly to them the alveoli of a two-fanged tooth are visible on the right side. The two premolars have each one outer and one inner cusp; and, like the molar, an inner and two outer roots. Anterior to the alveoli is a diastema, which on the right side is preserved to the extent of 10 millims.; further on the bone is broken.

#### MEASUREMENTS of the Teeth.

From the posterior margin of  $m_3$  sup. to the anterior margin of the alveolus of  $p_3$ , 74.5 millims.

$m_3$  sup., greatest length, 17.8 millims.; greatest breadth, 14.6 millims.

$m_2$  sup.           "           17           "           "           15.8           "

$m_1$  sup.           "           13.5           "           "           12.7           "

$p_1$  sup.           "           10           "           "           9.7           "

$p_2$  sup.           "           10.3           "           "           8.5           "

Breadth of the outer margins of the alveoli of  $p_3$  sup. : 9.8 millims.

#### FRAGMENT of Right Maxillary of a Second Specimen.

$m_3$ , greatest length, 18.5 millims.

$m_2$ ,           "           18           "           ; greatest breadth (at the base) 15.5 millims.

## INFERIOR Molars.

|                         |           |               |
|-------------------------|-----------|---------------|
| Length of $m_3$ — $m_1$ | . . . . . | 52·5 millims. |
| „ $p_1$                 | . . . . . | 10 „          |
| „ $m_1$                 | . . . . . | 13 „          |
| „ $m_2$                 | . . . . . | 15·5 „        |
| „ $m_3$                 | . . . . . | 23·5 „        |

## MANDIBULA.

|   |             |
|---|-------------|
| Height of the horizontal ramus beneath the anterior margin of $p_1$ , | 55 millims. |
| „ „ „ „ posterior „ $m_3$ ,   | 40 „        |

## DIMENSIONS of the Skull.

|   |           |              |
|---|-----------|--------------|
| From under margin of <i>foramen magnum</i> to a line uniting the anterior margins of the alveoli of $p_3$                         | . . . . . | 195 millims. |
| Greatest breadth (between the middle of the orbits)   | . . . . . | 111 „        |
| Approximate length of the frontalia in the middle line  | . . . . . | 47·5 „       |
| Length of the undivided sagittal crest  | . . . . . | 72·3 „       |
| <i>Foramen magnum</i> to posterior part of palate   | . . . . . | 130·3 „      |
| Greatest breadth between the zygomatic arches   | . . . . . | 105 „        |
| Approximate greatest breadth of nasalia   | . . . . . | 34 „         |
| Breadth of frontalia (narrowest part) at sutura coronalis   | . . . . . | 37·5 „       |
| Breadth of palate between the postero-external angles of the last molars  | . . . . . | 55·8 „       |
| „ „ „ alveoli of the last molars  | . . . . . | 48 „         |
| Approximate length of brain cavity (from under margin of the foramen magnum to the boundary between cerebral and olfactory fossa) | . . . . . | 71·5 „       |

## III. AFFINITIES.

A *superficial* examination of the skull of *Megaladapis* will certainly not suggest its classification amongst the *Lemuroidea*, from which it seems, *a priori*, precluded by its comparatively enormous size. Besides, we associate in our mind with the idea of a Lemurid cranium large orbits, approaching closely in the middle line and directed straight forward; a rounded and relatively large cranium proper; the covering of the brain-case due chiefly to the parietals, the frontals extending laterally backwards but slightly from the orbits, and the squamosals not rising high up vertically to meet the parietals; almost general absence of crests, which, when present (*Tarsius*, *Galago*, *Lepidolemur*), are but feebly developed; a slender zygomatic arch; long persistence

of the sutures. In all these characters the skull before us, as described in the preceding paragraph, is the exact reverse of what, judging from those Lemurids which are most familiar to us, we are inclined to consider as typical of the Lemurid skull; whereas, on the other hand, some features in the "physiognomy" of our fossil cranium seem to point to quite other directions. These we have first to consider.

The high and moderately outward-curved zygomatic arch; the backward prolongation of a rather narrow frontal region, which is continued with a slight constriction into an equally narrow parietal region; the squamosals extending rather high upwards to meet the parietals, and thus partaking to a considerable extent in the covering of the brain-case; the strongly developed sagittal crest, concealing somewhat the depressed form of the skull;—all these are features which at once call to mind the cranium of a Marsupial, and especially *Phascolarctos*. Added to this, the narrow, short, and low brain-case, indicated externally by some of the characters mentioned (and for which the only analogy is found amongst Marsupialia and Insectivora, *e.g.*, the *Centetidæ*, considered to be amongst the most lowly organized of all placental Mammalia), would seem to afford a strong aprioristic assumption against the association of *Megaladapis* with any of the *Lemuroidea*.

Besides, there are other features in the skull of *Megaladapis* which form some approach towards the South American Howlers (*Mycetes*). In *Megaladapis*, as well as in Marsupialia (*e.g.*, *Thylacinus*, *Phascolarctos*), the cranial portion of the skull is situated at a considerably higher level than the facial portion when the palate is horizontal; this, in the Marsupials, is exclusively owing to the small dimensions of the brain cavity. In *Mycetes*, although this genus is provided with a much more voluminous brain-case than the Marsupials and *Megaladapis*, the back part of the skull is still more elevated above the facial portion, and especially above its posterior moiety. This conformation is the result of the upward bending of the posterior part of the cranial portion, and partly of an equal upward bending of the anterior part of the snout, which result in the well-known elongate pyramidal shape of the *Mycetes* skull. At the same time the palate is arched downwards antero-posteriorly. It has already been pointed out that *Megaladapis* presents similar characters. However, the bending up of the anterior facial portion, and, as a consequence, the downward convexity of the palate, are more strongly developed in *Mycetes*. In relation with this conformation is the considerable hollowing at the roots of the nasals in *Mycetes*, whereas in *Megaladapis*, although the upper profile of its cranium slopes down abruptly from behind forwards, as in the former, the line formed by the profile is almost a straight one, there being but a very slight hollowing anterior to the orbits. The occiput is truncated in both.

The curious shape of the Howler's skull is partly related to the peculiar modification of the hyoid bone, with which is in relation, too, the considerable development of the mandibular rami. As far as can be judged from the somewhat incomplete condition of the mandible of *Megaladapis*, the ascending portion was unusually elongate antero-

posteriorly, though vertically it extends less than in *Mycetes*. There exists, therefore, a strong assumption that, as in *Mycetes*, the Malagassy fossil was provided with vocal organs of unusual size. This specialization, however, does not in the least imply a nearer relationship with *Mycetes*, for in numerous other characters of its skull *Megaladapis* departs from the South American genus.

I have placed in the strongest possible light the reasons which might be advanced against ranging *Megaladapis* amongst the Lemuroidea; we have now to review and weigh them, one after the other. As to the shape and extension of the interorbital frontal region, *Tarsius* represents one extreme, the orbits coming almost in contact in the middle line. But, proceeding from this genus, we meet with all possible gradations in this respect, the stages being *Nycticebus*, *Perodicticus*, *Lepidolemur*, *Hapalemur*, *Lemur*, and lastly the *Indrisinæ*, in which the interorbital region is considerably extended in a lateral direction, and most so in *Avahis*, though still much less than in *Megaladapis*, which presents the opposite extreme of *Tarsius*. The general depression of the interorbital region of *Megaladapis* is to be seen as well in the Tertiary Lemuroid *Adapis*; amongst existing forms in *Lepidolemur*, and to a somewhat lesser degree in *Hapalemur*.

Neither is the anterior direction of the orbits a constant character of Lemuroids; within the subfamilies *Galaginae* (*Chirogale*) and *Lemurinae* (*Hapalemur*, *Lepidolemur*) we meet with instances in which the orbits are more directed outwards than in others. *Adapis* presents likewise variations in this respect. In the typical skull of the smaller form, *Adapis parisiensis*, the orbits show a decidedly anterior direction; in *A. magnus*, as well as in a skull united by FILHOL with the smaller species,\* the direction is almost the same as that seen in *Megaladapis*, although they are far from possessing the peripheric position and the tubular form of the Malagassy fossil.

The rounded, vaulted cranial portion is characteristic for all existing Lemurids, with some variation (e.g., *Chirogale Mili*, in which the cranial portion is somewhat more flattened than in *Lemur*), as opposed to *Megaladapis*.

In *Adapis*, by the depression of this part, coupled with the enormous, though sharp, sagittal crest, a strong approach is made to *Megaladapis*. The brain-case of this last is comparatively much shorter and narrower than in the first.

A very elongate facial cranium is presented by the genus *Lemur*. As in many other natural groups, we meet with a great variety amongst Lemurids in this respect. *Lemur* on one side, the *Indrisinæ*, with a very short snout (e.g., *Avahis*), on the other, are the extremes. *Adapis*, though possessing four premolars, has a much shorter facial portion than *Lemur*.

The zygomatic arch, generally slender in the *Lemuridæ*, acquires greater strength and is higher in the *Indrisinæ*. Still closer approach is made to *Megaladapis* by *Adapis*, in which, besides, the squamosal rises still higher than in the former. In

\* 'Ann. des Sc. Géol.,' 14, 1883, Plate 10.



*Megaladapis* the vertical extension of the parietal is the double of that of the squamosal; in *Lemur* the first is four times higher than the last; whereas in *Adapis*, on the contrary, the vertical extent of the squamosal, near the occipital crest, is scarcely less than that of the parietal, and even exceeds it, if the sagittal crest be disregarded. In *Lemur*, as well as in most existing Lemurids, the great disproportion in the respective heights of the parietal and squamosal, is in relation with the greater volume of the brain-case; this does not, however, explain the vertical development of the squamosal in *Megaladapis*, and the still greater in *Adapis*, in which last a nearer approach to the Marsupialia is given than by *Megaladapis*. How little classificatory value can be attributed to this structure is sufficiently illustrated by the fact that we find very high parietals amongst Ungulates and Rodents as well. This same remark applies to the vertical extension of the zygomatic arch.

In a skull of *Adapis parisiensis* (Br. Mus.) the occipital condyles approach to the vertical position exhibited in *Megaladapis*. They are perfectly vertical, as in this last, in a skull of *Galago* from the Kilima-Njaro (Br. Mus., 92, 10, 18, 10) and in *Perodicticus potto*.

In other existing Lemurids, as *Lemur*, *Hapalemur*, *Propithecus*, in which the horizontal diameter of the foramen magnum is equal or superior to its vertical diameter, the anterior portions of the condyles are directed inwards, the posterior portions externally.

In some essential structures *Megaladapis* agrees with the *Lemuridæ*. Such are the orbits, which form a complete bony ring, and communicate freely with the temporal fossa beneath the postorbital bar; the lacrymal foramen, which is situated externally to the margin of the orbit; the horizontal mandibular ramus, which is higher in proximity to the symphysis, than further back; in the shape of the molars, *Megaladapis* is closely related to *Lepidolemur*, and more so to the smaller forms included in the genera *Microcebus* and *Chirogale*. The inferior molars, also, are of the same type as *Adapis*, with the difference that the anterior portion of the *Adapis* molars is less atrophied, the anterior transverse valley being better developed. Further, in *Adapis*, the last molar has only two internal cusps.

#### IV. PRIMITIVE ANCESTOR OR DEGENERATE DESCENDANT?

The question next arises as to whether, in the characters of its skull, *Megaladapis* must be regarded as a generalized or specialized member of the Lemuroidea. In other words, is *Megaladapis* a primitive ancestor or a degenerate descendant? An answer to the question has already been hinted; but it seems advisable to attempt a fuller discussion, dealing with the dentition and the cranium separately.

With regard to the dentition, the majority of palæontologists would doubtless regard the molars as primitive; the purely tritubercular type of the upper molars and the corresponding simplicity of the lower molars being usually considered to indicate a

generalized condition. I have, however, recently discussed this matter at length,\* and it thus suffices on the present occasion merely to point out how *Megaladapis* confirms the arguments I have adduced against the validity of the "tritubercular theory." No Mammal fauna is more appropriate than that of Madagascar for consideration in reference to the problem, and *Megaladapis* is an important discovery in this connection.

In Madagascar, the so-called tritubercular type of molar is found in families of three distinct orders, namely, in the Viverridæ, Centetidæ, and Lemuridæ.

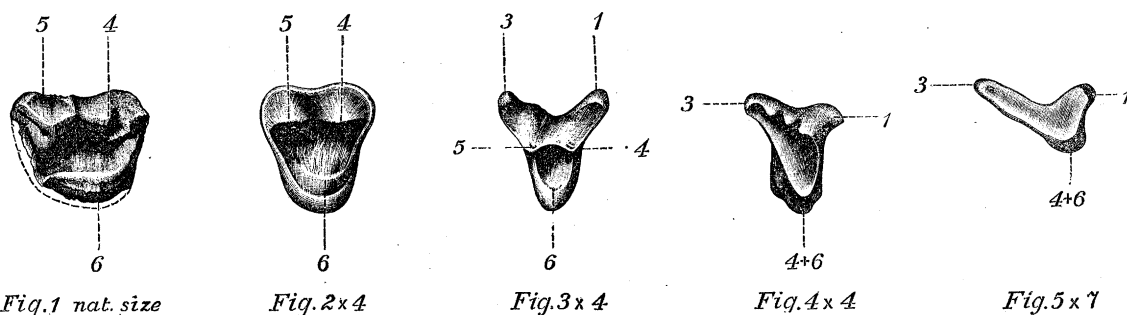


Fig. 1. *Megaladapis madagascariensis*,  $m_2$ , sup. dext.—Fig. 2. *Chirogale Milii*,  $m_2$ , sup. dext.—Fig. 3. *Eupleres Goudoti*,  $m_1$ , sup. dext.—Fig. 4. *Centetes ecaudatus*,  $m_1$ , sup. dext.—Fig. 5. *Hemicentetes madagascariensis*,  $m_2$ , sup. dext.—The method of numbering the homologous cusps is the same as that adopted by WINGE ('Vidensk. Meddel. Naturh. Foren. i. Kjoebenhavn,' 1882.)

