

## Notes on a New Fossil Mammal.

By

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AND

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*With 3 Plates.*

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In 1898 a fossil-skull of a large mammal apparently of an unknown type came into possession of Mr. IWASAKI. Accordingly, in the following year, Mr. YOSHIWARA visited the locality where the skull was reported to have been discovered, in order, if possible, to ascertain its exact mode of occurrence. The place is called Togari, situated in Kanigōri, province of Mino, and the rock in which the fossil was found is a tufaceous sandstone belonging to the Neogene Tertiary, probably Miocene. In this sandstone Mr. YOSHIWARA found a specimen of a tooth belonging to the same mammal, a fact which confirms the discovery of the skull in the same rock. The strata lying considerably below the sandstone contain *Vicarya callosa* JENKINS† and many other marine shells, which are generally considered to be Miocene. Associated with the above bones there are

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† K. Martin, Die Tertiärschichten auf Java. 1879-80, p. 62.

teeth of *Carcharias japonicus* SCHLEG., *Solen*, and impressions of some land plants (Pl. III. fig. 6 a). The occurrence of these plant-remains shows that the deposits, although marine, are of a shallow water origin.

About half a mile from the above locality, and in a stratum identical in age with that of the above mentioned sandstone, Mr. YOSHIWARA dug out a part of the lower jaw of a *Rhinoceros* with some teeth in the sockets. Bones of another species of *Rhinoceros* were also found by him in the Neogene tufaceous sandstone of Hazaki, about 6 miles from Togari. This was the first time that the remains of *Rhinoceros* had ever been discovered in Japan.

Detailed examination of the fossil skull mentioned seems to show many characters which are different from those of any other mammal hitherto described. A few peculiarly shaped bunodont molars and many tusk-like incisors, together with the long, narrow, flat and straight upper jaw, and a large, anteriorly placed, united nasal foramen are some of the significant characters which distinguish the fossil. The shape of the molars strongly reminds us of those in the *Mastodon*; but the peculiar arrangement of their cusps, the presence of many thickly enamelled incisors in both jaws, and the general outline of the skull, exclude the idea of the fossil belonging to that genus. Indeed in the shape of the skull our fossil resembles some of the Ungulates, amongst which order the groups possessing the bunodont teeth—a type of teeth generally considered to be of a primitive character—are represented by the Condylarthra, the primitive Equidæ (such as the Hyracotherinæ) among the Perissodactyla, and the Bunodontia among the Artiodactyla. But the small number of molars—viz. two premolars and one or two molars on each side of the jaw,—and six horizontal tusk-like incisors, together with the fact that the anterior end of the upper jaw protrudes somewhat over the

lower, are characters which distinguish our fossil from all the forms of hitherto known Ungulates. As an evidence that it is not a Sirenia, we may mention the differing position of the nasal foramen, the smooth surface of the upper jaw, the straight and not downwardly curved anterior ends of both jaws, the larger number of incisors and the peculiar form of the premolars and molars.

The discovery of this fossil is very important to the palæontology of Japan. But the lack of a sufficient literature concerning such fossils in our country compelled us to submit it to the examination of some recognized authority on vertebrate fossils abroad. So a brief description of the skull and teeth, accompanied by photographs, were sent to Professor OSBORN who was kind enough to inform us, that the skull belonged to the Proboscidea. According to this eminent vertebrate palæontologist, our form is a very primitive one in some respects, and a highly specialized one in other respects, belonging to the early types of *Mastodon*. The primitive characters of the fossil, he says, lie in the presence of successional incisors, while its highly specialized and aberrant characters lie in the peculiar form and arrangement of the mammilate cusps of the molars, and the narrow, compressed or connate roots supporting them.

The following is a detailed description of our new form.