On the widely accepted theory, it would therefore be necessary to assume some close relationship between these three families, and also between them and *Megaladapis*. I feel sure that not one of the adherents of trituberculism will venture to uphold such a view, although it would be consistent with the theory. But it will be asserted that they must rather be regarded merely as lowly organized representatives of their respective orders.

This assertion is disposed of by the fact that each family comprises some form showing a tendency to further reduction of the cusps of the molars, viz., the Carnivore *Eupleres*, the Insectivore *Hemicentetes*, and the Lemuroids *Chirogale Milii* and *Chiromys*.

These same genera, as well as *Megaladapis*, exhibit, moreover, evidence of retrogressive evolution in other characters. Hence it is reasonable to conclude that the tritubercular condition of the molars is the result of similar evolution, and by no means a primitive condition.

We may even go further, and combat the belief that the tritubercular type of molar has had a common origin. If we compare, for instance, the lower molars of *Centetes* and *Megaladapis* (or *Chirogale*), we observe that in the first, the posterior part of the

\* "On some Miocene Squirrels, with Remarks on the Dentition and Classification of the Sciurinae" ('Proc. Zool. Soc.,' London, February 28, 1893).

tooth—what has been termed its talon—is in a very reduced state; in the Lemuroids, on the contrary, the *anterior* part is reduced, and the greater portion of the molar is composed by a part which, according to the trituberculate theory, is of a late development. Similar remarks apply to the superior molars. The obvious conclusion is that in two genera whose molars present a similar or almost similar form, this similarity may have been brought about without the cusps constituting the tooth being throughout homologous in the two forms; in other words, that we have to do with isomorphisms, not indicating true relationship.

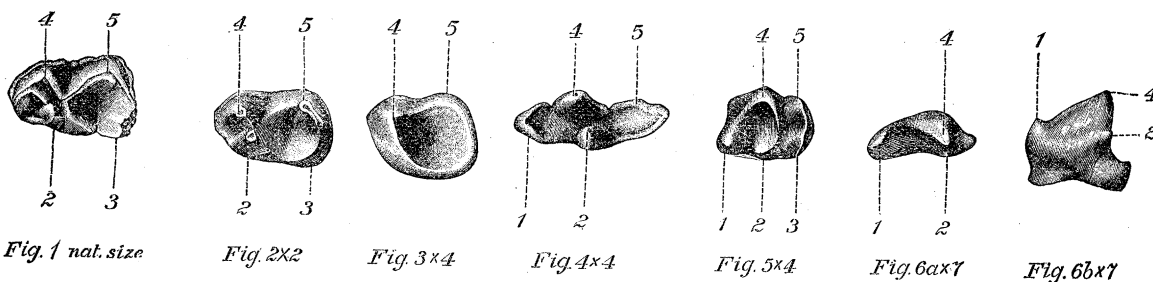


Fig. 1 nat. size

Fig. 2x2

Fig. 3x4

Fig. 4x4

Fig. 5x4

Fig. 6ax7

Fig. 6bx7

Fig. 1. *Megaladapis madagascariensis*,  $m_2$ , inf. dext.—Fig. 2. *Adapis magnus*,  $m_2$ , inf. dext.—Fig. 3. *Chirogale Milii*,  $m_2$ , inf. dext.—Fig. 4. *Eupleres Goudoti*,  $m_1$ , inf. dext.—Fig. 5. *Centetes ecaudatus*,  $m_1$ , inf. dext.—Fig. 6a. *Hemicentetes madagascariensis*,  $m_2$ , inf. dext. (from above as all the foregoing).—Fig. 6b. Same tooth, from the inner side. The outer cusps are numbered 4, 5; the inner cusps, 1, 2, 3.

With regard to the skull of *Megaladapis*, it may be remarked that the low cranium, with an almost straight upper profile and an elongate facial portion, would be regarded by most palæontologists as primitive.\* There are, however, several considerations which seem to indicate that in many cases it is in reality a highly specialized feature. Firstly, the increase of the facial portion of a skull, both in a vertical and a horizontal direction, is often obviously due in great part to the specialization of the teeth. The molars, generally speaking, are increased vertically and sometimes horizontally, and the canines are transformed into tusks and weapons of different kinds. Secondly, other facts of ontogeny and phylogeny also suggest the same conclusion; for any skull during growth from the immature state to old age† and any type of Mammalian skull (*e.g.*, the Ungulate) traced from Eocene times to the present day, almost invariably shows the gradual diminution of the cranial and the concomitant elongation of the

\* KARL A. ZITTEL, 'Handbuch der Palæontologie,' I. Abtheilung, vol. 4, 1892, p. 22.—MAX SCHLOSSER, 'Die Affen, Lemuren, Chiropteren, Insectivoren . . . des europäischen Tertiärs, &c.," 'Beiträge zur Palæontologie Oesterreich-Ungarns und des Orients,' I., Wien, 1887, p. 3): "Die Verkürzung der Kiefer und Vergrößerung der Schädelkapsel tritt bei allen Säugethierstämmen auf und ist überhaupt der Endzweck aller den Schädel betreffenden Veränderungen."

† HERMANN VON NATHUSIUS, 'Vorstudien für Geschichte und Zucht der Hausthiere zunächst am Schweineschädel,' Berlin, 1864, p. 8.—WILHELM LECHE, "Beiträge zur Anatomie des *Myrmecobius fasciatus*," 'Verhandlungen des Biologischen Vereins in Stockholm,' vol. 3, May, 1891, No. 8, p. 139.

facial portion. Finally, it is evident that the change just referred to continues with increasing age, from the fact that the first dentition is more generalized than the second one, and requires, as a consequence, shorter jaws; and as it is now proved that the first dentition is ontogenetically and phylogenetically the older,\* it follows that the shortness of the facial region is the primitive condition. There may, of course, be instances in which the reduction of the facial part of the skull is partly a secondary specialization (*e.g.*, certain Primates), but this circumstance does not invalidate the general result.

Let us proceed to consider the remaining parts of the skull of the *Megaladapis*, with a view of ascertaining whether they be primitive or specialized. The small brain-cavity in vertical, longitudinal, and transverse directions, gives this animal, when compared with the existing *Lemuroidea*, the appearance of being more lowly organized, and we must look among Insectivora and Marsupialia for a similar condition. It may sound like a paradox when I advance that the small size of the brain cavity in the two groups just mentioned, may be partially an acquired character. I have however, strong authority on my side for the assumption that the existing Marsupialia "are greatly modified members of the metatherial type," and "that most, if not all, of the Australian forms are of comparatively late origin."† On examining a bisected skull of a Marsupial, we may see that the great reduction in size of the cerebral fossa is very largely due to the development, in the adult animal, of sinuses in the walls of the covering bones, so that the brain cavity appears not only relatively, but absolutely larger in somewhat younger animals. The same takes place in several families of Insectivora, *e.g.*, the *Centetidae*, which are considered as some of the most lowly organized of placental Mammals, but which, to judge at least from their dentition, as well as from the suppression of the jugals, and other characters, are highly specialized; the specialization of the teeth being carried further in one of the genera, *Hemicentetes*, where they have undergone a retrogressive evolution.

In *Megaladapis*, the cerebral fossa is likewise much reduced in size, and moreover, the olfactory fossa is greatly constricted by the lateral development of aërial sinuses to such an extent that they protrude somewhat in the cerebral fossa, the result being a reduction in size of this part also of the brain cavity, and as an obvious consequence, a partial atrophy of cerebral substance must have taken place; both cause and effect were certainly wanting in the young animal. The inspection of the corresponding outer parts of the skull showed us a considerable elongation of the lateral parts of the frontalia, backwards from the orbits. This might have led to the conclusion, that compared with existing Lemuroids, in which this elongation is

\* W. LECHE, "Studien über die Entwicklung des Zahnsystems bei den Säugethieren," 'Morpholog. Jahrbuch,' vol. 19, 1892, pp. 530, 531.

† T. H. HUXLEY, "On the Application of the Laws of Evolution to the arrangement of the Vertebrata, and more particularly of the Mammalia," 'Zool. Soc. Proc.,' London, 1880, p. 656.

never met with, the cranial cavity of *Megaladapis* is very elongate in an horizontal direction ; but, as we have seen, the very reverse is the case. As shown by the semi-diagrammatic fig. 10 (Plate 7), the front part of the cerebral fossa is narrowed to such an extent by the two frontal sinuses, that the boundary between the cerebral and the olfactory fossæ is reduced superiorly to a mere vertical fissure, and at the base to a small triangular opening. I know of no other instance amongst Mammalia of a similar constriction between the two fossæ.

#### V. SYSTEMATIC POSITION.

From the foregoing comparison of the characters of *Megaladapis* with the existing *Lemuridæ*, and their discussion, the conclusion arises as to the systematic position we must assign to it. Unique as the skull is in several respects, so that we are entitled to place the animal in a distinct family, the *Megaladapidæ*, a closer examination has shown us that it only carries farther several characters possessed by various groups of existing Lemuroidea, and by *Adapis* amongst the extinct.

In the conformation of the dentition, *Megaladapis* closely approaches two Malagassy genera of Lemurids (*Lepidolemur*, and more closely still some of the forms which are included in the genus *Chirogale*), so that there is some ground for the assumption that an equally close analogy with *Lemuridæ* will be shown by the anterior part of the dentition, which is not known for the present. Even if this should not prove to be the case, I do not expect that it would alter the conclusions as to its systematic position.

The type of the inferior molars of *Megaladapis* approaches equally, as has already been stated, those of *Adapis*.

In the conformation of the interorbital frontal region, *Megaladapis* bears the most relation to *Adapis* amongst extinct, and the *Indrisinæ*, especially *Propithecus*, amongst recent Lemuroidea.

There are two characters in the cranium of *Megaladapis* for which we failed to find analogies amongst existing Lemuroidea, viz., the exceedingly small and low brain cavity, and the prolongation of the lateral parts of the frontals backwards from the orbits. As to the first, *Adapis* approaches somewhat *Megaladapis*, so far, at least, as having a *low* brain case ; but the cranial cavity of the former is considerably longer in proportion. I trust I have shown with sufficient evidence, that *Megaladapis* presents, in this respect, an instance of retrogression ; whereas the same character may be a primitive one in *Adapis*.

As regards the backward prolongation of the lateral region of the frontals, not in the least a Lemuroid feature, we meet with this character in groups remote from the Lemuroidea and from each other, viz., in the *Carnivora*, *Insectivora*, and *Marsupialia* ; and we have seen that it is the result of the developing of aërial sinuses ; so

that it reveals itself as a specialized character of secondary importance, which is totally, or almost totally absent in young animals.

It is to be anticipated that skulls of young specimens of *Megaladapis* will bear a much closer resemblance than the adult to the existing Malagassy *Lemuridæ*. These resemblances will prove to consist, *e.g.*, in a more rounded cerebral cranium, in the brain cavity being relatively much more, and probably even absolutely more voluminous than in the old specimen, as well as in a more shortened facial cranium. The post-orbital elongation of the frontals will be wanting.

By the name of *Megaladapis* no close approach to *Adapis* is implied; although I anticipate that younger specimens will show closer relation to *Adapis* as well. I consider *Adapis* to form another distinct family of Lemuroidea. As some palæontologists have assigned to this genus a more remote position from existing Lemuroids, a few words in support of my view will not be out of place here, as the argument bears close relation to the subject of this paper.

FILHOL proposed for this fossil genus a distinct group of the *Pachylémuriens*, on the ground that in its dentition it is nearly related to the Ungulata. To this may be objected, that by placing *Adapis* in a distinct family, sufficient account is taken of the more generalized character of its dentition, shown by the incisors and canines, and the greater number of premolars, as compared with existing Lemuroidea. On the other hand the researches of GRANDIDIER and MILNE EDWARDS have shown, that in their anatomical characters the existing Lemuroids bear curious relations to several Ungulates, so that the existing members would equally deserve the denomination of *Pachylémuriens*, which for this reason becomes superfluous. And the more so, as several existing Lemuroids approach, in the structure of their molars, some smaller members of the Eocene Lophiodont Ungulates, as well as *Adapis*.

A similar view of the question has long ago been held by Sir WILLIAM FLOWER, when much less of living and extinct Lemuroids was known than at present.\*

SCHLOSSER has thought it advisable to establish for the genus *Adapis* and several American Tertiary Lemuroids a distinct sub-order, *Pseudolemuridæ*, whilst *Necrolemur* of the European Eocene, and *Anaptomorphus*, *Cynodontomys*, *Mixodectes* of the American, are united with the existing *Lemuridæ*.†

If *Adapis* deserves to be separated from these last on account of its dentition, *Necrolemur* has the same claims, and so has *Anaptomorphus*. There is no greater difference in their dentition between *Adapis* on the one hand, *Necrolemur* and *Anaptomorphus*, on the other, than there is between the existing sub-families *Lemurinae* and *Indrisinae*. So that, as long as all these fossil forms are not more completely known, it seems advisable to leave them in the one sub-order, Lemuroidea,

\* WILLIAM HENRY FLOWER, "Extinct Lemurina," 'Ann. Mag. Nat. Hist.,' 4th series, vol. 17, London, 1876, pp. 323-328.

† MAX SCHLOSSER, 'Die Affen, Lemuren,' &c., 1, p. 19, *et seq.*

which would include the following families, leaving aside the less perfectly known fossil forms :—

- |            |   |   |
|------------|---|---|
| Lemuroidea | { | 1. <i>Adapida</i> (extinct) : <i>Adapis</i> .                                   |
|            |   | 2. <i>Anaptomorphida</i> (extinct) : <i>Anaptomorphus</i> , <i>Necrolemur</i> . |
|            |   | 3. <i>Lemurida</i> (recent).  |
|            |   | 4. <i>Megaladapida</i> (extinct) : <i>Megaladapis madagascariensis</i> .        |
|            |   | 5. <i>Chiromyida</i> (recent),  |
|            |   | 6. <i>Tarsiida</i> (recent).  |

#### VI. ASSOCIATED FAUNA.

Before proceeding to the question of the geological age, a brief review must be given of the Vertebrate remains found associated in the marsh of Amboulisatra. Those discovered by GRANDIDIER\* are the following :—

#### *Aepyornis*.

Bones of different size, which ALPH. MILNE EDWARDS and GRANDIDIER† are disposed to ascribe to three species : *Aepyornis maximus*, *Aep. medius*, and *Aep. modestus*. The largest bones were associated under the first name with the enormous eggs found in Southern Madagascar, and the association has been generally taken for granted, the only grounds for this view being that up to the present date no bones of a larger bird had been forthcoming. Taking in consideration, on the one hand, the number and great variety of forms of the New Zealand *Dinornis*, and on the other, the circumstance that a systematic palæontological exploration of the island is still a *desideratum*, some caution as regards this question was not out of place, and DAWSON ROWLEY has long ago‡ expressed strong doubts with respect to the above association.

In a recent meeting (June 6, 1893) of the Zoological Society of London, the Hon. WALTER ROTHSCHILD exhibited two femora, a tibio-tarsus and a tarso-metatarsus of *Aepyornis*, quite recently sent over by Mr. LAST from the south-west coast of Madagascar. These bones exceed in size the largest hitherto known, and the exhibitor suggested that they more properly might be associated specifically with the large eggs.

\* MILNE EDWARDS, "Sur des découvertes zoologiques faites récemment à Madagascar par M. ALFRED GRANDIDIER," 'Comptes Rendus Ac. Sc.,' vol. 67, pp. 1165–1167, Séance du 14 déc., 1868.

† ALPH. MILNE EDWARDS et ALF. GRANDIDIER, "Nouvelles Observations sur les Caractères zoologiques et les affinités naturelles de l'*Aepyornis* de Madagascar"; ALPH. MILNE EDWARDS, 'Recherches sur la Faune Ornithologique éteinte des Iles Mascareignes et de Madagascar.' Paris, 1866–1873, p. 110.

‡ GEORGE DAWSON ROWLEY, "On the Egg of *Aepyornis*: the Colossal Bird of Madagascar," 'Zool. Soc. Proc.,' London, 1867, pp. 892–895.

On the other hand, from a few preliminary remarks by DAMES\* on *Aepyornis* remains in the Berlin Museum, collected by HILDEBRANDT, at Sirabé, North-Betsileo (Central Madagascar), it appeared as probable that they represented an apparently new form of *Aepyornis*, of comparatively small dimensions. These remains, amongst which a pelvis deserves particular mention, have been recently described and figured by R. BURCKHARDT as *Aepyornis Hildebrandti*.†

### *Crocodylus.*

A Crocodile, *Crocodylus robustus*, VAILL. et GRAND., originally believed to be extinct,‡ but later on discovered by HUMBLOT§ as actually existing in the great lakes of the interior. This Crocodile, stated to reach a length of 10 metres, is nearly related to the Indian *Crocodylus palustris*, LESSON.|| A humerus of *Crocodylus* from Sirabé, in the Christiania Museum is supposed by DAMES¶ to belong to the same species.

### *Testudo.*

Two gigantic Chelonians, *Testudo abrupta*, GRAND., and *Testudo Grandidieri*, VAILL.\*\* The last mentioned form was discovered besides by GRANDIDIER, in "Couches Sablonneuses," at Etséré (South-West Coast),†† and the remains sent to the British Museum by Mr. LAST, and described by BOULENGER,‡‡ seem to come from the same locality, in a cave.

### *Hippopotamus.*

Finally, the remains of about fifty specimens of *Hippopotamus* were discovered by GRANDIDIER at Amboulisatra, and described as *H. Lemerlei*.§§ Remains of *Hippo-*

\* W. DAMES, "Vorlage eines subfossilen Crocodil-Humerus von Madagascar," 'Sitzungsber. der Ges. naturforsch. Freunde.' Jahrg. 1886, No. 5, Berlin, 1886, p. 68.

† R. BURCKHARDT, "Über Aepyornis," 'Palaeontologische Abhandlungen,' Neue Folge, vol. 2, Jena, 1893.

‡ A. GRANDIDIER et L. VAILLANT. "Sur le Crocodile fossile d'Amboulintsatre (Madagascar)," 'Comptes Rend. Ac. Sc.,' vol. 75, 1872, pp. 150-151.

§ L. VAILLANT, "Remarques sur le *Crocodylus robustus*, VAILL. et GRAND., de Madagascar," 'Compt. Rend. Ac. Sc.,' vol. 97, 1883, pp. 1081-1083.

|| L. VAILLANT, *loc. cit.* G. A. BOULENGER, 'Catalogue of the Chelonians, Rhynchocephalians, and Crocodiles in the British Museum (Natural History).' New ed., London, 1889, p. 286.

¶ W. DAMES, *l.s.c.*

\*\* MILNE EDWARDS, 'Sur des découvertes zoologiques,' *l.s.c.* ALFRED GRANDIDIER, "Madagascar," 'Bull. Soc. Géogr.,' 2, 1871, p. 91. L. VAILLANT, "Remarques complémentaires sur les Tortues gigantesques de Madagascar," 'Compt. Rend. Ac. Sc.,' vol. 100, 1885, pp. 874-877.

†† MILNE EDWARDS, 'Sur des découvertes zoologiques,' etc., *loc. cit.*

‡‡ G. A. BOULENGER, "On Remains of an extinct gigantic Tortoise from Madagascar (*Testudo Grandidieri*, VAILLANT)," 'Trans. Zool. Soc.,' vol. 13, pp. 305-311.

§§ MILNE EDWARDS *loc. cit.*



*potamus* have been likewise discovered in Central Madagascar. The German explorer, HILDEBRANDT, obtained skeletons of this Mammal from the salt-marsh of Sirabé (*i.e.*, "much salt"),\* and forwarded them to the Berlin Museum.† KOKEN‡ and DAMES§ identify this *Hippopotamus* with a skeleton from the same locality, obtained by Norwegian Missionaries and sent to the Christiania Museum, where they have been described by GULDBERG under the name of *H. madagascariensis*.||

The brief description of the *H. Lemerlei*, given by GRANDIDIER¶ does not enable us to decide for the present if the Sirabé specimen is identical with the *H. madagascariensis*, GULD. ALPH. MILNE EDWARDS is of opinion\*\* that the *H. Lemerlei* from Amboulisatra comes very near to the *H. liberiensis* (*Choeropsis*), a living form from Liberia. The *Aepyornis* remains from the central parts being different from those of the south-west coast, and it being doubtful at present if the age of the two deposits, which we shall have to discuss hereafter, is the same, there is an *à priori* assumption against the identification of the respective *Hippopotamus* remains. The question becomes more puzzling still by the circumstance that a cranium of *Hippopotamus* in the British Museum, found in a swampy deposit at Sirabé††—the same district from which were obtained the remains in the Berlin and Christiania Museums—is decidedly different in some essential points from the one described by GULDBERG. For some further particulars on this question, I refer to the following chapter.

\* J. M. HILDEBRANDT, "Skizze zu einem Bilde central-madagassischen Naturlebens im Frühling," 'Zeitschr. d. Ges. f. Erdkunde zu Berlin,' 16; Berlin, 1881, pp. 194–203. R. BARON, "Notes on the Geology of Madagascar." 'Quart. Journ. Geol. Soc.,' London, vol. 45, 1889, p. 308, where the name is written "*Antsirabe*."

† KOKEN, "Reste eines subfossilen Hippopotamus, *Hippopotamus madagascariensis*, GULDBERG," 'Sitzungsber. Ges. Naturf. Freunde.' Berlin, 1886, p. 55. W. DAMES, *l.s.c.*

‡ *Loc. cit.*

§ *Loc. cit.*

|| G. A. GULDBERG, "Undersøgelse over en subfossil flodhest fra Madagascar," 'Forhandlinger i Videnskabs Selskabet i Christiania, aar 1883.' Christiania, 1884, No. 6.

¶ MILNE EDWARDS, 'Sur des découvertes zoologiques,' *loc. cit.*

\*\* *Loc. cit.*

†† R. BULLEN NEWTON, "On the Discovery of a Secondary Reptile in Madagascar, *Steneosaurus Baroni* (*n. sp.*); with a reference to some Post-Tertiary Vertebrate Remains from the same country, recently acquired by the British Museum (Natural History)." ('Geolog. Magazine,' Decade III., vol. 10, No. 347, May, 1893, p. 197.) Mr. B. NEWTON draws besides attention to the fact that a few *Hippopotamus* teeth from Madagascar were sent to this country as long as sixty years ago, and are preserved in the Museum of the Geological Society, the label accompanying stating them to come from a locality thirty miles from Antananarivo, which is the capital, situated in Central Madagascar. The brief reference in the 'Proc. of the Geol. Soc. of London,' (vol. 1, No. 31, 1833, p. 479), runs as follows:—"A letter was afterwards read from Mr. TELFAIR to Sir ALEXANDER JOHNSTONE, V.P.R.A.S., accompanying a specimen of recent conglomerate rock, from the Island of Madagascar, containing fragments of a tusk and part of a molar tooth of a Hippopotamus, and communicated by RODERICK IMPEY MURCHISON, Esq., F.G.S."

The small collection obtained from the marsh of Amboulisatra by Mr. LAST, consists, besides the skull of *Megaladapis*, of two occipital portions and bones of *Hippopotamus*.

Part of the pelvis of *Sus* which, from its fresh appearance, seems to be more recent than the other remains.

Vertebræ of a species of *Potamochoerus*, which may prove to be the one actually existing in Madagascar.

Some remains of *Aepyornis*, and of other smaller birds.

Bones and fragments of the carapace of *Testudo Grandidieri*, VAILL., identified by Mr. BOULENGER.

The collection contains besides fragmentary bones of some Mammals, but so few in number, and at the same time so enigmatical, that the safer course to pursue will be to say as little as possible about them for the present. A femur of a young individual—the distal epiphyses are wanting—with a very strong lesser and a feebly developed third trochanter, presents, by its antero-posterior flattening, a striking resemblance with a *Manis* femur, with which however, for other reasons, I do not feel inclined to unite it; but it may be a Rodent or an Insectivore. The length of the bone, so far as preserved, is 135 millims.

## VII. GEOLOGICAL AGE.

We have next to meet the question as to the geological age of the cranium which forms the subject of the present inquiry.

From Mr. LAST'S correspondence it appears that the bones from the marsh of Amboulisatra were found lying between a stratum of a "white clayey substance" above, and a deposit of "greenish sand and stones" below. The white clay has a thickness of 18 inches to 2 feet, and is overlaid by 6 inches of black soil. The matrix adhering to the bones is in fact a green quartzitic sand. They have a very fresh appearance, and in their mode of preservation and colouring much resemble the animal remains from lake-dwellings, some of them having an even fresher appearance.

With regard to the remains of *Crocodylus robustus* from the marsh of Amboulisatra, it has already been stated that this species is actually existing in the lakes of the interior.

ALPH. MILNE EDWARDS and GRANDIDIER, in their paper on the remains of *Aepyornis* from this same deposit, sum up in the following words the discussion as to their age: "Il ressort donc clairement de ces faits que l'*Aepyornis* a vécu à une époque où l'homme habitait déjà Madagascar, mais que, dépourvu de moyens de défense et probablement aussi d'intelligence, il a été rapidement détruit, et que les voyageurs des xvi<sup>e</sup> et xvii<sup>e</sup> siècles n'ont pu que recueillir sur son compte les souvenirs

déjà anciens et, par conséquent, mêlés de merveilleux que les tribus sauvages se transmettaient de génération en génération.”\*

Reference is here made, first, to the legendary bird Roc or Ruc, mentioned by MARCO POLO and other travellers, influenced by which Professor BIANCONI, of Bologna, has endeavoured to prove in several Memoirs that the *Aepyornis* was a bird of prey allied to the Vulture.†

The legends referring to gigantic birds may not necessarily be considered as a proof of their contemporaneity with Man, as they might have been originated by the view of the enormous eggs. In the same manner as the fables relating to monsters and amazons inhabiting the island of Samos, and which are reported by ÆLIANUS and PLUTARCH, owe their origin to the acquaintance of the ancient Greeks with the great quantity and occasionally enormous size of (Miocene) bones met with in that island.‡

The opinion that the *Aepyornis* was contemporaneous with Man is, however, strengthened by the fact stated by MILNE EDWARDS and GRANDIDIER, viz., that on one of the tibiae, “On voit à l’extrémité supérieure des empreintes profondes pratiquées à l’aide d’un instrument tranchant; il semble évident que ces incisions ont été faites en coupant les ligaments du genou pour séparer les os de la jambe de celui de la cuisse, et elles décèlent la main de l’homme.”§

Moreover, on one of the fragments of metatarsus are to be seen, according to the same authors, some superficial cuts or scratches (*incisions*), very similar to those found sometimes on bones from caves and considered to be the work of Man.||

On the mandibula of the *Megaladapis* scratches are also seen which have the appearance of age, and which seem to have been produced by some cutting instrument; but they may also be referred to the action of sharp-pointed teeth.