### SKULL.

The specimen is a very well preserved skull, whose hind portion, however, is broken away (Pl. I & II). It is small, compared with the skull of other Proboscidea, the length being considerably greater than the breadth. The whole length of the skull is 55<sup>cm</sup> (1.8 ft.) ; from the anterior extremity of the upper jaw to the anterior

edge of the nasal foramen it measures 7<sup>cm</sup>, and from the posterior edge of the same foramen to the anterior part of the orbit 20<sup>cm</sup>. The nasal foramen is large, oval-shaped, 13<sup>cm</sup> long and 6<sup>cm</sup> wide, and placed quite in the anterior part of the skull (see Pl. I). The width of the skull running through the middle of the nasal foramen is only 13<sup>cm</sup>, and the distance between the inner sides of the molars of the upper jaw is 11<sup>cm</sup>. The height of the skull is more than 16<sup>cm</sup> at the posterior end, but anteriorly from the point of the insertion of the molar teeth, it thins out quite rapidly. The molars are found immediately beneath the orbital foramen as shown in Pl. II. Towards the nasal foramen the jaw becomes more and more flattened, and is only 5<sup>cm</sup> high at the posterior edge of the foramen, whence it thins out towards the anterior extremity. When viewed from above, the nasal foramen is completely surrounded by the premaxillæ, and the nasal bones do not extend to the foramen but lie beneath the premaxillæ. Maxillæ are well preserved, joined to other bones by distinct sutures. The upper surface of the upper jaw is almost smooth and its anterior portion shows no trace of a downward curvature.

The lower jaw is very low and also does not curve downward. Its ramus is 11<sup>cm</sup> high and 4.5<sup>cm</sup> wide at the part where the molars grow, but the height gradually diminishes towards the anterior part, finally thinning out at the extremity. The posterior end of the line of junction of the two rami is placed far back, being separated only about 5<sup>cm</sup> in a direct distance from the root of the molar. The distance from a point between PM<sub>2</sub> and M to the anterior extremity of the ramus measures about 40<sup>cm</sup> in the upper jaw, but only about 36<sup>cm</sup> in the lower. This shows that the upper jaw protruded over the lower.

### INCISORS.

The teeth are very characteristic in form. Incisors are all tusk-shaped, quite horizontally placed and not curved at the tip. There are found two pairs in the lower jaw and one pair in the upper. (See Pl. I). The upper incisors have not yet come into full growth, only the left tooth being slightly visible below the broken maxillæ. The two pairs of incisors in the lower jaw, especially the inner pair or  $I_1$ , are prolonged beyond the anterior extremity of the jaw bone. Incisors are very long and probably 20<sup>cm</sup> or more in length when measured from the extremity of the root to the summit of the crown. They are entirely covered by a thick coating of enamel, with the thick dentine and the pulp cavity inside. In the lower  $I_2$ , a transverse section at the distance of 7.8<sup>cm</sup> from the summit has the diameter of 3.15<sup>cm</sup>, where the enamel is 1.5<sup>mm</sup> thick, the dentine 6<sup>mm</sup> and the diameter of the pulp cavity 1.65<sup>cm</sup> (fig. 1). Towards the summit, the enamel becomes thicker measuring 3<sup>mm</sup> in thickness, while the dentine has the diameter of 1.4<sup>cm</sup> with no pulp cavity at the distance of 3.2<sup>cm</sup> from the summit (fig. 2). The upper jaw seems to have only one pair of incisors, for the transverse section of the skull at the distance of about 22<sup>cm</sup> from the anterior extremity shows no trace of teeth (fig. 4).

### PREMOLARS AND MOLARS.

Behind the incisors there is a wide gap in both jaws. The teeth collected by us are the right lower  $PM_1$ , the right upper  $PM_2$ , the right and left lower  $PM_2$ , the left lower  $M$ , and the right and left upper  $M$ . They all possess very peculiar forms never found in Proboscidea, or even in other Mammalia. The crown is an aggregation of long cylindrical column-like tubercles, which are generally arranged in two longitudinal rows, parallel to the longer axis of the crown, and in

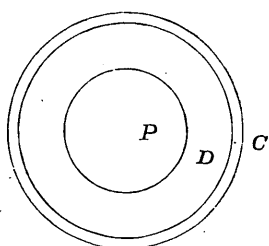


Fig. 1.

Section of  $LoI_2$  at the distance of 7.8cm from the summit (nat. size).

*C* Cement.  
*D* Dentine.  
*P* Pulp.

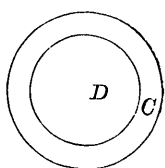


Fig. 2.

Section of  $LoI_2$  at the distance of 3.2cm from the summit (nat. size).

*C* Cement.  
*D* Dentine.

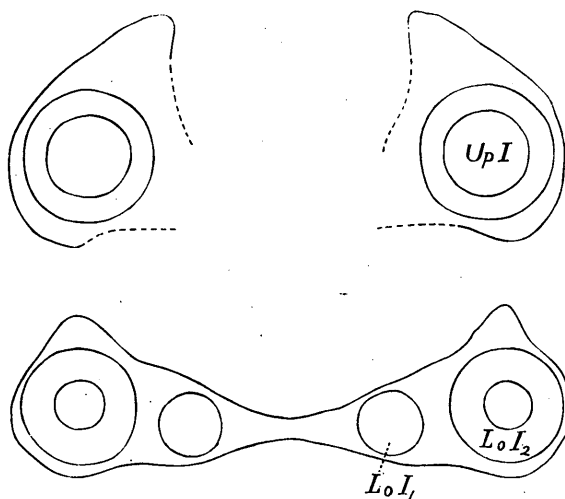


Fig. 3.

Diagrammatic transverse section of skull at the distance of 15cm from the anterior extremity of the upper jaw. ( $\frac{1}{2}$  nat. size).

*Up I* Upper incisor. *Lo I1* First lower incisor.  
*Lo I2* Second lower incisor.

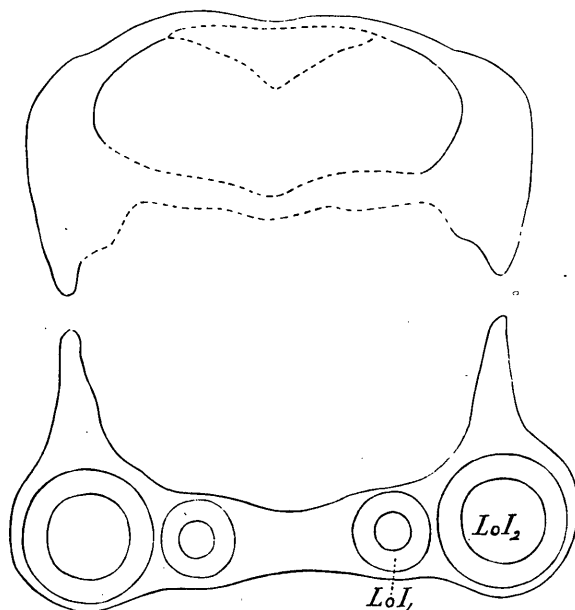


Fig. 4.

Diagrammatic transverse section of skull at the distance of 22cm from the anterior extremity of upper jaw. ( $\frac{1}{2}$  nat. size).

*Lo I1* First lower incisor. *Lo I2* Second lower incisor.

three transverse rows at right angles to it. The enamel is extraordinarily thick, and the dentine which occupies the centre of the column appears as a round section on the masticating surface. The base of the teeth is narrow, compressed and 2-rooted in all cases. The pulp cavity is almost wanting in the crown, only extending as a small rounded canal in each tubercle for a very short distance. Although we could not examine any other premolars than the last premolar in the upper jaw, yet it is almost certain that there must have existed another premolar located anteriorly, judging from the well worn surface of the lower premolar corresponding to it.