Most of the eggs of the *Aepyornis* have been reported to be found on the seashore of South Madagascar, “on the abrupt rise of the dunes, even on the surface of the sand, when there is a crumbling of the earth, or when tropical rains heave up parts of the sand.”¶ The dunes are considered both by GRANDIDIER\*\* and the Italian

\* ALPH. MILNE EDWARDS et ALF. GRANDIDIER, “Nouvelles Observations sur les caractères zoologiques et les affinités naturelles de l’*Aepyornis* de Madagascar,” *loc. cit.*, p. 112.

† BIANCONI, “Dell’ *Epyornis maximus* menzionata da Marco-Polo a da Fra Mauro,” ‘Memorie dell’ Accademia delle Scienze,’ Bologna, 1862; *ibid.*, “Degli scritti di Marco-Polo e dell’ uccello Ruc da lui menzionato,” *loc. cit.*, 2<sup>a</sup> serie, vol. 2, Bologna, 1862; *ibid.*, “Studi sul Tarso-Metatarso degli uccelli ed in particolare dell’ *Epyornis maximus*,” *loc. cit.*, 23 Aprile, 1863, e 12 genn., 1865.

‡ C. I. FORSYTH MAJOR, “Le Gisement ossifère de Mitylini,” ‘Extrait de “Samos,” étude géologique, paléontologique et botanique,’ par C. DE STEFANI, C. I. FORSYTH MAJOR, et W. BARBEY, Lausanne, 1892, pp. 1-2.

§ *Loc. cit.*, p. 112.

|| *Ibid.*

¶ ALF. GRANDIDIER, “Observations sur le gisement des œufs de l’*Epyornis*,” ‘Comptes Rendus Acad. Sc.,’ Paris, vol. 65, 1867, pp. 476-478. GEORGE DAWSON ROWLEY, “On the Egg of *Aepyornis*, the Colossal Bird of Madagascar,” ‘Zool. Soc. Proc.,’ London, 1867, p. 892.

\*\* GRANDIDIER, *loc. cit.* ROWLEY, *loc. cit.*

geologist, CORTESE,\* to be modern alluvia, the deposition of which is still in progress. So that here we have another proof that the Bird to which they pertain was still in existence at a recent period, later probably than the Pleistocene.

It would seem, however, that the eggs were more frequently obtained from some marshes. This circumstance seems to have been kept secret; the eggs, though rare, having become, on account of the high price paid for them by collectors, a sort of article of exportation from Madagascar. CORTESE† was the first to refer to their being found in marshes, and the geologist, PÉLAGAUD, to whom the Bologna Museum owes an egg of *Aepyornis*, and who has more than once visited Madagascar, informed Professor CAPELLINI as to the places where they are found and the methods resorted to in seeking for them.‡

To account for the presence of the eggs in the marshes, we must suppose that the water has only recently invaded the sandy region where they were originally deposited by the Birds; this, according to CAPELLINI,§ would be in relation with the gradual subsidence of the west coast of Madagascar, as admitted by CORTESE.||

Further arguments in favour of a recent origin of the bones occur in connection with the discovery of those of *Hippopotamus* in Central Madagascar.

HILDEBRANDT, who was the first to discover remains of this Mammal¶ in the salt marsh of Sirabé, states that the natives have various names for it, one of them being *Laloména*, which means, according to HILDEBRANDT, “the smooth red one.”\*\*

Dr. BORCHGREVINK, who was an eye-witness of the discovery of the *Hippopotamus* skeletons, now in the Christiania Museum, has given a report of this discovery in the

\* E. CORTESE, “Appunti geologici sull’isola di Madagascar,” ‘Boll. del R. Comitato Geologico d’Italia,’ vol. 19, Roma, 1888, pp. 118; 119.

† “La parte più meridionale dell’isola, cioè l’Antanosy, l’Antandroy e il Tanala, è bassa, paludosa in gran parte inesplorata. Pare che negli stagni di quella regione si trovino i gusci delle gigantesche uova di *Aepyornis*.” E. CORTESE, “Appunti geologici sull’isola di Madagascar,” ‘Boll. del R. Comitato Geologico d’Italia,’ vol. 19, Roma, 1888, p. 119.

‡ GIOV. CAPELLINI, “Sul primo uovo di *Aepyornis maximus* arrivato in Italia,” ‘Memorie R. Accad. delle Scienze dell’Ist. di Bologna,’ serie iv., vol. 10, Bologna, 1890. In a letter transcribed on p. 26, M. PÉLAGAUD states:—“Vous savez que tous ces œufs ont été trouvés dans un marais.” With reference to the egg sent to Bologna he writes (p. 27):—“Il vient des environs de Nos-Vey côte sud-ouest de la grande terre. Vous savez comme on les découvre. Des chercheurs sondent à coup de lance (sagaie) la vase des deltas de certaines rivières marécageuses jusqu’à ce qu’on rencontre un corps dur . . .”

Thirty years ago Professor TENNANT exhibited to the Zoological Society of London a very perfect egg of the *Aepyornis* (lent to him for exhibition by M. J. F. BRUNET), which was stated to have been obtained in Madagascar, “at a depth of 50 feet, in digging a mine of iron.” (‘Zool. Soc. Proc.’ London, 1863, p. 438.)

§ *Loc. cit.*, p. 35.

|| *Loc. cit.*, p. 127.

¶ Now in the Berlin Museum.

\*\* J. M. HILDEBRANDT, *loc. cit.*, p. 197.

'Transactions of the Christiania Scientific Society.'\* He, too, mentions, in connection with the *Hippopotamus*, a legendary monster, *Lalimena*, provided with large sharp tusks. According to Dr. BORCHGREVINK, the meaning of this word is not certain; perhaps it signifies "the red one who dives deeply" (*den Roede, som gaar dybt*), or "the red fly" (*den roede Flue*) (?). Some accounts state this animal to have resembled a huge boar; and tradition says that it was one of the prerogatives of the sons of kings to fight, or, as the tales have it, to *play* with, this monster.

The skeleton in question has been fully described by G. A. GULDBERG.†

From SIBREE, one of the editors of the 'Antananarivo Annual,' we learn that the remains of *Hippopotamus* obtained by the Museums of Berlin and Christiania were discovered during the excavations for the foundations of a bath-house, erected by the Norwegian Mission over the hot spring of Antsirabé; adding that there have been occasional vague reports of the existence of some huge animal in the southern parts of the islands, and suggesting that possibly the *Hippopotamus* is not yet extinct there, and that the half-mythical stories of the *Sangòmbi*, *Tòkandà*, *Lalòmèna*, and other strange creatures, current among the Malagassy, are traditions of the period when these huge Pachyderms were still to be seen in the lakes and streams and marshes of Madagascar.‡

In addition to these informations, it may be worth mentioning that FLACOURT, "Directeur Général de la Compagnie Française de l'Orient," who resided for years in the Fort Dauphin, erected by the French on the south-east coast of Madagascar, as a "Commandant pour sa Majesté dans la dite Isle et és Isles adjacentes," published in 1658 a 'History of Madagascar.' In this work two chapters are dedicated to the fauna of the island, giving the native names of the animals with brief descriptions,§ part of which are easily recognizable, their names having been confirmed by recent travellers. Besides these, FLACOURT names and describes four quadrupeds which, from the size as well as other characters assigned to them, cannot be identified with any known existing Malagassy Mammals.|| In some instances the author wrote only

\* CHR. BORCHGREVINK, "Oplysninger om et paa Madagascar fundet subfossilt Flodhest-Skelet." ('Oversigt over Videnskabs-Selskabets Moeder i 1882,' den 12 Mai; 'Mathematisk-Naturvidenskabelig Classe,' pp. 8-11; 'Forhandlinger Videnskabs-Selskabet i Christiania Aar 1882,' Christiania, 1883.)

† *L. s. c.*, p. 24.

‡ JAMES SIBREE, jun., "The Volcanic Lake of Tritriva: its Physical Features and Legendary History." ('The Antananarivo Annual and Madagascar Magazine,' Antananarivo, 1888, No. 12 (part 4 of vol. 3), pp. 468, 469.)

§ "Histoire de la grande Isle Madagascar, composée par le Sieur DE FLACOURT, Directeur Général de la Compagnie Française de l'Orient, et Commandant pour sa Majesté dans ladite Isle et és Isles adjacentes. Avec une Relation de ce qui s'est passé és années 1655, 1656, et 1657, non encor veuë par la première Impression." Chap. 38, "Des Animaux terrestres et des Insectes," pp. 151-159. Paris, 1661 (the first edition is of 1658).

|| *Loc. cit.*, pp. 154, 155. "Tretretrete ou Tratratrata, c'est un animal grand comme un veau de deux ans, qui a la teste ronde, et une face d'homme; les pieds de devant comme un singe, et les pieds de

from hearsay, and may have reported some of the more or less fabulous accounts of the natives. However, FLACOURT'S information deserves mention, especially as the general trustworthiness of his statements has been acknowledged by modern explorers.\*

The last set of Vertebrate remains, discovered by Mr. LAST on the south-west coast of Madagascar, without indication of the exact locality, and received in England in the beginning of June of this year, contains, besides the bones of *Aepyornis* of exceptional size, the following remains:—

1. An incomplete skull and mandibula, besides numerous bones and isolated teeth of *Hippopotamus*.
2. A skull, two humeri, as well as other bones of *Crocodylus robustus*.
3. Several mandibular rami and numerous bones of a slender-legged form of *Bos*.

The association of the last-mentioned genus goes far to prove that the extinct Vertebrata recorded, co-existed in the island with domestic cattle; the bones of the *Bos* presenting the same coloration as part of the other remains; whilst those of the *Aepyornis*, and several of those of the *Hippopotamus* show even a fresher appearance.†

derrière aussi. Il a poil frisé, la queue courte et les oreilles comme celles d'un homme. Il ressemble au *Tanacht* décrit par AMBROISE PARÉ. Il s'en est vu un proche l'estang de Lipomami aux enuirons duquel est son repaire. C'est un animal fort solitaire, les gens du país en ont grand peur et s'enfuient de luy comme luy aussi d'eux.

“*Antamba*, c'est une bête grande comme un grand chien qui a la teste ronde, et au rapport des Negres, elle a la ressemblance d'un Leopart, elle devore les hommes et les veaux. Elle est rare et ne demeure que dans les lieux des montagnes les moins frequentez.

“*Mangarsahoc*, c'est une bête fort grande qui a le pied rond comme un cheval et les oreilles fort longues. Quand elle descend d'une montagne elle a de la peine à voir devant elle, à cause que ses oreilles luy cachent les yeux, elle fait un grand cry à la façon d'un asne. Je crois que ce peut estre un asne sauvage. Il y a une montagne à vingt lieuës du fort Dauphin que les François ont nommé *Mangarsahoc* du nom de cette animal, y en ayans autres fois oüy crier un.

“*Breh*, c'est un animal que les Negres de Manghabei disent estre dans le país des Antsianactes, qui a une corne seule sur le front, grande comme un grand cabrit, et est fort sauvage, il faut que ce soit une licorne.”

When announcing the discovery of the *Aepyornis* eggs, ISID. GEOFFROY-SAINT-HILAIRE quotes the following passage from FLACOURT, referring to a bird called *Vouron patra*:—“C'est un grand oyseau qui hante les *Ampatres*, et fait des œufs comme l'Autruche; c'est une espèce d'Autruche. Ceux des dits lieux ne le peuvent prendre, il cherche les lieux les plus déserts” (*loc. cit.*, p. 165). FLACOURT'S *Vouron patra* has been supposed by GEOFFROY-SAINT-HILAIRE and other writers to be referable to one of the minor forms assigned to the genus *Aepyornis*, and in the first line to the fragmentary egg-shells, as mentioned by P. GERVAIS: “qui paraissent avoir dû être du volume de ceux des Autruches.” (ISID. GEOFFROY-SAINT-HILAIRE, *l. s. c.*; P. GERVAIS, *l. s. c.*)

\* See ALF. GRANDIDIER, Madagascar (*loc. cit.*, p. 82): “*L'Histoire de Madagascar*, par FLACOURT, seule, porte le cachet de la vérité; ce que le gouverneur de Fort-Dauphin écrivait, en 1661, sur la petite peuplade des Antanosses, est vrai encore de nos jours.”

† The following account of the Madagascar cattle in the 17th century, as given by FLACOURT,

The evidence contained in the foregoing pages, shows, with a sufficient degree of certainty, that the Vertebrate remains discovered in Madagascar belonged to animals, part, if not all, of which have been seen by Man at a relatively recent date.

There is however, besides, another piece of information, though scanty for the present, which entitles us to look forward towards the discovery of a Mammalian fauna, geologically older than the one treated of in the foregoing.

From the few papers published on the geology of Madagascar, which at the present day, according to GRANDIDIER,\* possesses but a scarce number of lakes, it appears that numerous old lake-bottoms exist in the central part, as well as terraces of lacustrine origin.† From the correspondence of Mr. LAST, who spent last autumn and the whole of the winter in the Antinosy country, we gather that in this almost unexplored region of Southern Central Madagascar, the beds of old lakes equally abound. Mr. LAST further states as follows: "Now the lakes are all dry, leaving a bed of grey, marly clay, from three to five feet thick, and near the bottom of this the isolated bones are found." Another formation, termed by the writer a "soft red sandstone," seems to overlay in many places the grey marl; in one place where the river Itungansuba has cut a passage through these various deposits, a section of them is seen. So that the suspicion arises that the grey marl of the interior is not the equivalent of the white clay in the marsh of Amboulisatra near the sea-shore, but rather belongs to a geologically older formation. CORTESE mentions‡ that in the central region, extensive stratified deposits of red arenaceous clays (*argille sabbiose rosse*) exist resulting from the decomposition of the gneissic rocks. These red arenaceous clays he ascribes to the Pleistocene. If they are the same formation with Mr. LAST'S "soft red sandstone" of the southern central parts, then the underlying grey marls and the fossils they contain, may be Tertiary.

Whatever may hereafter prove to be the case it appears *à priori* highly improbable that the formation of lake basins has been limited to the Post-Tertiary period. Whilst from the presence, in one or more districts, of lignite,§ believed by CORTESE

acquires a peculiar interest in relation with the above statement. "Il y a de trois sortes de bœufs en ce pays sçavoir ceux qui ont des cornes; d'autres qui se nomment *Boury*, qui ont la teste ronde, et n'ont point de cornes, et d'autres qui ont des cornes pendantes attachées à la peau de la teste seulement" (?), (probably *Bubalus*) "et tous ont de grosses loupes de graisse sur le chinon du col, de laquelle loupe l'on en fond la graisse pour manger au lieu de beurre: d'autant qu'elle est aussi agreable que le beurre. Ces bœufs quelques gras qu'ils soient, ont très-peu de suif, ce qu'il y en a est très-bon à faire de la chandelle. Il y a encores dans le pays des Machicores, ruiné des guerres, une grande quantité de bœufs sauvages qui n'ont point de loupes. Ils sont comme ceux d'Europe: Toutesfois sont hauts de jambe, et courent par troupe comme des cerfs." (DE FLACOURT, *loc. cit.*, p. 151.)

\* ALF. GRANDIDIER, "Madagascar" ('Bull. Soc. Géogr.', vol. 2, 1871, p. 104.)

† M. CORTESE, 'Appunti Geologici,' &c., pp. 106, 107, 108. R. BARON, *loc. cit.*, pp. 306-308.

‡ 'Appunti geologici,' p. 117.

§ E. CORTESE, "Osservazioni geologiche sul Madagascar," 'Boll. del R. Com. Geol.,' vol. 18, 1887, p. 187. *Ibid.*, 'Appunti Geologici,' &c., *loc. cit.*, p. 123. R. BARON, *loc. cit.*, p. 325.

to be of Pliocene age, it becomes further almost a certainty that lacustrine deposits of Tertiary age exist in Madagascar. I anticipate accordingly that a Tertiary Vertebrate fauna will sooner or later be forthcoming in the island.

With regard to this proposition I wish to call attention to another circumstance. In the foregoing inquiry reference was made to a paper by GULDBERG, containing a detailed description, with plates, of the *Hippopotamus* from Sirabé, in the Christiania Museum. GULDBERG supposes that this form may be identical with the *H. Lemerlei*, whose remains were discovered by GRANDIDIER in the Amboulisatra marsh. The provisional description given by the French author\* does not allow us to pronounce with certainty on the matter, so that, being in doubt, GULDBERG prefers to assign a new specific name to the Sirabé remains (*H. madagascariensis*).

The *Hippopotamus* skull in the British Museum comes, as above stated, from this same district of Sirabé; I was in consequence, as a matter of course, prepared to find it agreeing with the one described by GULDBERG. However, a close examination proved quite the contrary. It can only be said, in a general way, that both are somewhat intermediate between the lower pliocene *H. sivalensis* and the existing *H. amphibius*, a remark which likewise applies to, *H. Lemerlei*; but otherwise the skull in the British Museum differs from the one described by GULDBERG in various respects, some of the variations being such that it is impossible to account for them as being due to age or sex. The London skull appears to be equally different from those described by GRANDIDIER in some points in which these last agree with the Christiania skull, so far at least as one may be allowed to judge from GRANDIDIER'S description. Now, as it seems at first sight difficult to admit that two different forms of *Hippopotamus* existed in the same district, I feel almost inclined to conclude that the differences alluded to may be due to the fact of the two skulls from Sirabé being of a different geological age.

However, I do not wish to insist too strongly on this point so long as the Paris remains have not been submitted to a close comparison, in which would have to be included as well, the remains sent to Berlin by HILDEBRANDT.

\* MILNE EDWARDS, "Sur des découvertes zoologiques faites récemment à Madagascar par M. ALFRED GRANDIDIER," 'Comptes Rendus Acad. Sc.,' vol. 67, séance du 14 Déc., 1868, pp. 1165-1167.



## DESCRIPTION OF PLATES.

All figures natural size.

## PLATE 5.

*Megaladapis madagascariensis*, gen. et. sp. nov.

- Fig. 1. View of the right side of the skull.  
 Fig. 2. Outside view of the right mandibular ramus.  
 Fig. 3. Front view of the same, to show the symphysis.

## PLATE 6.

*Megaladapis madagascariensis*.

- Fig. 4. Upper view of the skull.  
 Fig. 5. Occipital view. The constriction between the cerebral and the olfactory fossa is visible through the foramen magnum.  
 Fig. 6. Fragment of the right maxilla of a second specimen, from below, showing the two posterior molars and the alveoli of the first molar, as well as of the two posterior premolars.  
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- Fig. 8. Inferior view of the skull. *ms.*, backward prolongation of the inflated maxilla, which on the left side is broken, so that the maxillary sinus is visible.  
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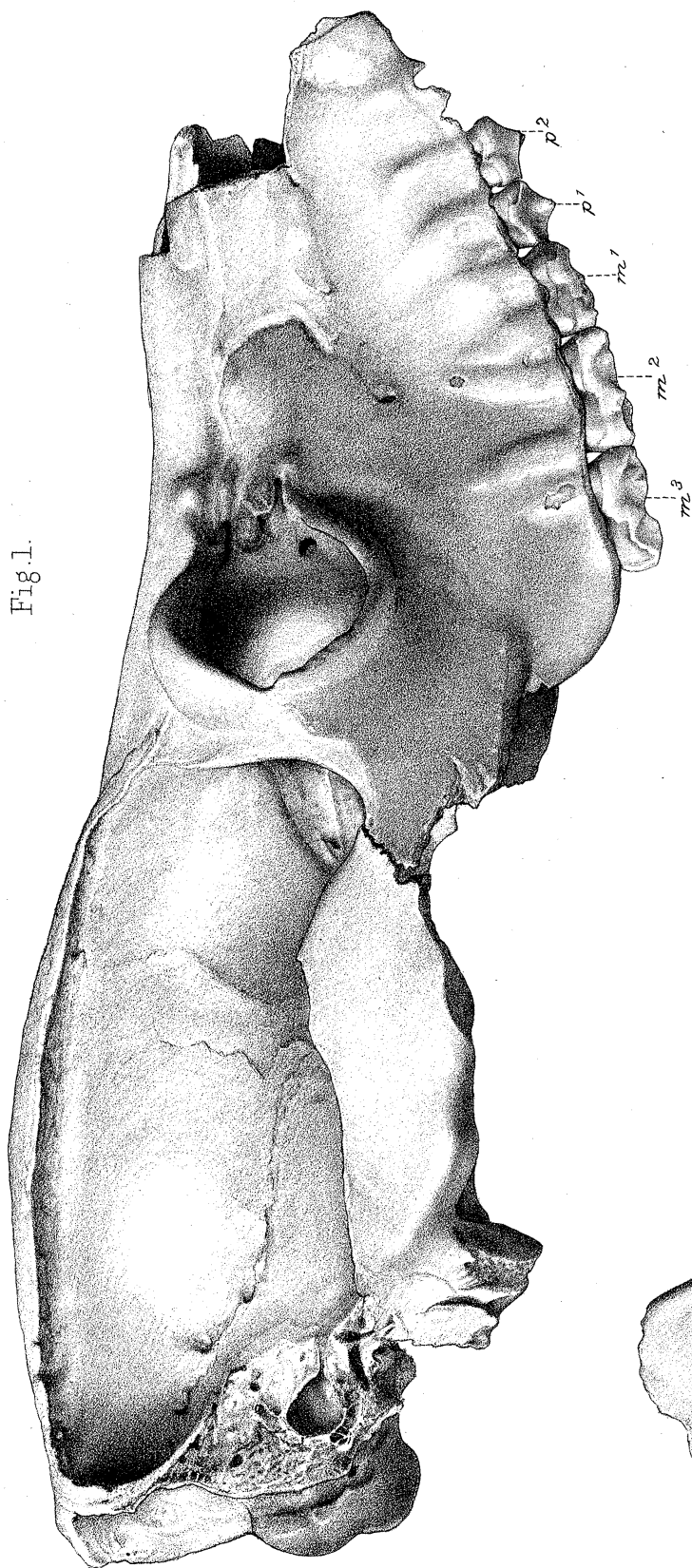


Fig. 1.

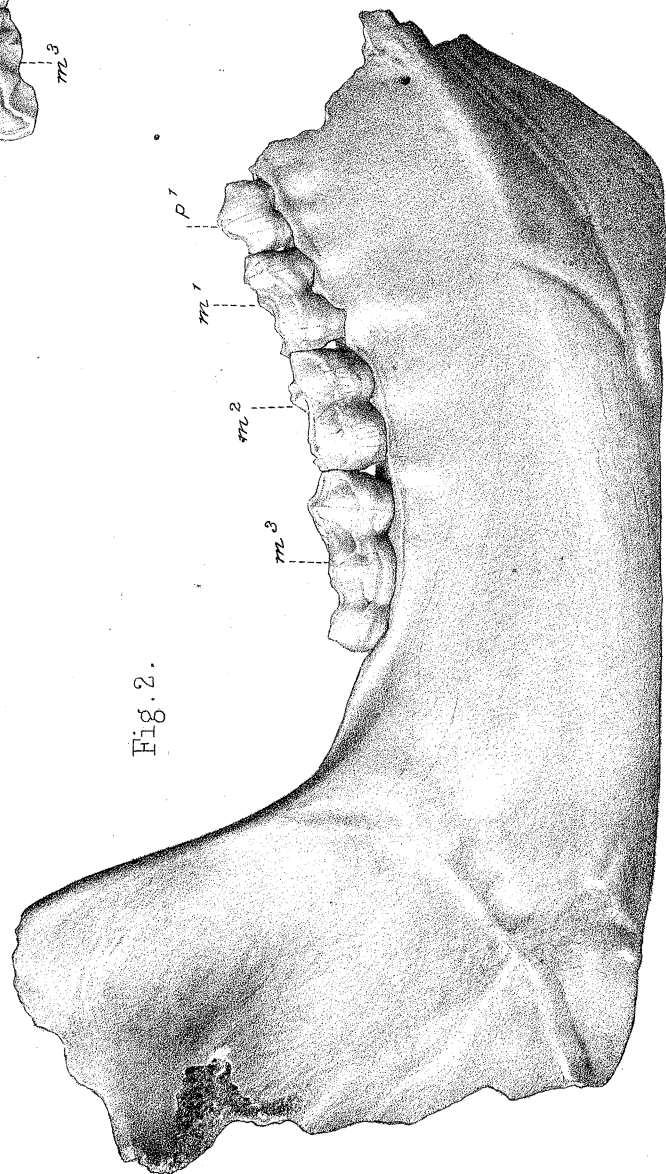


Fig. 2.

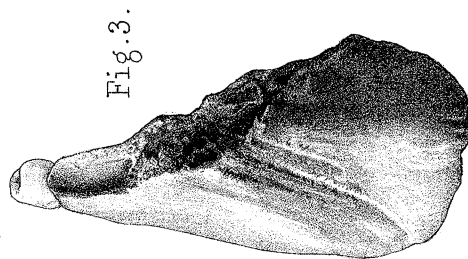


Fig. 3.