*First premolar:* The premolars of the lower jaw are two in number. The crown in the first premolar (Pl. III. fig. 1 a & b) has a longer axis of 3.2<sup>cm</sup>, a shorter axis of 2<sup>cm</sup>, and a height of about 2.7<sup>cm</sup>. It is composed of seven pillars, which are not so distinctly separated into two symmetrical halves as is seen in the succeeding teeth. These pillars are very close together so that there is no space left between them. So when seen from above, the pillars are not circular in section, but appear strongly compressed toward one another. The masticating surface is comparatively little worn, so that the dentine is not much exposed on it. The posterior side of the tooth presents neatly fitting faces to the second premolar, but on the anterior side we can not find any face which might have come in contact with another tooth.

*Second premolar:* The second premolar of the lower jaw (Pl. III. fig. 2 a & b, fig. 3 a & b) has a longer axis of 4.7<sup>cm</sup> and a shorter axis of 3.2<sup>cm</sup>, while the height of the crown is reduced to 2.5<sup>cm</sup>, as the result of much friction. It is divisible into two longitudinal halves and three transverse parts. Each of these parts consists of a column-like tubercle with the thick outer enamel and the

centrally placed dentine. Only in the posterior outer one of these parts is there found by the side of a larger ordinary pillar another smaller one, which corresponds to the talon of other bunodont mammals. At the base of the middle of the anterior side, there is a little protuberance which however has been almost entirely worn away by rubbing with the first premolar.

The second premolar of the upper jaw (Pl. II. Pm, Pl. III fig. 4) is only seen on its right side. The crown is composed of four cylindrical pillars and a very small protuberance at the anterior outer edge. Thus the teeth of the upper jaw, when compared with those of the lower, show much fewer tubercles. This fact is probably not due to the loss of tubercles by mechanical action after the death of the animal, but seems to have been a natural state, for, on examining the corresponding PM<sub>2</sub> in the lower jaw, we find that the surface in contact with the former is deeply worn in, so that the surrounding portion projects a little over the other parts. This projecting portion is also worn by friction, which indicates the existence of PM<sub>1</sub> in the upper jaw.

*Molars:* Molars are very large and distinctly 2-rooted. The molar of the lower jaw (Pl. III. fig. 5 a & b) has a length of 6.4<sup>cm</sup> and a breadth of 4<sup>cm</sup>; and the height of the worn crown measures 3.9<sup>cm</sup>. It closely resembles in form the lower PM<sub>2</sub> but is much more simple, being composed only of six regular pillars.

The molars of the upper jaw (Pl. II. M<sub>1</sub>, Pl. III. fig. 4, fig. 6 a & b) are rather complex in form. The outline of the masticating surface takes the form of an isosceles triangle with the apex directed posteriorly. The pillars are arranged in two longitudinal and four transverse rows. The transverse row making the base of the triangle is formed of three pillars with a smaller one intercalated between the two innermost pillars of this and the next posterior row.



The central rows are composed of two anterior and two posterior pillars of which the anterior ones are the largest of all. At the apex of the triangle are two pillars, the larger being placed almost in the median longitudinal line and the smaller in contact with it at the inner posterior edge.

Near the posterior margin of the right orbital foramen, a trace of a molar is found enclosed in the bone (Pl. II. M<sub>2</sub>). Judging from its position, as well as from the young state of the animal, it is probably to be considered as the second molar which was not yet functional as in the case of the upper incisor. As the posterior portion of the lower jaw, posterior to the position of the first (?) molar, is broken away, it is not certain whether the second (?) molar ever existed.

From the above statement it is to be concluded that the animal had probably two incisors, four (?) premolars and four molars in the upper jaw, and four premolars and two or four molars in the lower.