*Megaladapis madagascariensis, gen. et sp. nov.*

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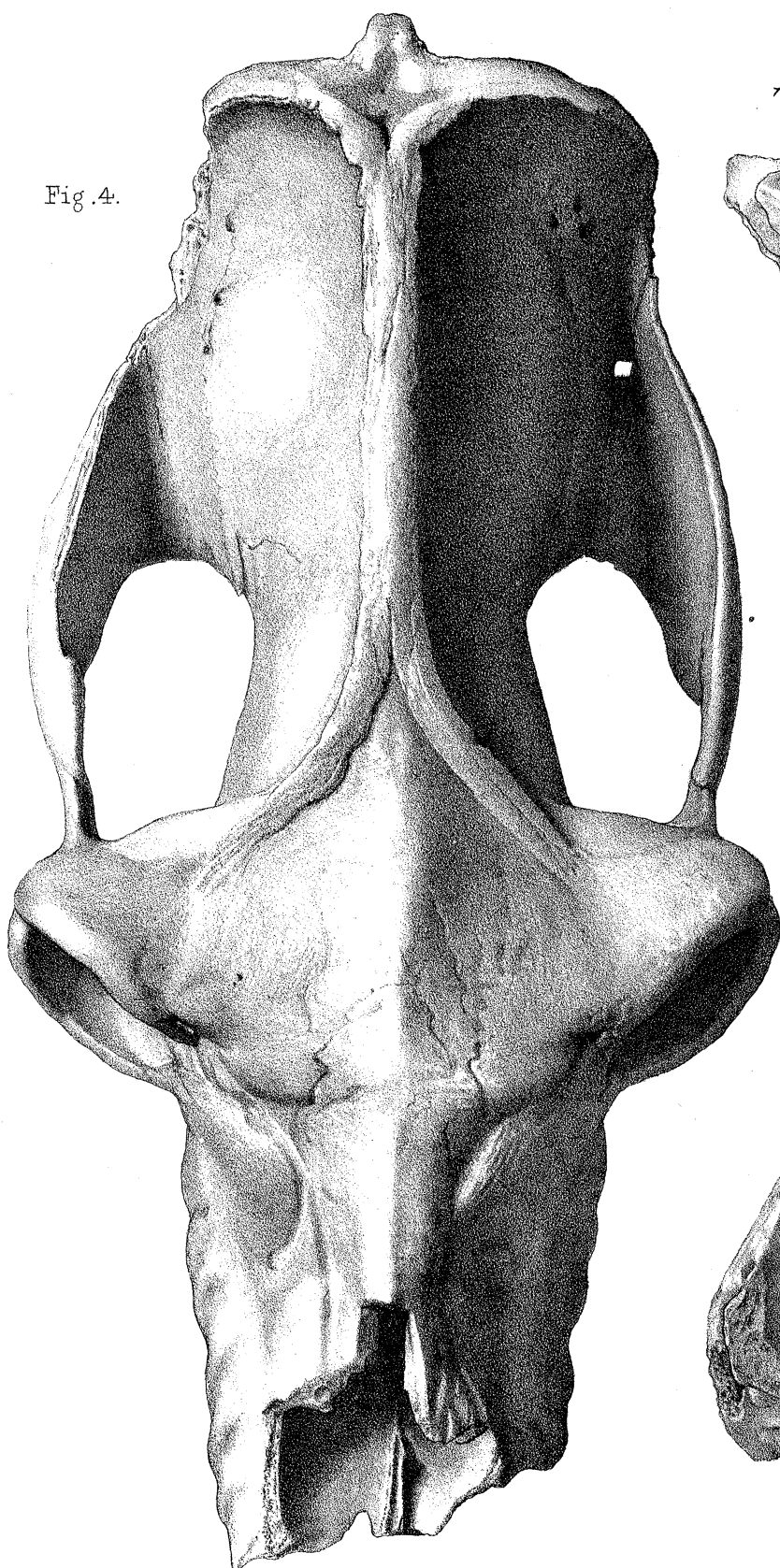


Fig. 4.

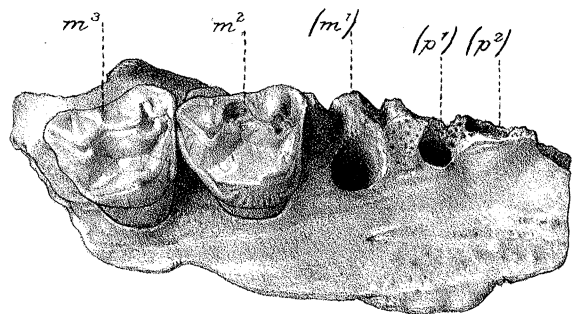


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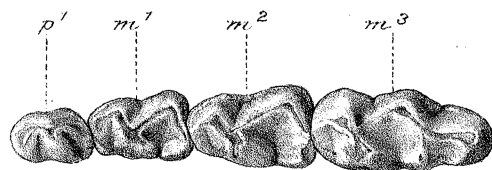


Fig. 7.

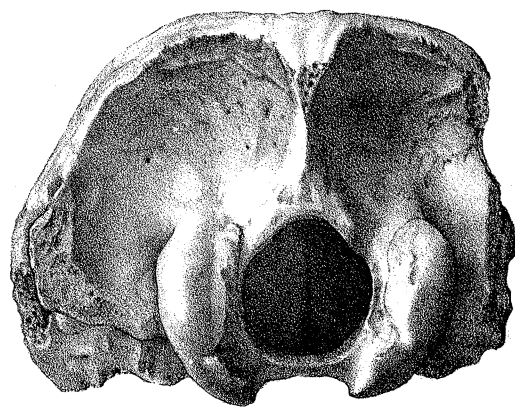


Fig. 5.

G.M. Woodward ad nat. libt.

West, Newman imp.

*Megaladapis madagascariensis*, gen. et sp. nov.

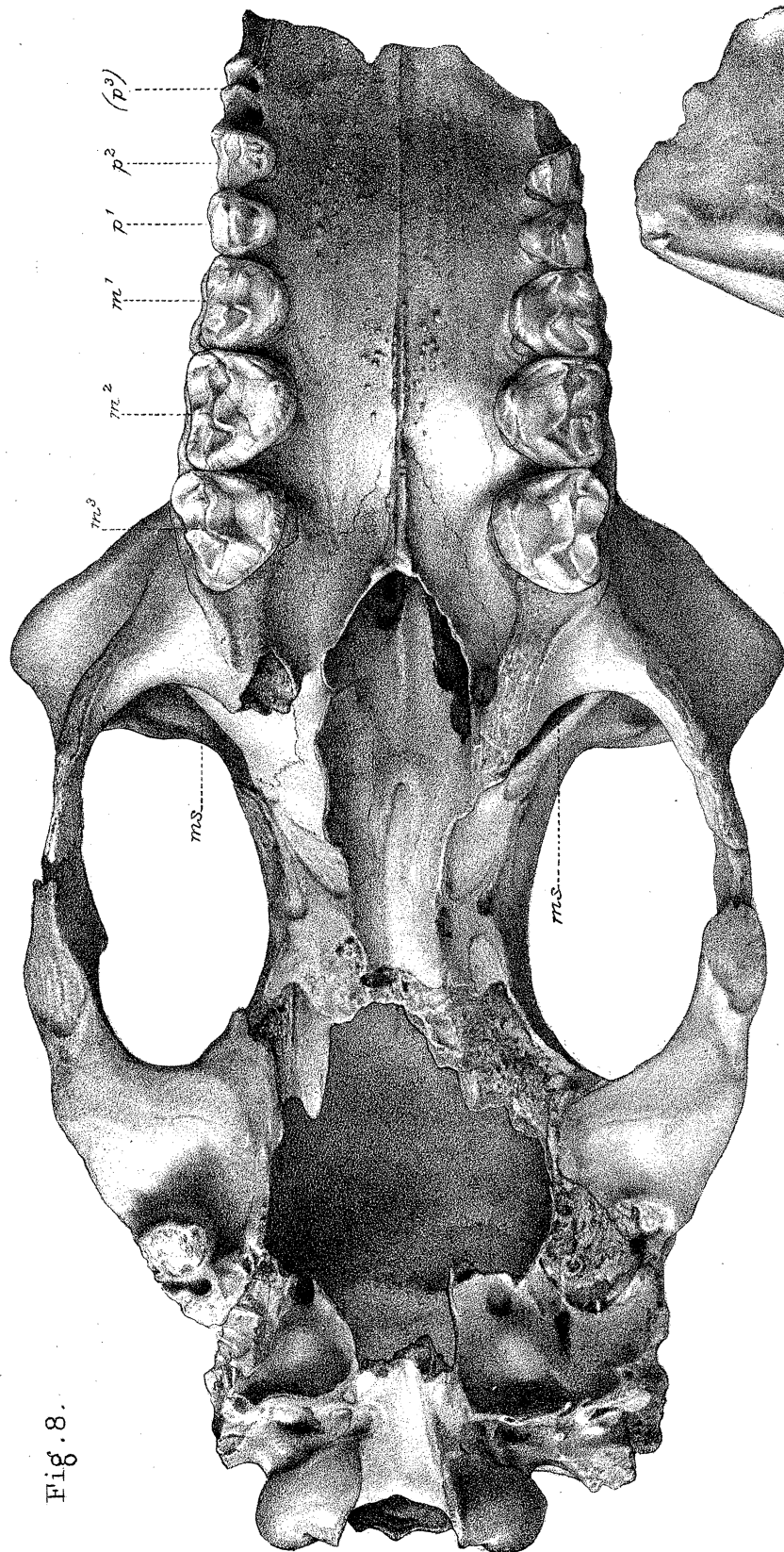


Fig. 8.

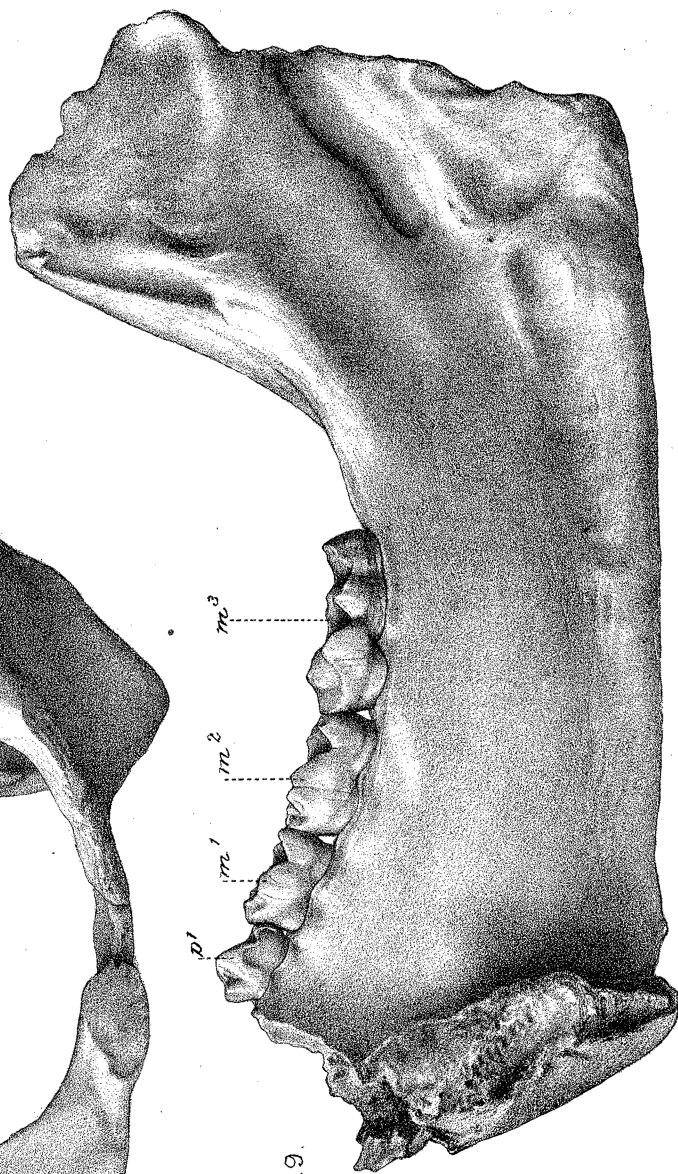


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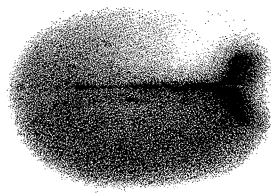


Fig. 10.

*Megaladapis madagascariensis, gen. et sp. nov.*

Fig. 1.

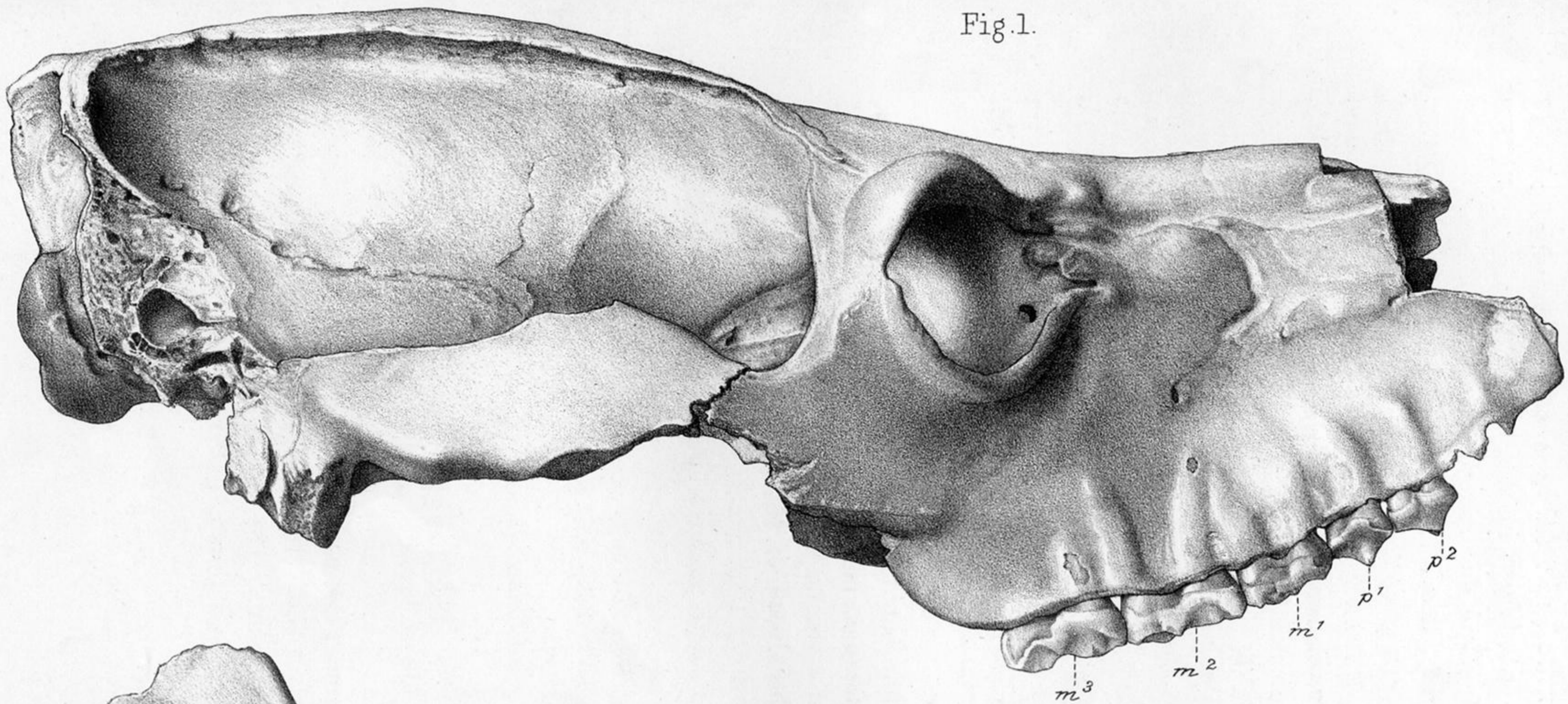


Fig. 2.