It is of interest to add here, that another tooth probably belonging to the same genus, if not to the same species, was brought by a Mr. S. Irō in 1897 from an entirely different locality. He is a resident of the village of Yunomachi near Matsue in the province of Izumo, and it was reported by him that the specimen had been picked up by another person in the vicinity of the village. It (Pl. III. fig. 7 a & b) has a crown which is quite similar in color and structure to the above described teeth. The crown is likewise split by a longitudinal furrow running down to its base. The small number of tubercles in the tooth seems to indicate that it is a lower molar, but the crown is very small in size when compared with the specimens already described, being only 4.3<sup>cm</sup> in height, and 3.5<sup>cm</sup> and

2.9<sup>mm</sup> in the longer and shorter axes on the masticating surface. Moreover the pillars are not arranged in three transverse rows, and there is no sign of either its anterior or its posterior face having been in contact with another tooth. The outer surface of one of the two longitudinal halves containing three tubercles is convex, but that of the other half is almost flat. The wearing is rather slight and the dentine is exposed only in a small round section. The two-rooted character of the base is distinctly shown in the tooth examined. Comparing the form of the present tooth with that of the above described specimens, there is among these not one which quite agrees with it in the arrangement of the column-like tubercles. In the size of the crown the tooth somewhat approaches the second premolar of the other specimens, but there exists a great difference in the number of tubercles. Therefore it is not certain whether we have before us a premolar or a molar, a milk tooth or a permanent one.

#### PHYLOGENETIC VIEW OF THE PRESENT SPECIMENS.

Our specimens decidedly belong to a new genus. Among the Proboscidea there are at present two families, viz., Dinotheridæ and Elephantidæ. The former contains only one genus called *Dinotherium*, which is found in the upper and middle Miocene (or even in the Pliocene?) of Europe and the East Indies. The animals which are commonly known as elephants are all included in the latter family which comprises three genera *Mastodon*, *Stegodon* and *Elephas*. The chief characters which distinguish those families from one another seem to me to be the following :

- (1) In the Dinotheridæ a pair of incisors appear only in the lower jaw, and are directed vertically downwards in consequence of the abrupt downward flexure of the front part of the mandible, while in

the Elephantidæ they appear either only in the upper jaw as seen in *Elephas*, *Stegodon* and many species of *Mastodon*, or in both jaws as in some other species of *Mastodon*.

(2) In the Dinotheridæ the grinding surface of the molars is provided with very simple transverse ridges which are three in number in the first molar, and two in the other molars, and are entirely destitute of cement; while in the Elephantidæ the construction of the teeth is more complicated. Some species of *Mastodon*, in which the teeth show a very simple construction, have two or more transverse ridges with somewhat deeper valleys, and also show a tendency for each ridge to divide itself into a right and a left half, while most frequently these ridges are further subdivided into tubercle-like bosses. In *Elephas* the ridges become very numerous and are separated from one another by deep cleft-like valleys filled with thick cement, while in *Stegodon* the teeth present the transitional form between those of *Elephas* and *Mastodon*.

(3) In the Dinotheridæ all the teeth (two premolars and three molars) are simultaneously functional, while in the Elephantidæ there are no more than one or two in place and in use at all times.

Now examining the Japanese specimens, there are many characters which distinguish them from the two families above described. Indeed the distinction is quite as great as that existing between these two. The Japanese form has a great number of incisors, viz., one pair in the upper jaw and two pairs in the lower. Although the specimens seem to belong to a young form and the incisors are not yet perfectly developed, there is reason to believe that they will not develop so strongly as to form tusks which are seen in the above two families. In the fact that the premolars and molars are all simultaneously functional, they resemble *Dinotherium*, while their