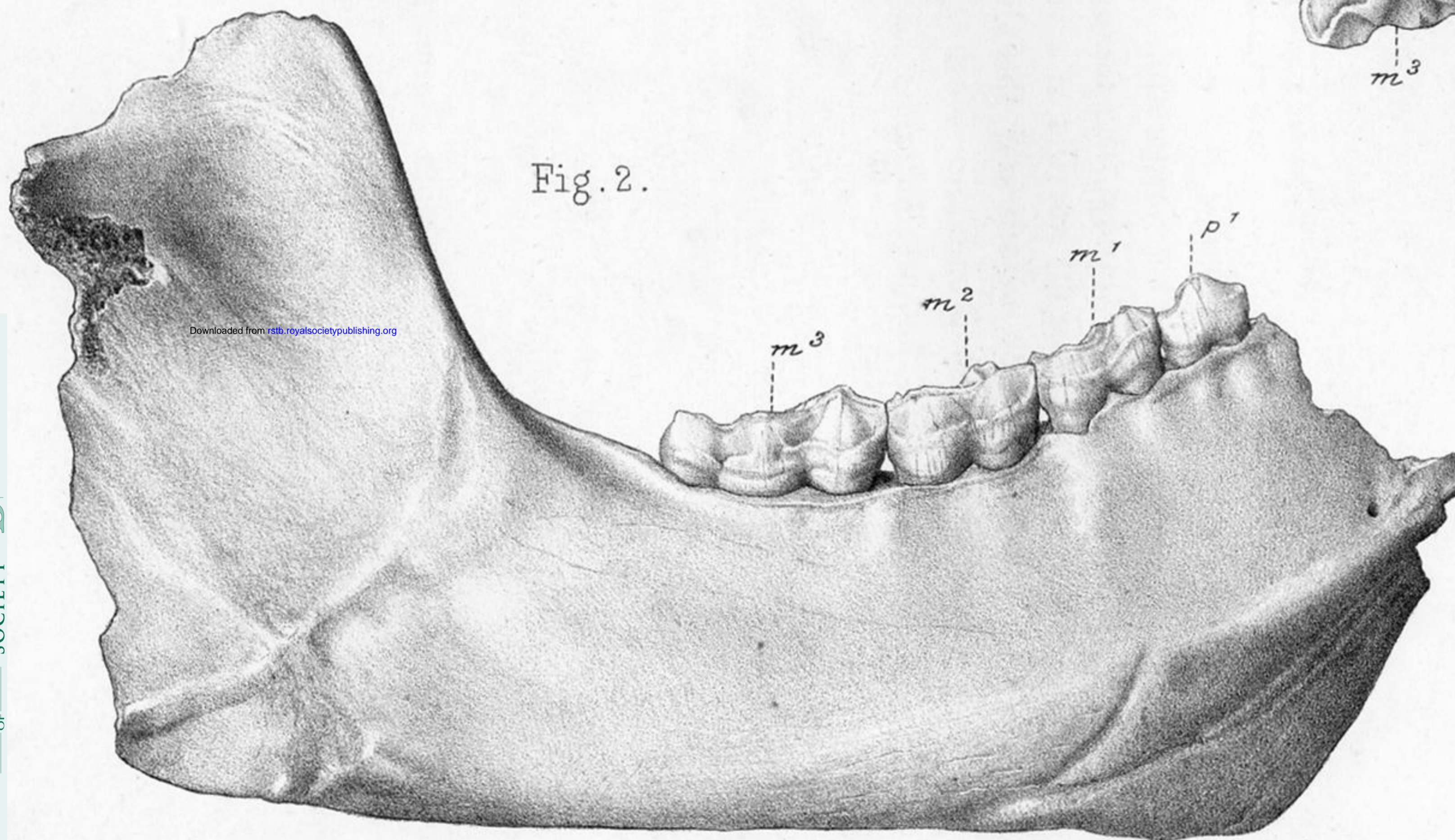


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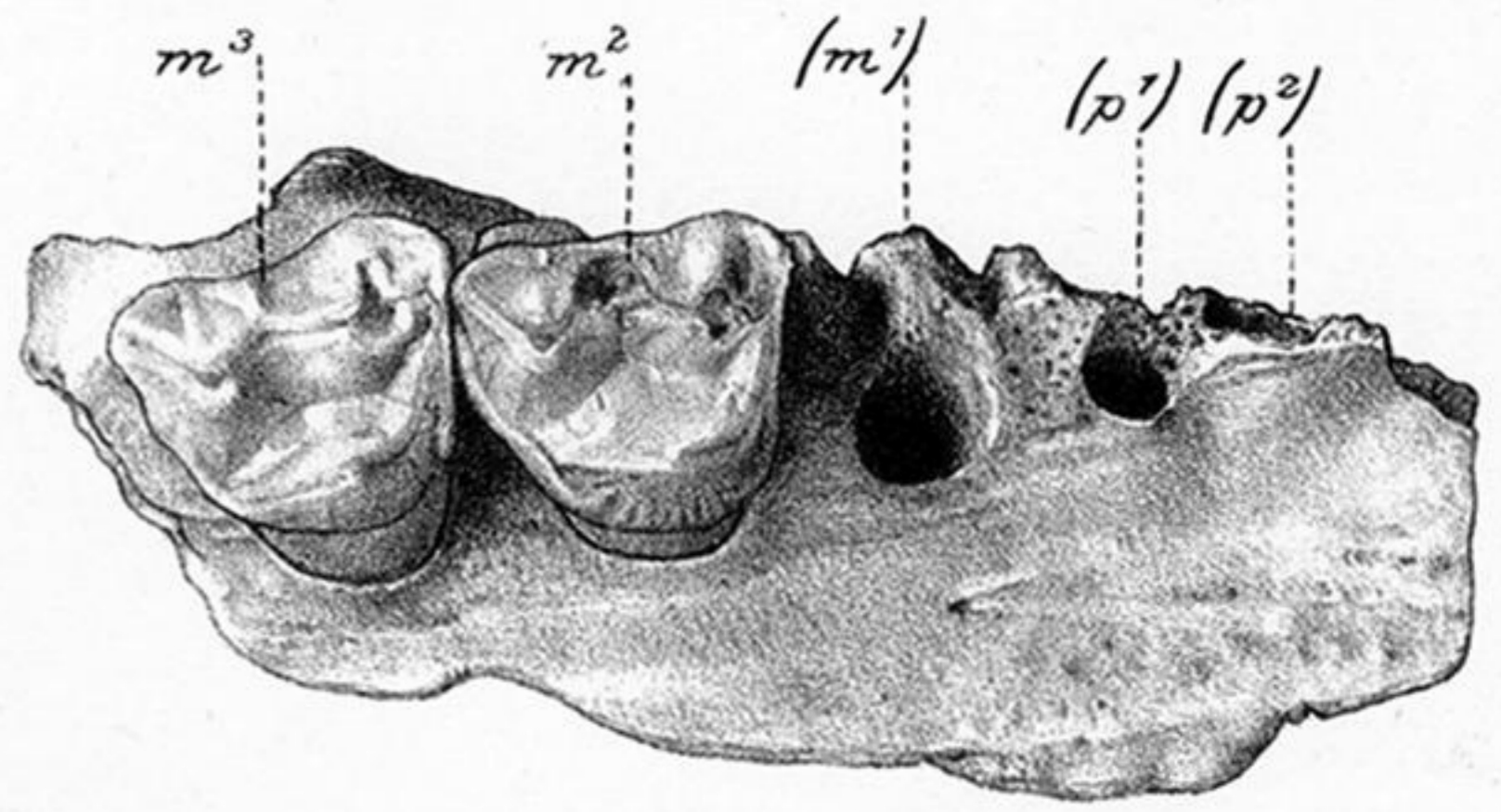
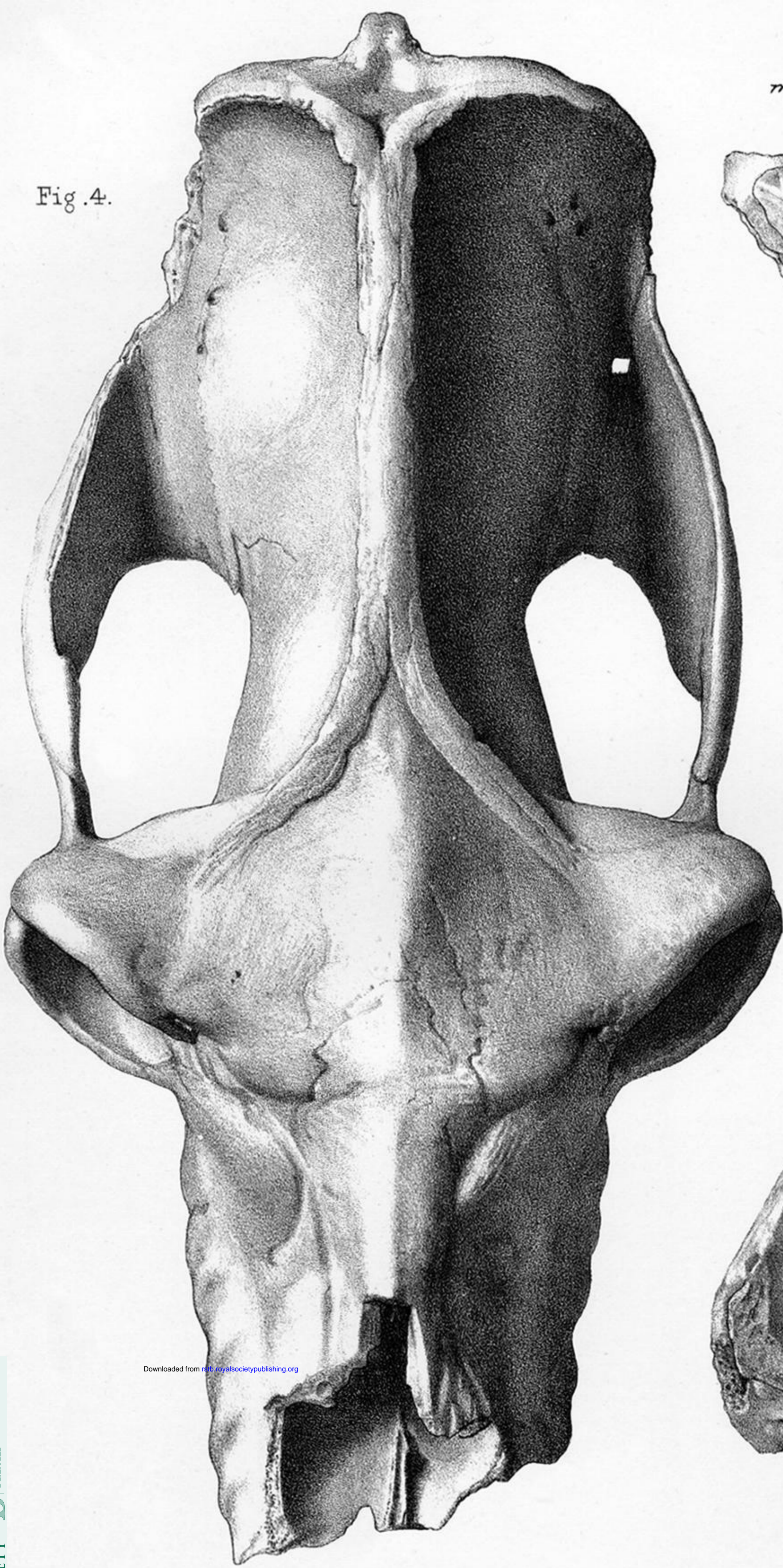


Fig. 6.

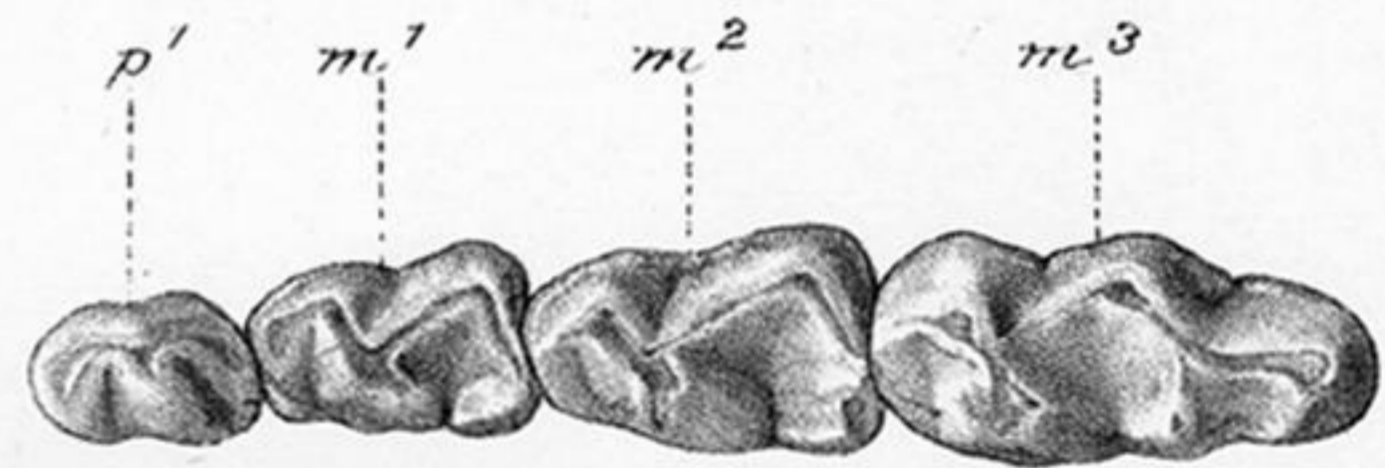


Fig. 7.