peculiar form reminds us of the most primitive teeth of *Mastodon*. The great elongation of both jaws which are narrowed and quite flattened, the anterior position of the nasal foramen, and the much narrowed and compressed roots of the teeth are characters quite different from those of Proboscidea, if we except some very aberrant forms. In the Japanese form, the enamel is thick and covers the whole surface of the incisors. Such a case is never found in the hitherto described Proboscideans; *Stegodons*, most *Elephas* and the Pliocene *Mastodons* having no trace of enamel. The only cases in which the presence of enamel has been ascertained are those of some Miocene species of *Mastodons*, and of some *Elephas*. But in the former the enamel covers only the lateral side of the tusks as a longitudinal band, and in the latter it covers only the apex of the teeth which, however, soon wears away. Thus the great number of thickly enamelled small incisors and the most primitive form of premolars and molars which are all simultaneously functional, are the characters which make the Japanese fossil approach to the primitive Ungulata, from which Proboscidea is supposed to have descended. Our form also resembles, in some respects, certain Sirenia, viz., in the structure and number of incisors, in the bunodont character of the molars, in the thinning out of both jaw bones anteriorly, and in the protrusion of the upper jaw over the lower, &c. It is true that Sirenia has a close relationship with the Ungulata; its most primitive form, *Prorastomus*, having a great number of incisors, a pair of canines, and a smooth, straight and slender upper jaw, all which characters decidedly show its descent from an Ungulata like *Phenacodus* or *Tapirus*. LYDEKKER is of opinion that *Halitherium varonense* ZIG. is a form which has descended from an artiodactyle Ungulata with short-crowned and solenodont molar teeth. ZITTEL also mentions that the molars of Sirenia resemble partly those of the

*Tapirus* and partly those of the primitive hog or Condylarthra. So it is quite natural that there should exist some coincidence in the characters of the three orders of Sirenia, Proboscidea and Ungulata, and that our new form which shows very primitive characters of Proboscidea should also resemble the two other orders above mentioned.

We here express our great indebtedness to Professor H. F. OSBORN for the valuable hints given to us in his very kind letters during our investigations. Thanks are also due to Professors YOKOYAMA and WATASÉ for the trouble they have taken in revising our manuscript.

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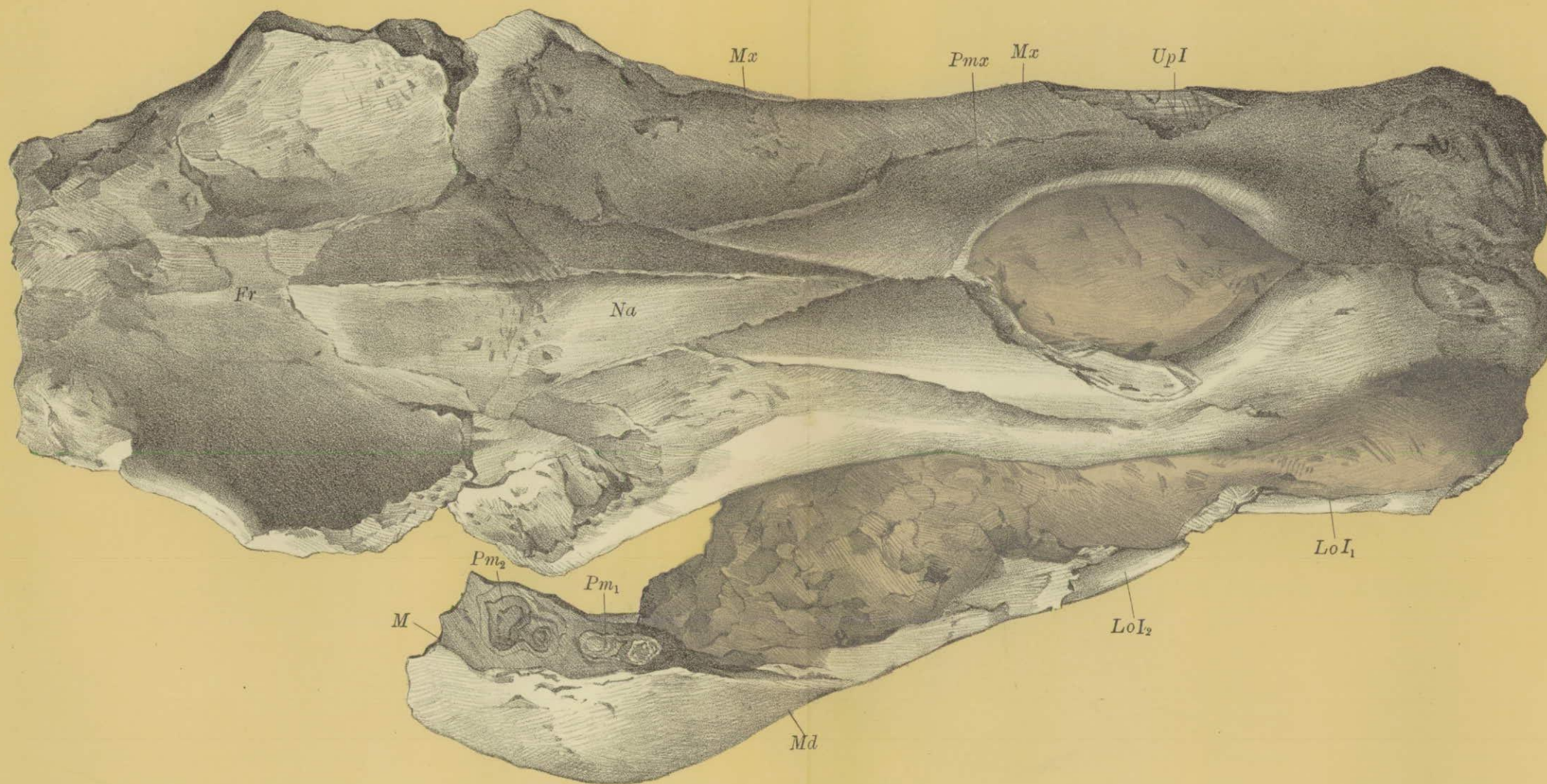
PLATE I.