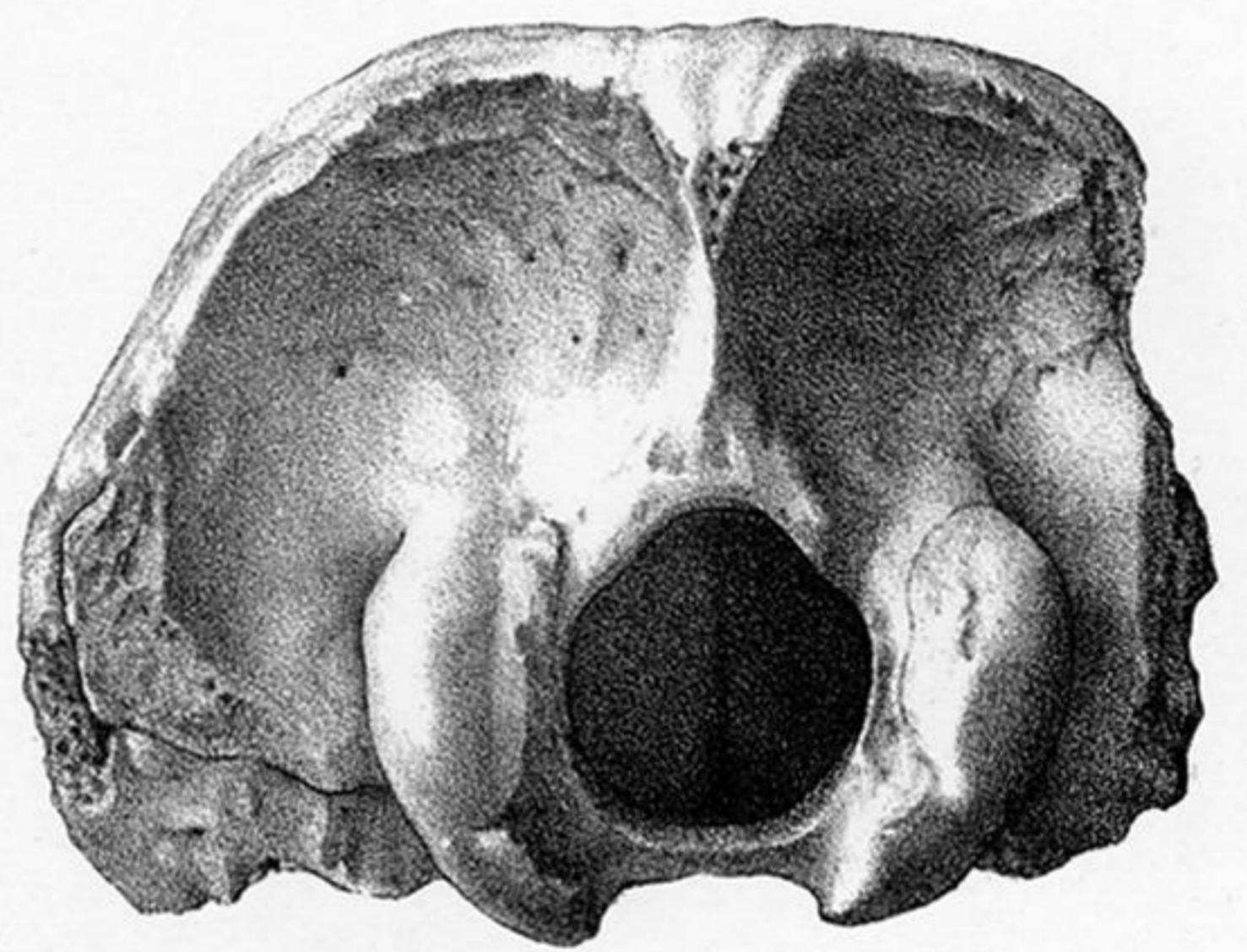


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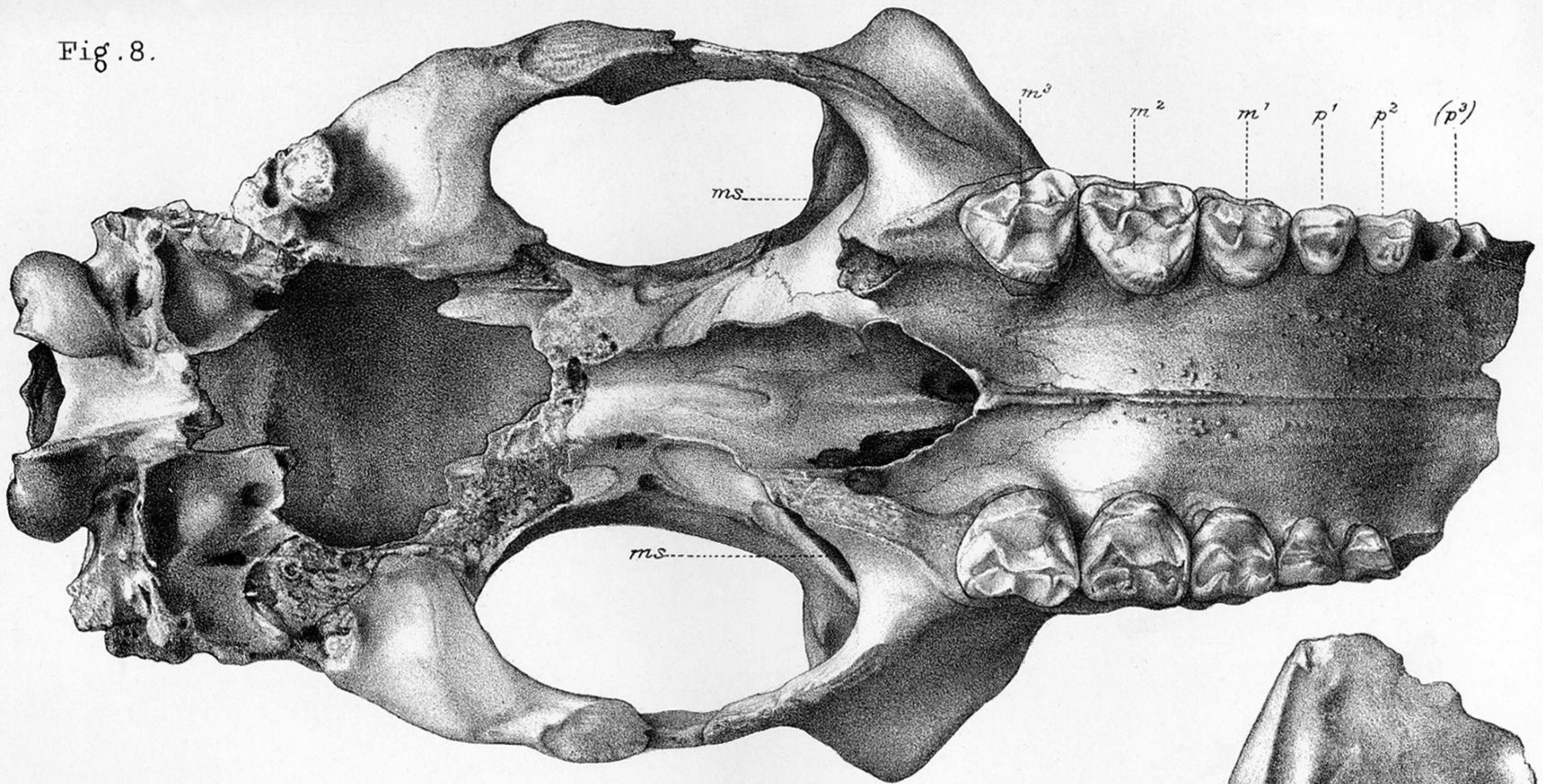


Fig. 10.

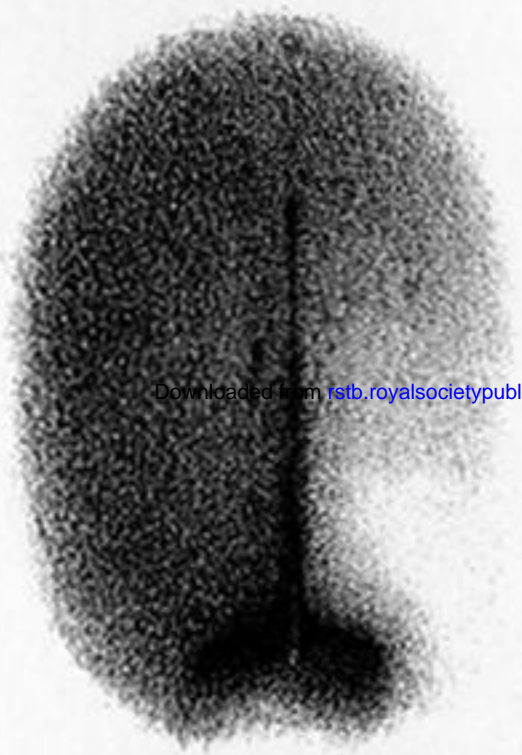


Fig. 9.

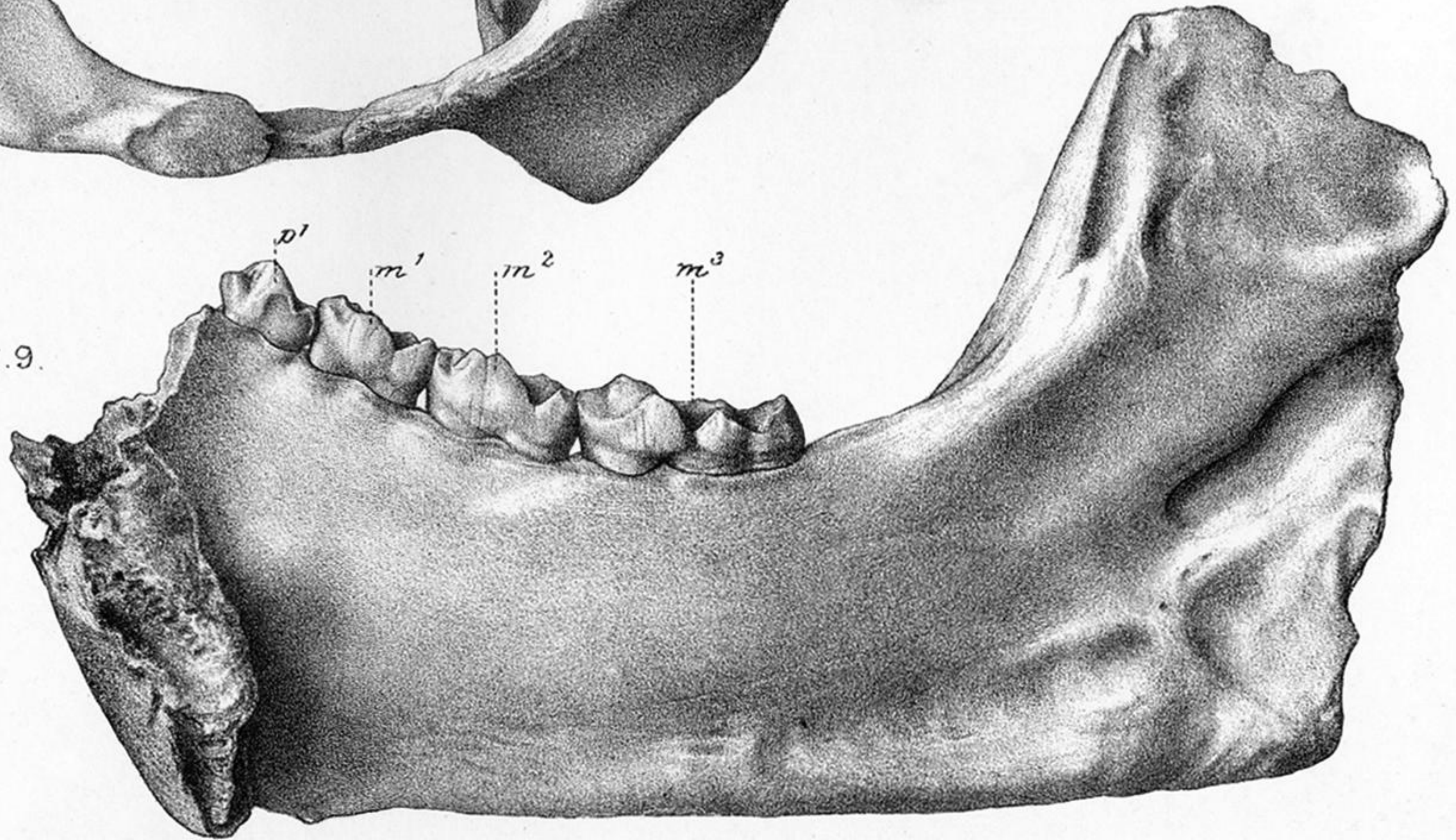


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