## PLATE I.

Upper view of skull (reduced to one half of natural size).

Fr	Frontale.	Up I	Upper incisor.
Na	Nasale.	Lo I <sub>1</sub>	First lower incisor.
Pmx	Premaxillæ.	Lo I <sub>2</sub>	Second lower incisor.
Mx	Maxillæ.	Pm <sub>1</sub>	Root of first lower premolar.
Md	Mandible.	Pm <sub>2</sub>	Root of second lower premolar.
		M	Contacting position of lower molar.

Portion colored light purple showing sandstone matrix.



Ishizaki del.

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PLATE II.

## PLATE II.

Profile view of skull (reduced to one half of natural size).

Pmx	Premaxillæ.	L <sub>0</sub> I <sub>1</sub>	First lower incisor.
Mx	Maxillæ.	L <sub>0</sub> I <sub>2</sub>	Second lower incisor.
Or	Orbital foramen.	Pm	Upper premolar.
Md	Mandible.	M <sub>1</sub> & M <sub>2</sub>	Upper molars

Portion colored light purple showing sandstone matrix.



PLATE III.

### PLATE III

- Fig. 1 a & b. View of the masticating and outer surfaces of the first right lower premolar ; anterior surface on the right side of plate.
- Fig. 2 a & b. View of the masticating and outer surfaces of the second right lower premolar ; anterior surface on the right side of plate.
- Fig. 3 a & b. View of the masticating and outer surfaces of the second left lower premolar ; anterior surfaces on the left side of plate.
- Fig. 4. View of the masticating surface of the right upper premolar and the right upper molar ; anterior surface on the right side of plate.
- Fig. 5 a & b. View of the masticating and outer surfaces of the left lower molar ; anterior surface on the left side of plate.
- Fig. 6 a & b. View of the masticating and inner surfaces of the left upper molar ; anterior surface on the left side of plate.
- Fig. 7 a & b. View of the masticating and convex surfaces of the specimen from the province of Izumo.

All figures in natural size.



